APPRENTICESHIP ENGAGEMENT STRATEGY: A LOOK AT THE PATHWAY FROM SECONDARY TO POSTSECONDARY TO EMPLOYMENT

TN Department of Economic & Community Development

MIDDLE TENNESSEE STATE UNIVERSITY

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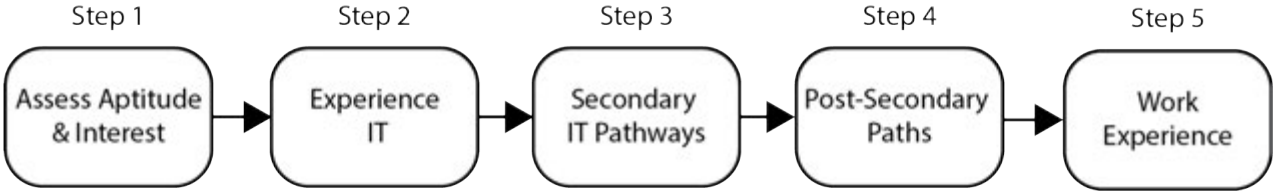
Executive Summary

This study focused on pathways from secondary to postsecondary schools and then on to work experience (full-time employment or an apprenticeship program). To accomplish this, the following individuals and organizations were contacted and interviewed with to determine the pipeline for getting more students into technology.

Individuals and organizations for this study:

- Companies that hire individuals for a technology related career
- Secondary school systems that teach CTE pathways
- Post-secondary educators and administrators
- Organizations that are developing or have developed apprenticeship programs

Other programs that pertain to pathways within technology and apprenticeship programs were also researched and included in this study. By interviewing and researching these entities it enabled this study to develop a five-step process for identifying individuals interested and that have an aptitude for technology pathways through secondary and postsecondary education and then on to an apprenticeship program that completes their technical skills to become an IT professional the state of Tennessee.



Steps from K-12 to Work Experience to attain Knowledge and Skills

This report starts by reviewing companies and the stakeholder meetings that were conducted (Section 1). It is then followed by a look at the labor market in the middle Tennessee area for technology and identifying the different levels of education needed for the jobs posted (Section 2). Section 3 looks at apprenticeship programs in Tennessee that pertain to technology and Section 4 looks at apprenticeship programs outside of Tennessee that have been successful either as a state-run organization or private entity with funding. Section 5 then reviews programs in secondary and postsecondary education as well as organizations, like the Rutherford Chamber of Commerce, that promote and develop programs for education.

Based on the analysis of Sections 1 - 5, a pathway from secondary to postsecondary to employment was identified (Section 6). Five different paths for education were explained in Section 6 that indicate different levels of knowledge and technical skills. The different levels

of knowledge range from low to highest and the different levels of skills range from low to medium. It is the assertion of this study that no educational pathway offers a student a high level of technical skills. This is not a fault within the educational system, it is merely an indication that to attain a high level of technical skills an individual must have the ability to practice this within a work environment, similar to an apprenticeship model.

Therefore, in Section 7 an implementation plan for piloting an apprenticeship model in Tennessee is proposed. It includes the explanation of the five-step process for identifying individuals to secondary and postsecondary education and on to an apprenticeship program.

This discovery process has been quite enlightening. It shows a need for all avenues of education and skills building to be used in order to fill the gap between job opportunities and IT career ready individuals. It is not the job of the four-year institution only, or the TCATs, but it is a combination of all possible educational pathways. This is especially emphasized by the wide variety of possible technology jobs where a different educational path might be needed. There is no one specific educational path or career trajectory that will get you ready for every job in technology, which is why all avenues of education are important.

To be IT career ready, it takes more than just skills or book knowledge. It is a well-rounded education that emphasizes soft skills, relevant content, technical skills, and an ability to work in a fast-paced environment that creates lifelong learners out of our next generation of IT professionals. A struggle within technology will always be that we are teaching technical skills that may be obsolete within a short timeframe. Therefore, the well-rounded educational experience will always put our students above any specific technology and allow them to pivot into anything new that might get forefront of technology in the future. The creation of the agile employee.

Future implementation and apprenticeship program should embrace Tennessee's current post-secondary educational opportunities. To develop customized partnership programs for every different technology or company will not scale and will not be affordable in the long term. However, by looking at other models that use their current educational partners within the state as well as industry partners, there will be a way for apprenticeship programs to succeed in the state of Tennessee.

Acknowledgements

This report and opportunity was made possible from a grant from Tennessee Department of Economic and Community Development. Special thanks to all companies, school systems and administrators that were willing to meet. Also, a thank you to MTSU and the newly formed Data Science Institute at MTSU, which gave the resources to allow for this project to happen.

This report also used Economic Modeling Specialists International (EMSI), which was used for the labor market data.

Section 1
Company Summaries and Stakeholder Meetings

To understand the business environment and the companies that look to hire entry-level employees, three companies were contacted and interviewed for this study: Tractor Supply, Trinisys, and HCA. Each company has a unique perspective in different business model, which means that there needs from an employee are unique and very challenging to find in the Nashville market.

The largest employer of IT talent in the Nashville market is HCA. With several different divisions and a large corporate infrastructure that is highly technical they employ well over 2000 IT professionals in Nashville. Tractor Supply is a fast-growing organization that continues to incorporate data and new technologies within their retail stores and corporate infrastructure. They seem to struggle with finding good talent and have resorted to hiring from outside of the state of Tennessee. One of their main areas that they go to attract talent is Chicago, Illinois. Trinisys is a small consulting and software company that is very flat in structure and has specific needs that are different than a large corporation. They offer a unique experience by allowing entry-level employees the ability to work in several different aspects of the business with many different individuals within the company as well as with customers. Tractor Supply and HCA normally hire individuals for specific tasks or technologies within their organizations, which is different than Trinysis.

The following is a summary of each of the meetings with these companies as well as their unique corporate structures and needs for entry-level talent. It is also noted within each of the summaries specific needs they need for an entry-level IT professional.

1.1 Tractor Supply Company

1.1.1 Who is Tractor Supply

Tractor Supply is an online retailer of home improvement, agriculture, garden maintenance and pet care products.

Tractor Supply's headquarters is in Brentwood, Tennessee. Tractor Supply has a revenue of $7.2B, and 14,000 employees. Tractor Supply's main competitors are PetSmart, Home Depot and Lowe's. As of August 2017, Tractor Supply has 4.7K fans on Facebook and 871.0K followers on Twitter[1].

Tractor Supply Company is the largest operator of rural lifestyle retail stores in America. Founded in 1938 as a mail order tractor parts business, Tractor Supply Company (also referred to as TSC) owns and operates over 1,700 stores in 49 states supplying basic maintenance products to home, land, pet and animal owners. Based in Brentwood, Tenn., Tractor Supply is a public company whose stock is traded on The NASDAQ National Market under the symbol TSCO.

The company was founded in 1938 as a mail order catalog business offering tractor parts to America's family farmers. Today Tractor Supply is a leading edge retailer with annual revenues of approximately $7.26 billion[2].

1.1.2 Meeting Summary (4/11/2018)

Who Attended

- Marcus Magee - IT Manager of Quality Assurance
- Gregg Zollinger - Manager of Business Intelligence
- Michael Browning - Information Security Manager
- Mark Duckworth - Director of Enterprise IT Infrastructure & Shared Services
- Geoff Edwards - Manager of Network Infrastructure Engineering
- Chris Dey - Manager of IT Cloud & Infrastructure Services
- Glen Wingerd - Director of IT Software Quality Assurance

[1] https://www.owler.com/company/tractorsupply
[2] https://www.tractorsupply.com/

Main points from Meeting

Several areas of IT were represented at this meeting. It became evident that the most important aspect of Tractor Supply is culture. Fitting into a unique environment is highly sought after for long-term viability within their organization.

The skills expected for an entry level professional

- Communication
- Time management
- The process of solving a problem
- Culture
- Driven to learn
- Technical skills are not expected, but knowledgeable in:
    - SQL - ability to pull data
    - Javascript or a different scripting language
    - HTML and CSS
- Since they have a proprietary software, any other technical skills may not be needed.

Observations for the path to a company like Tractor Supply

Tractor Supply is a large organization that struggles to find good talent. They not only are looking for individuals that can meet their technical rigor, but they also are looking for individuals that share in the vision of the company and embraces the culture. In almost every instance with each person that was represented at the meeting, the ability to work in a team environment was more important than technical skills. The most sought after technical skill is SQL since every application touches a database. This will continue to be evident as Tractor Supply does a better job of integrating their data and using it better to make predictions.

These findings speak to the need for entry level employees to be the following:

- IT career ready in terms of professionalism, where professionalism is:
    - Good communication and team skills
    - Understanding a business problem and the process for solving a problem
    - A lifelong learner
    - Someone that embraces a team and community-oriented culture
- Someone that has a passion for IT and continuous learning

1.2 Trinisys

1.2.1 Who is Trinisys

Trinisys provides enterprise data capture, data integration and web application solutions. Their headquarters are in Brentwood, Tennessee and have revenue of $5.2M and 25 employees.[3]

Trinisys continues to change the way organizations approach enterprise data management and workflow automation. Their core product, Convergence, enables sophisticated yet intuitive data conversion, disparate system integration, and web enabled workflow management by effectively and efficiently solving modern business problems.

Their success is based on the company's philosophy and culture that drives continuous innovation and delivers quality software focused on the needs of today's business environment. The power of the Convergence platform allows organizations to leverage integrations among disparate systems and automate intelligent workflow solutions in an intuitive and efficient manner – quickly.

Trinisys Clearview HRV builds upon the capabilities of the Convergence platform, enabling comprehensive and secure legacy system conversions and automated workflows for the nation's leading healthcare organizations.[4]

1.2.2 Meeting Summary (4/11/2018)

Who Attended

- Travis Gregg - Co-Founder/Principal
- Rachel Mitchell - Human Resource Manager
- Beth Hoeg - Chief Operating Officer

[3] https://www.owler.com/company/trinisys
[4] http://www.trinisys.com/about/

Main points from Meeting

Trinysis considers themselves a flat organization that must have employees that are productive (billable). They are a software company, but many employees are service oriented, which means communication and culture are a key to their organization. Although they are considered a small company, they identify the following as reason to work at Trinisys.

- Get to work on software.
- Team oriented and flat - get to work with high level executives on a daily. basis and as mentors.
- A lot of different tasks, never placed in a silo.
- Can see your contribution on a consistent basis.

It is not an easy task to bring in an inexperienced employee, however they have hired several entry-level employees from a 4-year degree.

The skills expected for an entry level professional

- Work in a team environment
- Communication skills with customers and higher-level management
- Solve a problem on their own
- Be willing to thrive in a culture that is more of a flat organizational structure
- Lifelong learner
- Technical skills are not expected, but knowledgeable in:
    - Some programming background
    - SQL - ability to pull data

Observations for the path to a company like Trinisys

Trinisys does expect a four-year degree for new employees. Employees interact with customers on a regular basis and they expect a certain level of business acumen. Entry level employees will come in as a business analyst or software developer and will be integrated within teams from the beginning. This culture can be intimidating for someone that is not adaptable to different technology and to different dynamics within a business. They were not interested in an apprenticeship program due to the nature of their business.

1.3 HCA Healthcare (Hospital Corporation of America)

1.3.1 Who is HCA

One of the nation's leading providers of healthcare services, HCA is made up of locally managed facilities that include 178 hospitals and 119 freestanding surgery centers located in 20 U.S. states and in the United Kingdom. [5]

HCA Information Technology and Services (IT&S) delivers healthcare IT products and services to HCA's portfolio of business and other pre-eminent healthcare brands, including Parallon Business Solutions, HealthTrust, Sarah Cannon Research Institute, and Workforce Solutions. Our services include business analysis, systems development and integration, information security, customer support, training and education, and infrastructure support.[6]

1.3.2 Meeting Summary (4/6/2018)

Who Attended

- Elizabeth Peyton - Manager of Enterprise Data Architecture at Corporate
- Robert Schley - Data Architect of Enterprise Data Architecture at Corporate
- Andrew Lyttle - AVP Product Development at Physician Services Group
- Loren Ashayeri - Application Engineer at Physician Services Group

Main points from Meeting

HCA is a unique company, in that it has many divisions within the corporation. It not only services its corporate environment, but it also has IT related companies such as Parallon, Health Trust, Sarah Cannon, and Workforce Solutions. The meeting on April 6th, included individuals from the enterprise data architecture at corporate and product development for physician services. These individuals tend to work in environments where their biggest challenge is data. Therefore, they have unique challenges when dealing with the need for new employees.

[5] https://hcahealthcare.com/about/hca-at-a-glance.dot
[6] https://hcahealthcare.com/careers/career-areas/corporate/it.dot

First and foremost, these two divisions are looking for individuals that understand data and its application within a business. This is normally not something that can be taught prior to employment at HCA. But, individuals that possess the ability to understand data structures as well as work in a team environment seem to be optimal for employment. In the past, these two divisions of HCA have hired many individuals from MTSU and these individuals have been successful in this type of environment.

Individuals form MTSU are hired in as:

- Data architects
- Application engineers
- Business intelligent analysts
- Data analysts
- Database administrators

It should be noted that in other divisions of HCA, MTSU students are hired in in many other capacities. For example, in the IT&S division, which is the corporate IT department, students are hired in in the same roles as listed above as well as IT auditors, security professionals, business analysts, and software developers.

Therefore, HCA offers a unique perspective on the hiring of students at the entry level as well as experienced IT professionals. They are by far the largest employer of IT professionals in the middle Tennessee region.

The skills expected for an entry level professional

- Data driven problem solving
- Work in a team-oriented environment
- Understanding complex data structures and providing real world
- Culture
- Lifelong learner
- Technical skills expected:
    - SQL - ability to pull data
- Technical skills preferred, but not required:
    - Some type of scripting language or programming logic
    - HTML and CSS
- Since they have a proprietary software, any other technical skills may not be needed.

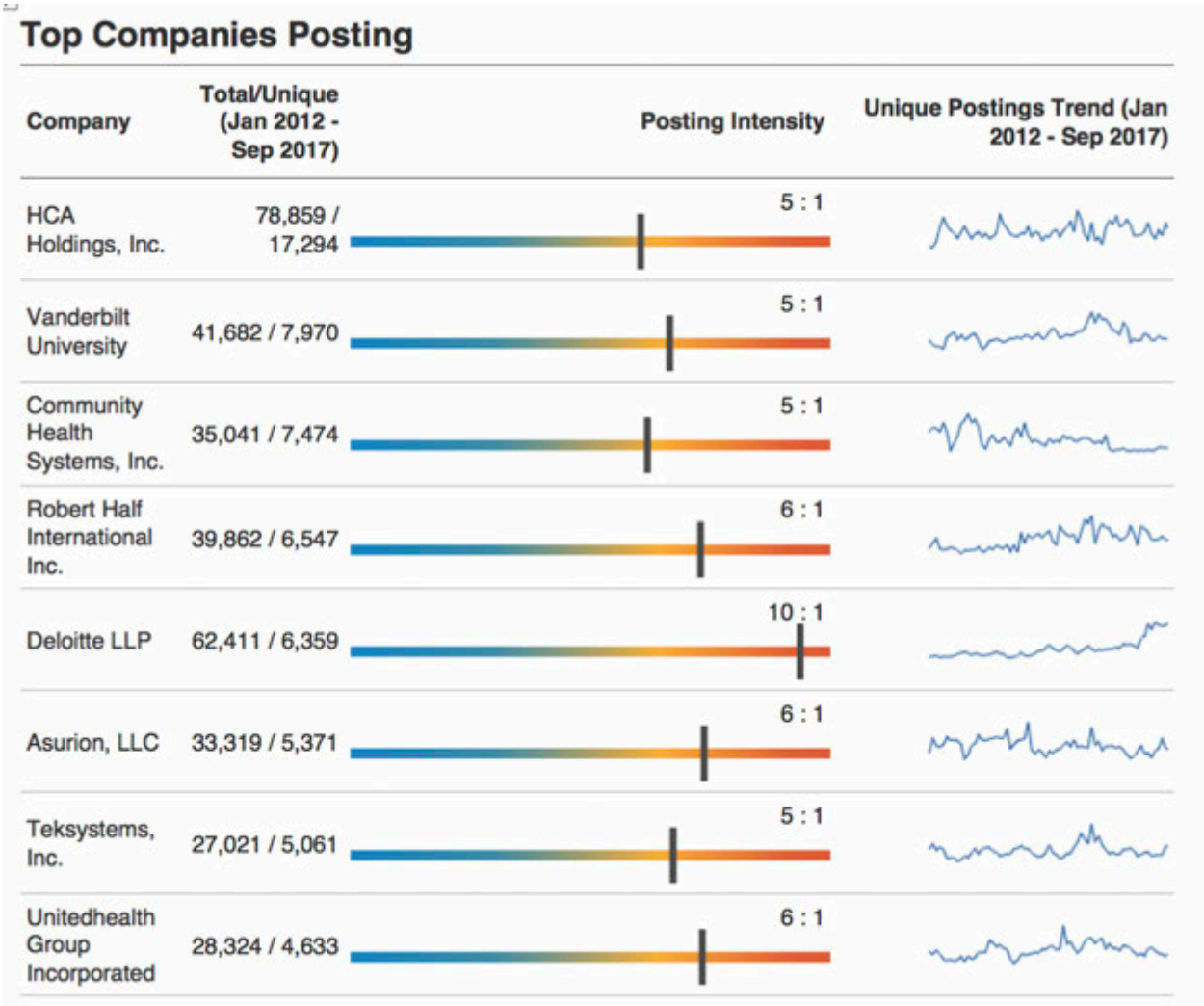


Figure 1: Total Job Postings in the Middle Tennessee region (2012-17)

Observations for the path to a company like HCA

There is no one direct path for working at HCA, since there are so many different divisions and areas within the corporation. According to Andrew Lyttle, the education skills are highly sought after but a specific degree is not required. In many instances, he has been able to take an individual with little to no technical background but a high business acumen and make them into a highly productive application developer. In many instances the hardest part is an individual understanding the business and its special challenges in terms of data, solving business problems, and being able to tell a story with the data. Therefore, the intrinsic qualities of an individual are more important than the technical skills.

Section 2
Labor Market Data for Middle Tennessee

To understand the labor market and the needs in terms of the IT workforce, it is important to look at the educational attainment of Tennesseans in the Nashville, Clarksville, Murfreesboro, and Franklin regions.

Region Groups

- 17300 Clarksville, TN-KY
- 34980 Nashville-Davidson--Murfreesboro--Franklin, TN

The list of job occupations was selected based on a careful analysis with the help of Middle Tennessee State University and the Nashville Technology Council. The basis of the groups is CompTIA occupation codes that are used for their reports. The CompTIA list includes 50 occupation codes. After careful review of the list, which includes trades and occupations that did not specifically relate to technology related careers, for example Architectural and Engineering Managers, the list was paired down to 27 occupation codes.

The need for more talent is quite evident when looking at the unique job postings compared to positions filled. Over a 12-month average, Figure 2 indicates a large gap between unique postings and jobs filled. For example, for April 2018, there were 7,708 unique postings and only 2,537 positions filled.

Occupation Codes

11-3021 - Computer and Information Systems Managers
13-1111 - Management Analysts
13-1161 - Market Research Analysts and Marketing Specialists
13-1199 - Business Operations Specialists, All Other
15-1111 - Computer and Information Research Scientists
15-1121 - Computer Systems Analysts
15-1122 - Information Security Analysts
15-1131 - Computer Programmers
15-1132 - Software Developers, Applications
15-1133 - Software Developers, Systems Software
15-1134 - Web Developers
15-1141 - Database Administrators
15-1142 - Network and Computer Systems Administrators
15-1143 - Computer Network Architects
15-1151 - Computer User Support Specialists
15-1152 - Computer Network Support Specialists
15-1199 - Computer Occupations, All Other
15-2031 - Operations Research Analysts
15-2041 - Statisticians
17-2061 - Computer Hardware Engineers
17-2199 - Engineers, All Other
19-3022 - Survey Researchers
27-1014 - Multimedia Artists and Animators
27-1024 - Graphic Designers

Figure 2: Unique Job Posting Compared to Positions Filled[7]

Fortunately, the individuals ready to retire is lower than the national average, but the racial and gender diversity lag the national average. Therefore, the need for a more diverse talent pool is vital and a source for opportunity for future IT professionals.

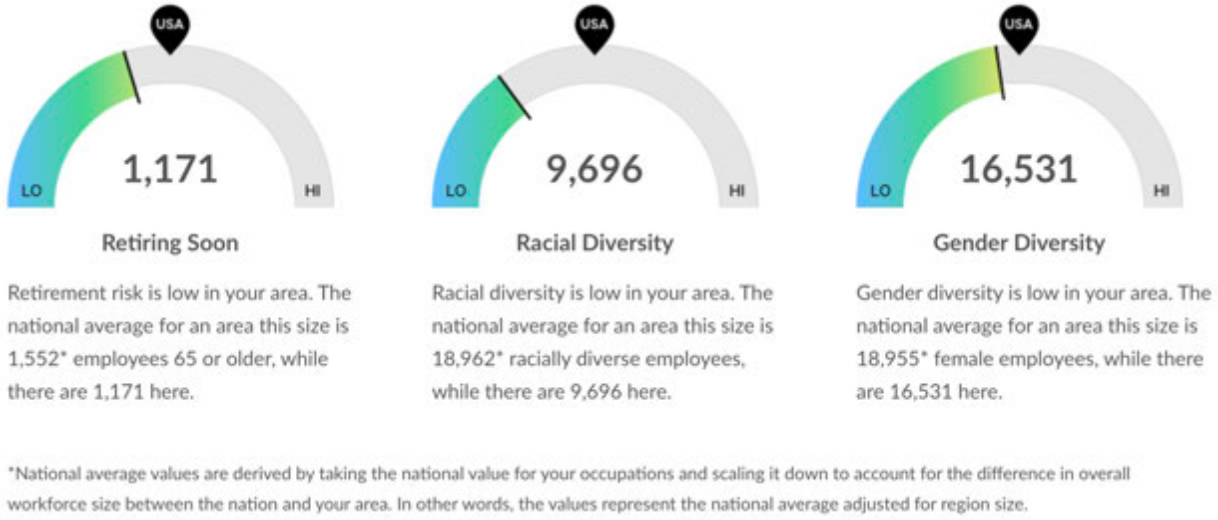


Figure 3: Unique Job Posting Compared to Positions Filled[8]

[7] EMSI – Occupational Report – Retrieved May 2018 – Region and Occupation Codes set as described in this report
[8] EMSI – Occupational Report – Retrieved May 2018 – Region and Occupation Codes set as described t

To understand the differences in degrees wanted, a snapshot of the job postings from September 2017 were aggregated and divided based on degrees. The count for each SOC code is based on job postings that ask for the desired level of education (Table 1). The counts are not mutually exclusive, since a job posting may ask for a Bachelor's Degree or Master's Degree, therefore a job posting may be counted more than once in the chart but it does give an indication of the desired education. The most popular is a Bachelor's Degree (3,445), compared to Master's (691), High School (492), Associate's (309), and PhD. (58).

Companies continue to look for a Bachelor's Degree or higher (83.4%). Therefore, the emphasis for education can be on attaining skills but companies still value the four-year or more education. It is also evident that the level of education does matter when looking at the wage earned

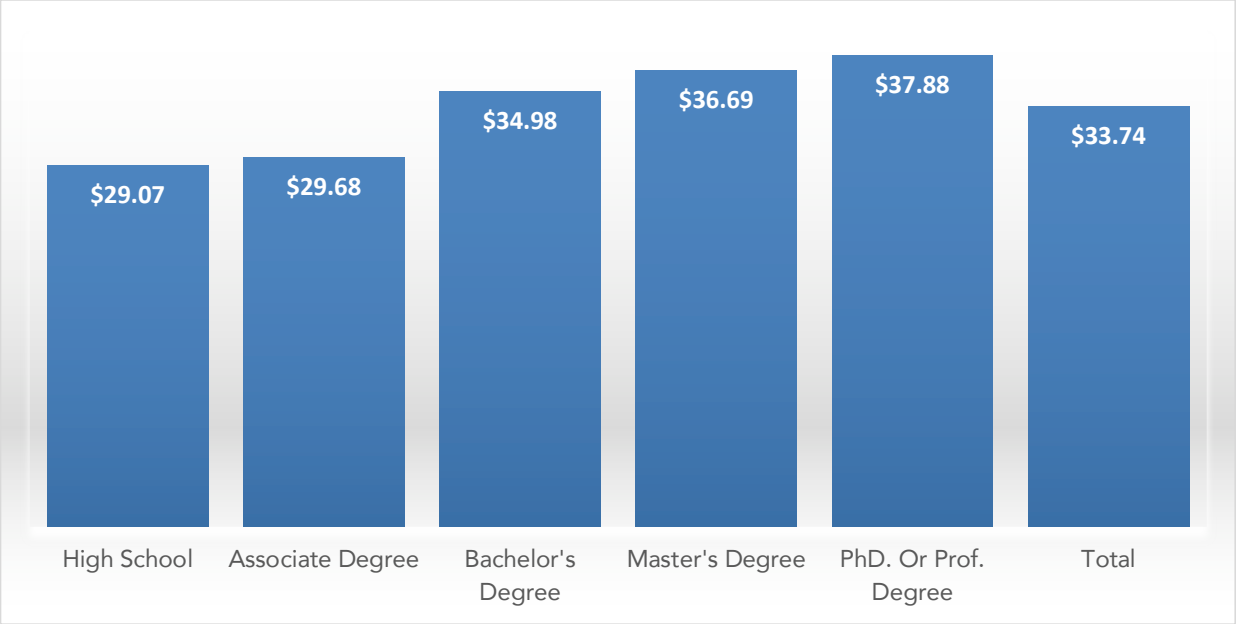


Figure 4: Hourly Wage for Each Job Posting Based on Education Level

It is also interesting to look at the varying wages per hour that a person in IT can make. This was calculated by taking the number of jobs per SOC per level of education and multiplying by median hourly earnings (MHE). The sum per education level was divided by the total number of jobs per education level to create an average hourly wage per education level, which is shown in Figure 4. The difference between an hourly wage from High School to Associate's Degree is only $0.61. However, it jumps from $29.68 to $34.98, which is over $10,000 annually. The difference is not as steep but continue to grow with the higher level of education.

Table 1: Job Postings based on SOC Codes and Divided by Education Level[9]

SOC	Description	High School	Associate Degree	Bachelor's Degree	Master's Degree	PhD.	MHE
15-1151	Computer User Support Specialists	205	138	236	22	2	$23.55
15-1132	Software Developers, Applications	18	11	467	94	9	$41.94
15-1199	Computer Occupations, All Other	25	14	459	92	6	$33.46
13-1111	Management Analysts	38	17	373	87	6	$35.47
15-1121	Computer Systems Analysts	18	26	395	46	3	$33.87
15-1142	Network and Computer Systems Administrators	30	43	248	25	4	$38.39
15-1122	Information Security Analysts	9	3	231	60	4	$36.47
13-1199	Business Operations Specialists, All Other	63	16	180	41	3	$27.39
11-3021	Computer and Information Systems Managers	13	4	189	93	2	$48.90
13-1161	Market Research Analysts and Marketing Specialists	21	13	188	40	3	$26.66
15-1134	Web Developers	12	5	131	11	0	$27.54
15-2031	Operations Research Analysts	13	4	71	14	0	$33.82
15-1141	Database Administrators	2	3	78	16	0	$41.15
15-1131	Computer Programmers	3	4	65	8	0	$34.01
27-1024	Graphic Designers	13	3	34	4	0	$22.35
15-1143	Computer Network Architects	1	2	38	5	1	$47.98
15-2041	Statisticians	2	0	13	13	3	$31.90
17-2199	Engineers, All Other	1	0	21	3	1	$34.82
15-1133	Software Developers, Systems Software	0	0	18	5	1	$40.42
15-1111	Computer and Information Research Scientists	1	0	2	9	9	$48.47
15-1152	Computer Network Support Specialists	2	2	5	1	0	$30.40
17-2061	Computer Hardware Engineers	0	0	3	1	1	$42.89
19-3022	Survey Researchers	2	1	0	0	0	$11.50
43-9011	Computer Operators	0	0	0	1	0	$21.19
27-1014	Multimedia Artists and Animators	0	0	0	0	0	$24.05
43-9031	Desktop Publishers	0	0	0	0	0	$24.02

Note: MHE refers to Median Hourly Earnings

[9] EMSI – Job Posting Occupational Table – Retrieved May 2018 – Region and Occupation Codes set as described

As evident by the data presented in this section, the education requirements per job varies quite drastically. When although the most common requirement is a bachelor's degree, there are still many other jobs that do not require that level of education. For example, the computer user support specialist mostly requires a high school education or an associate's degree with a median hourly wage of $23.55. Although this is considered a low median hourly wage for a technology career, it still equates to a respectable annual salary. Therefore, an individual with an associate's degree or less has an opportunity for a well-paying job, as indicated in Figure 4 at about $29 per hour. It was also quite telling to see the drastic difference in hourly wage between associate's degree and bachelor's degree, at $5.30, which indicates that in order to earn a high wage a four-year degree is desired.

Section 3
Apprenticeship Programs in Middle Tennessee

3.1 Apprenti Tennessee

In a response to growing need for IT talent in the middle Tennessee market, the Nashville Technology Council Foundation (NTCF) is launching the first technology apprenticeship program in Tennessee. This program, Apprenti Tennessee, is based on the successful experience of the Washington Technology Industry Association (WTIA) in Seattle. They launched the original Apprenti program in 2015. Unlike traditional job-training options, Apprenti Tennessee combines education and paid on-the-job training for placement in a high paying, high-skill occupation. The program works with tech employers to identify mid-tier jobs ready to be filled by highly competent people — regardless of educational background. With the tech industry seeking to diversify its workforce, Apprenti Tennessee will actively recruit women, minorities and veterans — although anyone is eligible to apply.

Program design is inclusive and builds upon Nashville's current assets to offer a solution to close the tech skills gap. This program partners with existing training providers (e.g., Nashville Software School) to provide high quality, accelerated skill building. The classroom training period will be 12-24 weeks depending on occupational track. The apprentice will then be placed with a hiring partner for one year of paid on-the-job training. During those 12 months, they will begin at a training wage at least 60 percent of fully-qualified regular employees, which will increase over the year of apprenticeship.

Time-to-market and sustainability were critical factors in the decision of NTCF to partner with WTIA and Apprenti. From the beginning, Apprenti has been structured with the goal of national expansion in-mind. The Apprenti program is both scalable and repeatable. Although piloted in Nashville with three occupation tracks in 2018, NTCF intends to scale to other Tennessee communities and additional tech occupations thereafter.

Apprenti Tennessee is projected to be self-sustaining after three years. Funding for the apprenticeship program will come from multiple sources. One is through the $2,500 administrative fee charged to the hiring partner for each apprentice hired for assessing, placing and tracking of apprentices throughout the program. Another is public funds available for

training through the local workforce agencies throughout Tennessee. Additionally, corporate partners have invested $330,000 to date for the launch of the program. NTCF is also currently seeking funding through other private partners, national and local foundations, and government grants to meet the additional $500,000 of funding required to complete the three-year pilot.

3.1.1 Program Design [10]

Utilizing the successful framework developed by Apprenti, tech employers in Middle Tennessee can take advantage of the time-tested method of apprenticeship for bolstering their ranks with a diverse, well trained, and experienced talent pool, and those interested in starting a career in the high-paying field of information technology will have a path to do so.

Those that make it into the program and successfully complete their front-loaded technical training and 2,000 hours (or one year) of OJT can expect to earn the going rate for entry level positions in their chosen occupation.

As an affiliate partner of Apprenti, NTCF will be able to leverage several resources to assist with the implementation and operation of the Apprenti program in Tennessee:

- An interactive assessment portal which will include use of a comprehensive skills assessment, localized reporting, and an apprenticeship document storage database;
- Training and access to a CRM to manage hiring, community, and training partners;
- Sales and outreach assistance including cultivation and outreach strategy, PR and social media strategy,
  and templates and outreach materials;
- Documentation such as program operations manual, apprenticeship handbook, standardized contracts
  for apprenticeship and hiring partners, and surveys to monitor employer satisfaction and apprentice
  performance; and
- Sharing of best practices.

Candidate Evaluation:

Guided by Apprenti's commitment to increase access to high-paying information technology jobs for minorities, women, and veterans, is a unique and comprehensive on-boarding process. That process begins with the completion of a basic online profile through the Apprenti Tennessee portal, which will be accessible through the apprenticeship section of the NTC website. This on-boarding process does not require a candidate to disclose any education or employment background, rather a candidate is evaluated through an online assessment,

[10] Nashville Technology Council Foundation, "Business Plan for Apprenti Tennessee", April 2018.

followed by a series of phone and direct interviews. At no point in the process is the hiring partner allowed to inquire about past work or education experience.

The online assessment, developed to identify individuals with the potential to succeed in high demand information technology career pathways, tests the candidate's competencies in math and logic, critical thinking, and emotional intelligence. If the assessment is passed successfully, the applicant is moved into a ranking system, based on their assessment scores, and the highest-ranking candidates move forward into the interviewing process.

The applicant will then participate in a face-to-face interview with Apprenti Tennessee staff. This interview will also be used as an opportunity to work with the candidate to optimize the chances of success in the hiring partner interview to follow.

Apprentice On-Boarding:

Once the hiring partner interview is successful, the candidate and hiring partner will then sign a contingent contract (the contingency being that the candidate successfully completes the front-end training associated with the occupation of need). Following the signing of the contingent contract, depending on the field chosen, the new apprentice will receive two to five months of technical training followed by one-year (2,000 hours) of full-time, paid, OJT training in the occupation being sought by the hiring partner(s). Upon completion of the OJT portion of the apprenticeship, the apprentice becomes a journeyman in their occupation and receives a journeyman card that will be recognized as a national, portable certificate of occupational competence.

Hiring Partner Responsibilities:

As a registered apprenticeship program, Apprenti is required by law to meet the parameters established by the National Apprenticeship Act to protect the welfare of the apprentice. Hiring partners affiliated with Apprenti will need to commit to following the Standards of Apprenticeship, including but not limited to, supervision and one-to-one mentorship of apprentice for OJT training, paying apprentices 60% of entry-level salary (depending on market) plus benefits for one year with a 10% raise after six months based on improved proficiency, and providing OJT instruction and experience as is necessary to become a qualified journey- level worker in the agreed upon occupation.
This agreement is solidified with the signing of a memorandum of understanding (MOU) by the hiring partner. Apprenti Tennessee will act as the Apprenticeship Intermediary - managing the apprentice employment process, maintaining documentation and fulfilling statutory reporting requirements for all apprentices registered in the Apprenti program.
The hiring partner is also responsible for identifying the number of apprentices needed by occupation as well as identifying the desired start dates for the apprentices selected. Hiring partners will also be required to pay a placement fee of $2,500 per apprentice to cover administrative costs associated with all clerical duties, including, but not limited to recruiting,

placing and tracking of apprentices, and meeting government reporting requirements, which are managed by Apprenti and NTCF personnel.

Training Partner Requirements:

To be considered as a training partner with Apprenti Tennessee, the training partner must be certified by the Department of Veterans Affairs. Once approved, the training partner must sign a master services agreement (MSA). Upon signing the MSA, the training partner agrees to the following:

- The curriculum developed by the training partner must meet or exceed the professional competencies established by any applicable testing or certification providers and meet or exceed the content coverage of vendor-specific reference courses (e.g., Microsoft Official Academic Course standards, Cisco, CompTIA, etc. competencies) and that all instructors are qualified and experienced in the subject matter undertaken by Apprenti students

- The training partner will provide adequate physical facilities, computing hardware, and software licensing to accomplish the learning outcomes of the training programs

- The training partner will honor the minimum hours and content coverage required to satisfy completion of the training program as agreed, and will supply NTCF with all required progress, attendance, academic performance (including grades), and exam results data related to Apprenti students upon request.

3.2 FastTrack'D Program

The FastTrack'D program from Cook Systems[11] trains and develops individuals to possess the necessary technical and interpersonal skills to embark on a successful software development career - with no upfront costs.

3.2.1 Overview of Program

Over a 9-week intensive training course, candidates will master full stack web development in a challenging, rewarding and team-centered learning environment.

Candidates will also develop key skills beyond learning code. Over our 30 years in business we've seen first-hand that great developers need other valuable skills, which is why we focus on the following areas:

1 - Team Leadership
2 - Effective Communication
3 - Problem Solving

Graduates are hired into full time development positions (with benefits) upon deployment to client locations across the US.

Job Requirements
Requirements:

- Eligibility for Full Time US Employment
- Open to Relocation within the US
- Technical Aptitude

Placement Process:

- Application
- Screening Assessments
- Instructor Interviews
- Registration and Training
- Graduation and Deployment

[11] https://cooksys.com/

3.2.2 How the FastTrack'D Application Process Works[12]

Phase 1 - Application

- All candidates can apply for the FastTrack'D program using a form on their website.
- Once the application is successfully submitted, a confirmation email will be sent with next steps.

Phase 2 - Predictive Index

Two online aptitude assessments are used to help determine which candidates are the best fit for the FastTrack'D program.

- Candidates will receive an email from The Predictive Index[13] for 2 online tests which will need to be completed in 24 hours.
- Assessment 1 - PI Cognitive
    - The PI Cognitive Assessment is a 50 question, 12 minute timed test. Answer as many questions as possible in the time given.
- Assessment 2 - PI Behavioral
    - The PI Behavioral Assessment is an untimed assessment, but it's helpful to complete it in a quiet place without distraction.

Phase 3 - Technical Assessment

- If the Predictive Index Assessments show that the candidate is a good fit for the program, they will receive an email to take a technical assessment.
- The technical assessment is centered around solving simple problems programmatically.
- From the time the assessment is sent, the candidate has 24 hours to begin.

Phase 4 - Technical Interview

- If the candidate successfully passes their technical assessment, they will receive an email to schedule a technical interview with an instructor.
- The candidate will complete live coding challenges given by the instructor during the interview.

Phase 5 - Interpersonal Interview

- If the candidate passes the technical interview, they will receive an email to schedule an interpersonal interview with a recruiter.
- The interview is a personal conversation that will cover several life areas and scenarios for us to get to know the candidates better.

Phase 6 - Acceptance / Pre-Class Prep

- If the candidate successfully passes both interviews, they will be offered an invite to join the class!
- The recruiter will discuss training and placement agreements, background and drug screening, class location, room and board, orientation details, and any other pertinent information the candidate would need to know prior to the start of class.

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[12] https://cooksys.com/fasttrackd-application-process/

[13] https://www.predictiveindex.com/

Section 4
Apprenticeship Programs Across the United States

This section includes apprenticeship programs from outside of Tennessee. Although several programs could be considered private, such as the Apprenti, there are also several states run their own apprenticeship programs and use their technical schools for skills training. This section tries to show a few different types of programs that have been successful over the years and how the state of Tennessee can learn from their processes.

First, Apprenti from the state of Washington is reviewed. It received Federal funding but is considered an organization that is separate from the state. They do have a few large employers which makes it easier to recruit jobs for the trainees. Next, Apprenticeship Carolina is reviewed. This has become more of a standard for apprenticeship programs and is only 10 years old with over 900 apprenticeship programs within the state which are serviced by 16 technical colleges. Finally, California's program is reviewed. This has been around since 1938, which makes it one of the oldest in the country. Their successes are shared.

4.1 Apprenti – Washington State

Apprenti[14] was developed by The Washington Technology Industry Association (WTIA) to address the tech workforce shortage facing the State of Washington and identify diverse talent to meet industry needs. This is also the model for the Nashville Technology Council's Apprenti Tennessee program. The federal funding and private investments enabled WTIA to establish an industry-supported apprenticeship program in September of 2015. In September of 2016, Apprenti was awarded an additional grant to expand nationwide to address the talent needs of the tech industry nationally.

Apprenti expanded first to Oregon, Virginia and Michigan, and now to Tennessee. The expansion follows Apprenti's success with the State of Washington pilot program, which received almost 6,000 applicants and placed over 200 apprentices into technology roles since it launched.

[14] https://apprenticareers.org/

Apprentices are currently working at Amazon, Microsoft, Avvo, Comtech, F5 Networks, Silicon Mechanics, and Accenture. These apprentices are in the positions of web developer, software developer, network security administrator, Windows system administrator, Linux system administrator, cloud support specialist, data center technician, and IT support.

According to recently released data by the Apprenti national team regarding the demographics of current apprentices in the Seattle program, 40% are women, almost doubling the percentage currently found in IT occupations across the nation which is at 26%. The percentage of Black/African Americans presently on the job in the program are at 13%, five points higher than the national average which is approximately 8%. The on-the-job training (OJT) apprentice has seen their salary increase by average of over $30,000, and an average starting salary of $49,097.

4.1.1 Types of training and certificates:

- Database Administrator - MCSA/E from Microsoft
- Project Manager - CAPM, prep for PMP
- Network Security Administrator - CCNA/P from Cisco
- Web Developer - Through local best-aligned coding academy
- Software Developer - Through local best-aligned coding academy
- Windows Systems Administrator - MCSA/E from Microsoft
- Linux Systems Administrator - LPIC 1, 2, and 3
- Cloud Support Specialist - Network+, MCSA in SQL, Linux+, Security+
- Data Center Technician - A+, Network+, Server+, Linux+
- IT Business Analyst - ITIL, MTA, MCSA in SQL, Linux+, Security+

4.1.2 Steps for the Accelerated Career Path for Apprenti[15]

- Step 1 - Take the competency assessment. [16]Applicants must be at least 18 years old with a high school diploma (or equivalent) and a United States citizen or permanent legal resident.
- Step 2 - Receive information about your assessment test performance. Top ranked candidates will be invited to interview with staff when apprenticeship opportunities are available.
- Step 3 - If you interview well with staff, you will be invited to a hiring partner interview based on occupational suitability and hiring partner demand. Prepare for your in-person

[15] http://apprenticareers.org/apply/#1489120145402-d2f0279a-58f4
[16] https://portal.apprenticareers.org/

Table 2: Different Accelerated Training Option for Apprenti

Accelerated Training	Description	Required Certifications	Continuing Certifications	Length
Project Manager	Learn to plan, execute, and manage projects.	CAPM or PMP	CAPM or PMP	8 weeks
Network Security Administrator	Learn to install and configure firewalls and routers; monitor security, configure and troubleshoot systems.	CCENT, CCNA	CCNP, SSCP	12 weeks
Software Developer	Learn to design, develop, and deploy software applications.	None	None	22 weeks
Web Developer	Learn to design, develop, and deploy web applications.	None	None	22 weeks
Windows Systems Administrator	Maintain, configure and ensure the reliable operation of Windows-based systems.	MTA - WSA, MCSA, Server 2012	MCSE, Productivity	13 weeks
Linux Systems Administrator	Maintain, configure and ensure the reliable operation of Linux-based systems	Network+, LPIC 1 and 2	LPIC 3	12 weeks
Cloud Support Specialist 1	Investigate and resolve problems with cloud applications in collaboration with systems engineers.	Network+	Linux+	12 weeks
Cloud Support Specialist 2	Investigate and resolve problems with cloud applications in collaboration with systems engineers.	Network+	Linux+ and proprietary expert level certification	12 weeks
Data Center Technician	Troubleshoot and repair servers, including hardware and network issues.	A+, Network+	Server+ and Linux+	12 weeks
IT Business Analyst	Facilitate reporting, identify trends, and develop business cases based on data provided by tech. systems.	ITIL and MTA in SQL	Tableau Associate	12 weeks
Network Operations Developer (Dev Ops)	Help create a network that is not only available with high levels of reliability, performance and security, but is also agile in configuration, capacity and operations.	Network+	Linux+ and proprietary expert level certification	13 weeks

interview by researching the hiring companies and practicing responses to sample interview questions.

- Step 4 - Attend an interview with one or more hiring partners.
- Step 5 - If you've been selected by a hiring partner for an apprenticeship, Apprenti will notify you and provide information about your start date and the technical courses required.
- Step 6 - After successfully completing your courses, you'll be placed with a hiring partner for one year of paid on-the-job training.

4.1.3 Job Descriptions[17]

Project Manager

- Learn to plan, execute, and manage projects. Project Managers will be trained to monitor project risk, quality, and identify solutions with stakeholders to keep projects on track.
- Required Certifications to Begin Paid On-the-Job Training
    - Certified Associate Project Manager (CAPM) or Project Management Professional (PMP)
- Continuing Education Certifications
    - Certified Associate Project Manager (CAPM) or Project Management Professional (PMP)
- Length – 8 weeks
    - Apprentices must pass the CAPM exam before beginning paid on-the-job training. After apprentices have accrued the required 4,500-7,500 hours of project management experience, they will be eligible to receive their PMP.

Network Security Administrator

- Learn to install and configure firewalls and routers; monitor security, configure and troubleshoot network systems.
- Required Certifications to Begin Paid On-the-Job Training
    - Cisco Certified Entry Networking Technician (CCENT), Cisco Certified Network Associate (CCNA)
- Continuing Education Certifications
    - Cisco Certified Network Professional (CCNP), Systems Security Certified Practitioner (SSCP)
- Length – 12 weeks
    - Apprentices must complete required certification before beginning paid on-the-job training. Coursework for the CCNP and SSCP will be completed before on-the-job training. Apprentices will have a year to complete their CCNP and SSCP exams.

[17] http://apprenticareers.org/apply/#1489120145402-d2f0279a-58f4

Software Developer

- Learn to design, develop, and deploy software applications. Develop and write code, test and fix bugs.
- Length – 22 weeks

Web Developer

- Learn to design, develop, and deploy web applications. Develop and write code, test and fix bugs.
- Length – 22 weeks

Windows Systems Administrator

- Maintain, configure and ensure the reliable operation of Windows-based systems.
- Required Certifications to Begin Paid On-the-Job Training
    - Microsoft Technology Associate (MTA, Windows Server Administration), Microsoft Certified Solutions Associate (MCSA, Server 2012)
- Continuing Education Certifications
    - Microsoft Certified Solutions Expert (MCSE, Productivity)
- Length - 13 weeks
    - Apprentices must complete required certifications before beginning paid on-the-job training. Coursework for the MCSE will be completed before the on-the-job training, however apprentices will have a year to complete the MCSE exams.

Linux Systems Administrator

- Maintain, configure and ensure the reliable operation of Linux-based systems
- Required Certifications to Begin Paid On-the-Job Training
    - Network+, LPIC 1 and 2
- Continuing Education Certifications
    - LPIC 3
- Length - 12 weeks
    - Apprentices must complete required certifications before beginning paid on-the-job training.

Cloud Support Specialist 1

- Investigate and resolve problems with deployed cloud applications in collaboration with systems engineers.
- Required Certifications to Begin Paid On-the-Job Training
    - Network+
- Continuing Education Certifications
    - Linux+
- Length - 12 weeks

    - Apprentices must complete required certifications before beginning paid on-the-job training.

Cloud Support Specialist 2

- Investigate and resolve problems with deployed cloud applications in collaboration with systems engineers.
- Required Certifications to Begin Paid On-the-Job Training
    - Network+
- Continuing Education Certifications
    - Linux+ and proprietary expert level certification such as AWS Solutions Architect Certification
- Length - 12 weeks
    - Apprentices must complete required certifications before beginning paid on-the-job training.

Data Center Technician

- Troubleshoot and repair servers, including hardware and network issues.
- Required Certifications to Begin Paid On-the-Job Training
    - A+, Network+
- Continuing Education Certifications
    - Server+ and Linux+
- Length - 12 weeks
    - Apprentices must complete required certifications before beginning paid on-the-job training.

IT Business Analyst

- Facilitate reporting, identify trends, and develop business cases based on data provided by technology systems.
- Required Certifications to Begin Paid On-the-Job Training
    - ITIL and MTA in SQL
- Continuing Education Certifications
    - Tableau Associate
- Length - 12 weeks
    - Apprentices must complete required certifications before beginning paid on-the-job training.

Network Operations Developer (Dev Ops)

- Help create a network that is not only available with high levels of reliability, performance and security, but is also agile in configuration, capacity and operations.
- Required Certifications to Begin Paid On-the-Job Training
    - Network+
- Continuing Education Certifications

    - Linux+ and proprietary expert level certification such as AWS Solutions Architect Certification
- Length - 13 weeks
    - Apprentices must complete required certifications before beginning paid on-the-job training. Coursework for the MCSE will be completed before the on-the-job training, however apprentices will have a year to complete the MCSE exams.

4.2 Apprenticeship Carolina

Apprenticeship Carolina, a division of the SC Technical College System, works to ensure all employers in South Carolina have access to the information and technical assistance they need to create demand-driven registered apprenticeship programs.

At no cost to the employer, apprenticeship consultants are available to guide companies through the registered apprenticeship development process from initial information to full recognition in the national Registered Apprenticeship System.[18]

Targeted Industry Clusters

- Advanced Manufacturing
- Construction Technologies
- Energy
- Healthcare
- Information Technology
- Tourism & Service Industries
- Transportation, Distribution & Logistics

Apprentices

The process for the student to pursue an apprenticeship program is to contact a registered program specialist then helps them find the appropriate technical college. They can choose from several different paths, including computer technology. A student enrolled in a computer technology path will learn core skills including:

- Computer hardware and operating systems
- Microsoft Office suite
- Network terms and concepts
- Programming terms and concepts
- Technical support concepts
- Entry level Visual Basic.NET and Microsoft SQL Server
- Business analyst systems and procedures

[18] http://www.apprenticeshipcarolina.com/about.html

They will also have the ability to earn certifications from Microsoft, CompTIA, and Cisco.

4.2.1 Employers

The SC Technical College System has a total of 16 technical colleges and each one participates in the apprenticeship program. This program seems to focus more on the employer than the students. However, it does allow an apprenticeship program to scale statewide.

For an employer to sign up for this program, they will work directly with a consultant that helps them understand the apprenticeship training model, identify existing models of interest, connect them with appropriate resources, and help them submit the paperwork to the USDOL. This is all at no cost to the employer.

Benefits to an employer[19]

The combination of customized job-related education and supervised on-the-job learning provides a number of benefits for participating employers.

- Highly-Skilled Workforce
  - On-the-job training along with job-related educational instruction gives employees a full understanding of their job — both the "how" and the "why". Employees clearly see the impact their actions have on such important measures as productivity, quality, safety and customer service.
- State Tax Credit
  - Eligible businesses can receive a South Carolina tax credit of $1,000 per apprentice per year for up to four years.
- Standardized Training
  - Registered apprenticeship provides an opportunity for employers to build a structured, consistent training program that ensures reliable workforce performance that meets both organization and industry standards.
- Reduced Turnover
  - Organizations committed to investing in their workforce experience increased employee motivation and morale. Companies sponsoring registered

[19] http://www.apprenticeshipcarolina.com/employer-benefits.html

apprenticeship programs often enjoy a cluster of loyal, skilled workers who represent potential leaders for the organization.

- Increased Productivity
  - As apprenticeship participants hone their skills, employers experience a noticeable contribution to the bottom line through higher quality levels and productivity. Employees have a deeper understanding of their jobs and use this knowledge to best meet the business needs of your organization.
- A Reliable Plan for the Future
  - As many industries face an aging workforce, registered apprenticeship ensures a system structured to successfully facilitate the transfer of knowledge from experienced employees to new recruits.

The program has been in existence since 2007. Since that time 918 apprenticeship programs have been started with a total of 26,864 total apprenticeship served with 14,475 currently active apprentices.[20]

Observations of this model for an apprenticeship program

This seems to be a good model that is scalable statewide. It is very similar to the TCAT system, but it encourages employers to develop a formalized apprenticeship program. Based on the targeted industry clusters, they seem to be hitting the high demand for jobs areas, including information technology. The student would be going directly to one of their 16 technical colleges, which gives them the flexibility and opportunity to pursue an apprenticeship program in all regions within South Carolina.

[20] http://www.apprenticeshipcarolina.com/index.html

4.3 California Apprenticeship Council (CAC)

The state of California has an apprenticeship program through its Department of Industrial Relations. The number of apprenticeship programs is quite extensive and is commissioned through the California Apprenticeship Council (CAC).

The CAC was established by the Shelley-Maloney Apprentice Labor Standards Act of 1939. The council holds an open quarterly meeting to conduct the business of apprenticeship in California and fulfill its statutory responsibilities: providing policy advice on apprenticeship matters to the Director of the Department of Industrial Relations, issuing rules and regulations on specific apprenticeship subjects to be published in the California Code of Regulations, and conducting appeals hearings.

As the administrator of apprenticeship, DIR's Director investigates and issues determinations regarding apprentice disputes. The CAC hears appeals of these determinations.

Of the council's 17 members, 14 are appointed by the governor for four-year terms: six represent management, six represent labor, and two represent the public. The remaining three are ex officio members representing the chancellor of the California Community Colleges, the superintendent of public instruction, and DIR's Director. The chief of the Division of Apprenticeship Standards serves as secretary to the CAC, and DAS provides staff services.[21]

Apprenticeship Programs

To become an apprentice in the state of California, a student must find an available apprenticeship program that meets the minimum requirements, which includes age education physical requirements and any other requirements such as a driver's license being needed.

[21] https://www.dir.ca.gov/cac/cac.html

The following are information technology apprenticeship programs:

- Computer Support Specialist/Cybersecurity from the California Cybersecurity Apprenticeship Project (Ccap);
- Computer Support Specialist/Help Desk-Networking from the Able-Disabled Advocacy U.A.C.
- Computer Support Specialist-Cyber Security from the Able-Disabled Advocacy U.A.C.
- Cybersecurity Analyst from the Bay Area Cybersecurity Apprenticeship Committee
- Information Security Analyst from the City College Of San Francisco Information Security Analyst Apprenticeship Training Committee
- Internet Sales Manager from the Surplus Service

Example of an Apprenticeship Program - Cybersecurity Analyst[22]

An example of program requirements for one apprenticeship program is the Cybersecurity Analyst which is from the Bay Area Cybersecurity Apprenticeship Committee and managed by Transmosis (http://www.transmosis.com/). Some of the specifics include:

- Program length: 24 months
- Starting wage: $50,000 first year
- Minimum age: 18
- Education prerequisites: High School/Ged/Equivalent
- Exams: Written and Oral Exams
- Contact information:
  - Bay Area Cybersecurity Apprenticeship Committee www.transmosis.com
  - Robi Papp 381 Bush Street #600
  - San Francisco, CA 94104
- Contact person: Robi Papp, Chairman
- Contact phone / e-mail: (408) 723-4242
- Applications taken: Continuous

Observations of this model for an apprenticeship model

This apprenticeship model has been around for a long time and was perfected with vocational programs. IT is relatively new and is using the same model that was used in the past. So, results may not be the same for IT as other vocational trades since a higher-level knowledge may be needed.

[22] https://www.dir.ca.gov/databases/das/results_aigdetail.asp?varOccId=8577

Section 5
Overview of Programs in Secondary and Post-Secondary

This section focuses on the three school systems that make up most of the middle Tennessee region; Williamson, Metro Nashville – Davidson, and Rutherford County. To acquire the necessary knowledge needed to understand the capabilities of each school system, meetings and workshops were held to identify strengths and weaknesses. New ideas were also proposed and are expected to followed through after the work of this project is complete.

The following is a synopsis of each of the three school systems and the meetings held with each. The individuals involved and what was learned is also included in each section. Also included in this section is Rutherford Works, which is an initiative started by the Rutherford Chamber of Commerce that has been trying to get businesses and schools together to work on a seamless path to a career.

5.1 Rutherford Chamber of Commerce

5.1.1 Rutherford Works and their involvement with schools:

Rutherford Works[23], the umbrella for the collaborative work of the Rutherford County Chamber of Commerce offices of Economic Development (ECD) and Workforce Development (WFD), oversees programs and services that help businesses start, grow, and chose to locate in Rutherford County. Guided by the mission of Destination Rutherford, Rutherford Works helps ensure a strong and diverse economy helping to increase our County's commercial tax base through business attraction and retention; and helping to prepare our workforce for the 21st century economy.

Led by Beth Duffield, the mission is to identify industries of high growth and need and look to bolster those areas through economic and workforce development.

Economic Development

The economic partnership that exists between the Rutherford County Chamber of Commerce, Destination Rutherford, the community leaders of Murfreesboro, Smyrna, LaVergne, and Eagleville, and state economic development officials, provides seamless services to new and existing businesses. The 5 keys workforce sectors include construction, healthcare, manufacturing, supply chain, and ***technology***.

Workforce Development

The uncommon partnership between Rutherford County businesses, K-12 Schools, and our post-secondary education partners empowers and inspires the current and future workforce of Rutherford County to become highly skilled, highly employable citizens to achieve a better life and help support the continued growth of our business community.

[23] https://rutherfordworks.com/

Some of the major initiatives of Rutherford Works includes:[24]

- 8th Grade Career Pathways Fair
  - Students hear from industry professionals and CTE teachers to identify possible CTE pathways for high school.
- Summer Camps for K-12 (week long camps) – 2018 schedule of camps
  - Girls in STEM Camp (Girls 6th – 8th)
    - Engineering basics and program robots for girls.
  - The Maker's Coding Lab (All 3rd – 5th)
    - Explore computer science through various coding activities and hands-on physical computing.
  - Bits and Bots Camp (Boys 6th – 8th)
    - Engineering basics and program robots
  - Buy it, Make it, Sell it Camp (10th – 12th)
    - Hands-on workshops and tours for supply chain concepts.
  - Create with Code Camp (All 9th – 12th)
    - Programming concepts and electrical circuits
- Career Pathway Partnership
  - Online directory based on Career and Technical Education (CTE) pathways and acts as a resource to both the professional looking for volunteer opportunities within the classroom and the educator seeking workforce partners.
- High School Internships
  - The Rutherford Works High School Internship Program provides students enrolled in Rutherford County Schools the opportunity to gain paid work experience while being placed with Rutherford County employers.
- Senior Hiring Event
  - Intended for graduating high school students that are looking to enter the workforce directly.
- Teach Ready
  - The Teach Ready conference informs educators about best practices for utilizing technology, problem-based learning, and STEM (science, technology, engineering, math) in the classroom.
- Work Ethic Distinction
  - The purpose of the Work Ethic Distinction is to address the needs that industry has for employees who have both technical and employability/soft skills. The Work Ethic Distinction is a proactive solution to the challenge employers have in hiring individuals who are prepared for the world of work. Students who obtain this distinction are proving that they are both college and career ready.

[24] https://rutherfordworks.com/building-tomorrow-s-workforce/programs

Through Rutherford Works, the Rutherford Chamber of Commerce takes an active role in education and workforce development. Most of their efforts have focused on K-12 and two-year schools. They are active with the Rutherford County teachers and in helping them build curriculum. They also are very interested in creating the pathway from K-12 to two-year to four-year to career.

The following are summaries from their two most recent Rutherford Works Technology Council meetings (April 18th and May 16th), where the focus was on K-12 initiatives and connecting all aspects of education to career, as well the Tech Pathway Alignment meeting on May 2nd.

5.1.2 Rutherford Works Technology Council Meeting - April 18th

Attendees:

- Beth Duffield - Rutherford Chamber of Commerce
- Charles Apigian – MTSU
- Brian Robertson – Rutherford County
- Chris Lilly – Murfreesboro Electric
- Doug Brown CUDR
- Trisha Murphy - Rutherford Chamber of Commerce
- Erin Hutchens - Rutherford Chamber of Commerce
- Tyra Pilgrim – Rutherford County Schools
- Carol Puryear – TCAT Murfreesboro
- Amy Henderson – LeanKit and Nashville Tech Council
- Robert Benton – Network Technology Partners
- Brandon Hudson – TCAT – Shelbyville

Summary

- Senior Hiring Event – April 10 - High percentage of students requested job opportunities in tech
    - No employers participated representing just tech
    - 79 students out of 224 earned a job
    - 124 students have follow up activities
- High School Internship Program –
    - 45 students placed for 2018
    - Stonecrest, RUCO Government and Murfreesboro City are hosting IT interns
- Work Ethic Distinction –
    - 155 students qualified in 2018

- Teacher Externship Pilot Summer 2018
    - 3 middle school teams
    - Stonecrest, Ingram and Nissan hosting the teams
- Summer Camps 2018
    - Elementary camp full
    - Boys middle school camp 15 out of 20 spots full
    - Girls middle school camp only has 3 participants
    - High School has 16 out of 20 spots full
- TCAT Shelbyville Dual Credit (working towards Dual Enrollment)
    - Begin fall 2018
    - Program is linked to Cyber Security Program
    - Giving high school teachers access to online tools/lesson plans/PP/exam materials – this is a supplement to state DOE curriculum
    - Comptia Security+ will be the goal certification
    - Potential talent pool from RUCO high schools – nearly 100 students at 4 schools
- TCATs and Community Colleges Articulation for Cyber Defense AAS Degree (common curriculum across the state)
    - TBR is close to making this a reality – possibly for fall 2018
    - Potential of 24 hours transfer from TCAT to Motlow out of 60 hours required
- New Program Opportunities thru MTSU – Charlie Apigian
    - $4600 going toward certifications for high school students
    - April 28th @ 10:30 – all are invited – to a tech workshop for high school teachers
    - Passion for getting young students interested in technology
    - Need more diversity in technology
    - Doing a good job of teaching networking in our high schools and getting better at cyber security
    - Advocating for high school program around big data: python, excel, stats/analytics, project idea
    - Feedback on big data program of study in high school:
        - Charlie is getting requests for analytics by high school students
        - At MTSU – 18% are women in MIS 33% are women in Masters in MIS and 51% are women in Masters in Data Analytics – a good way to recruit women in the field

5.1.3 Tech Pathway Alignment Meeting- May 2nd

Attendees:

- Beth Duffield - Rutherford Chamber of Commerce
- Charles Apigian - MTSU
- Carol Puryear - TCAT-Murfreesboro
- Gina Burke - Motlow State Community College
- Tyra Pilgrim - CTE for Rutherford County Schools
- Brandon Hudson - TCAT-Smyrna

Summary:

- This meeting focused around Goal 1 of the Rutherford Works group from the Rutherford Chamber of Commerce. Review of curriculum and pathways allowed us to identify the optimal path from K-12 to community college to four-year degree.
- Pathways between TCAT's and Motlow State Community College were identified. Also discussed were classes at Motlow that could align with a degree from MTSU.

5.1.4 Rutherford Works - May 16th

Attendees:

- Beth Duffield - Rutherford Chamber of Commerce
- Charles Apigian – MTSU
- Brian Robertson – Rutherford County
- Chris Lilly – Murfreesboro Electric
- Trisha Murphy - Rutherford Chamber of Commerce
- Byrn Sommardahl – Acklen Avenue
- Sonia Sappenfield – Acklen Avenue
- Brian Moyer – Nashville Technology Council
- Amy Henderson – LeanKit and Nashville Tech Council
- Deanna Morris-Stacey – TBR
- Robert Benton – Network Technology Partners
- Gina Burke - Motlow State Community College
- Brandon Hudson – TCAT – Shelbyville
- Michael Torrence – Motlow State Community College

Summary:

- Reviewed action items from previous meetings, and also received a update on the code camps. The remaining time was focused on the Goals 1, 2, and 3 that were developed at the beginning of this year. Those goals are:
    1. Develop seamless pathway – TCAT/Motlow/MTSU to include dual enrollment and industry certs and TCAT and Motlow are working as a team by fall 2019
    2. Expand IT Cluster/Programs of Study to all Rutherford County High Schools by fall 2019
    3. Increase diversity in IT Cluster/Programs of Study in Secondary and Post-Secondary in Rutherford County by fall 2019
- For each one of these goals, this grant and actions based on this grant have been a catalyst for realizing these initiatives. At this meeting, I was able to speak at length to some of the goals that we feel will lead to a better seamless path, expanding the IT clusters and programs, and increasing diversity within the clusters and programs.

5.2 Rutherford County Schools

5.2.1 Overview of Rutherford County CTE pathways

Rutherford County Schools offers CTE pathways in a few tech related fields. Their main focus is on networking and programming. The schools that offer a tech related pathway are:

- Blackman High School – Coding and Networking Systems
- Central Magnet School - Coding
- LaVergne High School – Networking Systems
- Oakland High School – Coding
- Riverdale High School – Coding
- Siegel High School - Networking Systems
- Stewarts Creek High School - Networking Systems

5.2.2 Rutherford County Teachers Workshop - April 28th

Attendees:

- Frank Cathey - LaVergne High School
- Scott Mosier - Blackman High School
- Joseph Marco - Stewarts Creek High School

- Patrick Vest - Stewarts Creeks High School
- Amy Henderson - LeanKit and President-elect of the Nashville Technology Council (2019-2020)

Summary:

- A four-hour workshop was conducted with high school CTE teachers to identify challenges and future opportunities for the education of students within a technology field. It became evident through this workshop that Rutherford County and its teachers do an excellent job of teaching those students that have a passion and a narrowly focused interest in information technology. What is missing from this equation are fringe students that may be interested in a technology field but are not sure or aware of all possibilities. Too often, students in middle school as well as high school do not understand the breadth of tech careers and unfortunately assume that all technology careers are based on networking and programming. This is not the fault of the teachers within Rutherford County schools but it is a challenge. In order to make a significant difference in the number of individuals pursuing a technology career, the fringe student must be attracted into a technology pathway our cluster. Therefore, this workshop identified an opportunity to pursue the IT fringe student through an external competition and showcase that allows a team to be given a problem and identify an IT related solution.

5.2.3 Observations about Rutherford County Schools

Rutherford County does an excellent job in educating students that love technology. With the Rutherford County Chamber of Commerce, they seem to do an excellent job upbringing industry into the education workspace. What is lacking is the ability for the schools to attract students that may have an aptitude for technology but have not realized their interest in a technology related career. Therefore, reaching out to those fringe IT students could increase the number of individuals interested in a technology related career.

5.3 Williamson County Schools

5.3.1 Overview of Williamson County Schools College, Career and Technical Pathways

Williamson County Schools (WCS) encourages students to take advantage of nearly 40 different programs of study to explore their individual strengths and how they may align those strengths with a rewarding career.[25]

WCS CCTE students enroll in one or two courses each year while taking the core academic course load that they can manage. The advantage of taking CCTE courses is that students are able to get a look at the world of work and careers while still in high school. Students are able to then make informed decisions about post-secondary programs and the credentials needed for the jobs they desire.

WCS CCTE courses combine a rigorous classroom experience with the relevancy of real world application. Classes consist of cutting edge equipment, shadowing/internships, guest speakers, business practicums, and many are available for college credit. The WCS program of study document link below displays the 16 career clusters offered in WCS. The specific programs of study, sequence of courses, and specific schools offering each program of study are listed individually under each career cluster. Students wanting a specific CCTE program of Study not offered at their zoned school may have the option of attending a school out of their zone if seats are available. Students should see their Counselor for more information.

The Information Technology Pathway includes classes, such as the following:

- IT Foundations
- Computer Systems
- Creativity in the 21st Century
- Cabling and Internetworking
- Programming and Logic I
- Programming and Logic II

[25] https://www.wcs.edu/teaching-learning/college-career-technical/

Williamson County Schools (WCS) Meeting- April 20th

Attendees:

- Dr. David Allen - Executive Director for CTE for WCS
- Charles Apigian - MTSU
- Dr. Charles Farmer - Assistant Superintendent Secondary for WCS
- Tim Gaddis - Assistant Superintendent for Teaching, Learning, and Assessment

Summary:

- Williamson County Schools focus on pathways that lead directly to four-year degrees. Because of this emphasis, the CCTE classes and programs offered are quite different than other county school systems. They do not focus on certifications like Rutherford County. Instead look for ways to engage their students in unique opportunities to engage students in technology-related education.
- For example, Franklin High School is using a curriculum developed by MIT for autonomous systems in vehicles. This gives students very unique skills and opportunities in terms of problem-solving, hardware related skills, programming, and other important aspects that relate to a technology career.
- Because of this emphasis on pursuing a four-year degree for their students, they are willing to look at unique opportunities for programs and curriculum. One unique challenge that they face is that in their K-6 curriculum they have incorporated computational thinking in every aspect of learning. However, once students get past sixth grade there is no specific curriculum to enhance or improve the style of thinking. Therefore, I proposed a data analytics curriculum that would foster and hopefully excite the notion of computational thinking to another level.
- The curriculum would include:
    - Programming using Python
    - Work-related applications, such as Microsoft Excel
    - Statistical modeling, business intelligence, and analytics
    - Project-based problem-solving in a team environment
- Future discussions with key individuals in these areas has already been set for June 2018.

5.3.3 Observations of WCS College, Career and Technical Pathways

Williamson County Schools are not afraid of trying something different. They try their best to create programs that best gets their students ready for college and a great career. Therefore, in some of their schools they may not teach CCTE, but they do have pathways that are technology related what one at Franklin high school that looks to program autonomous vehicles. They also are interested in pathways that may reach the fringe IT student and are looking for guidance and how to achieve this. Therefore, working with Williamson County Schools to determine please pathways is the next step entertaining more students that may be interested in technology

5.4 Metro Nashville Schools

5.4.1 Overview of Metro Nashville Schools

Nashville Metro Schools includes 17 high schools; however, it only has 4 high schools with listed CTE pathways. Other schools do offer certain tech related courses; but it is not one of the pathways. For example, Antioch High School offer computer science classes, taught by Michael Lee, but he is split between technology related classes and chemistry. He focuses more on electrical engineering in his classes and not specifically on computer systems.

For the Career Technical Education (CTE) programs, they provide a sequence of courses for students in grades 9-12 to gain knowledge and skills in career programs by integrating academics with technical skills. Students who graduate with a concentration in a CTE program are prepared for both post-secondary institutions and/or the workplace. A concentration is three credits in a focused, sequential program of study.

CTE Standards

All CTE programs are funded primarily with federal Carl D. Perkins funds and programs must meet the following quality standards:[26]

- The teacher is certified to teach the program, including industry
- certification for Trade and Industrial (T&I) Education teachers where applicable
- The teacher is using the current state approved curriculum
- The program has an active advisory committee consisting of business and community leaders.

[26] https://www.mnps.org/s/AON-CTE-Programs-of-Study-2016-17.pdf

- The program has an active, affiliated career-technical student organization (CTSO) that represents their area
- The program has active dual credit/dual enrollment agreements with post-secondary institutions
- The program is supported by current labor market data
- The program is of sufficient size and scope to allow for a student to earn a minimum of three (3) credits in a sequenced program of study

Schools and CTE Pathways[27]

- Overton – Programming and Software Development, Networking Systems, and Web Design
- Hunters Lane - Programming and Software Development
- Stratford - Programming and Software Development
- Glencliff – Web Design

5.4.2 Building a Tech Seamless Pipeline from Middle to High School to College - May 7th

Attendees:

- Brian Brewer - CTE Metro Nashville Schools
- Charles Apigian - MTSU
- Michael Torrence - Motlow State Community College
- Reginald Gardner - Nashville State Community College
- Sandi Hoff - Nashville Technology Council

Summary:

This brainstorming session brought together the Nashville Technology Council, three community colleges, and the Nashville Metro School – CTE. Through this process we were able to identify needs that Nashville Metro Schools are struggling with and how the two-year and four-year schools can offer some help.

Identified needs for students as they transition from secondary to post-secondary:

- Professional development through industry partners
- Hands-on opportunities to attain and retain students in IT
- Opportunities to attract a more diverse set of students

[27] https://www.mnps.org/media-library/?tag=CTE%20Programs%20of%20Study

This meeting was also intended to identify an agenda for the We Build Tech Summit in July, which is hosted by the Nashville Technology Council. This summit brings together technology teachers and CTE administrators to discuss topics that are pertinent to the technology classroom. Based on this meeting, it was decided that the theme for the summit will be connecting the different pathways to a technology related career. Possible topics include:

- Incorporating professional development with industry.
- Overview of the Memphis model for teaching technology in the classroom.
- Augmented reality
- Tech kitchen concept for learning new technologies
- The Smart Home – Asurion
- Mobile opportunities for schools

5.4.3 Observations of Nashville Metro Schools

With the number of schools in the Nashville Metro region, it is an uphill battle for them to reach the number of students that should partake in a technology related pathway. However, the schools that do offer a CTE pathway in technology are doing quite well. Their challenge is to not just offer pathways for the elite students, but to offer more classes or more opportunities technology experiences in the more diverse schools. This continues to be a recurring theme in the schools.

Schools that do offer CTE pathways are teaching to the elite students that have an interest prior to high school. They are not reaching the students that might have an aptitude for technology but do not know if they would be interested since they have not been exposed to technology.

A case in point is Antioch High School, where technology is taught by one of the chemistry teachers; Michael Lee. He has put together an engaging program that looks to inspire students to learn technology, but with a lack of resources he struggles to gain much interest.

5.5 TCAT Murfreesboro

5.5.1 Overview of TCAT Murfreesboro

The Tennessee Colleges of Applied Technology (TCAT) offers students an opportunity to pursue a career that lends itself more as a vocation or trade after high schools. The intent of a TCAT is to learn specific skills that translate directly to a trade of choice. It is not meant to allow for transfer to a two-year or four-year degree, although this may change in the future. Th following gives a full description of TCAT Murfreesboro and its offerings.

The Colleges fulfill their mission by:[28]

- Providing competency-based training through superior quality, traditional and distance learning instruction methods that qualify completers for employment and job advancement;
- Contributing to the economic and community development of the communities served by training and retraining employed workers;
- Ensuring that programs and services are economical and accessible to all residents of Tennessee; and
- Building relationships of trust with community, business, and industry leaders to supply highly skilled workers in areas of need.

To offer a more comprehensive view to the different fields that students may pursue, the following is a list of certificates.

- Administrative Office Technology
- Automotive Technology
- Collision Repair Technology
- Computer Information Technology
- Cosmetology
- Dental Assisting
- Digital Graphic Design
- Drafting & CAD Technology

[28] https://tcatmurfreesboro.edu/

- Heating, Air Conditioning, and Refrigeration
- Industrial Electrical Maintenance
- Machine Tool Technology
- Pharmacy Technician
- Practical Nursing
- Surgical Technology
- Welding Technology

5.5.2 Computer Information Technology Program

The mission of the Computer Information Technology program is to prepare and develop students so they can acquire and retain employment in the high-tech Computer Networking Technology field upon graduation through traditional education. Hands-on, real world experiences within an individualized objective based program with personal instruction prepare each student to pass the A+, Network+, Security+, and Microsoft Certifications.

The Computer Information Technology Program (IT) trains the student in the technical aspects of hardware and networking.

The only certificate that pertains to the technology field is Computer Information Technology.

Which is the following:

- Typical Program Length - 20 Months
- Clock Hours - 2,160
- Class Type - Day, Night
- Credentials - Certificate, Diploma

The completion is not a specific degree, but students do receive a certificate, which is not an industry certificate.

5.5.3 Nissan/TCAT Tour and meeting - April 23rd

Attendees:

- Dan Caldwell - Nissan
- Charles Apigian - MTSU

Summary:

- A tour of the Nissan/TCAT facility was facilitated by Dan Caldwell. Throughout the tour, the collaboration between Nissan and TCAT was quite evident. The TCAT offers

industrial electrical, a tool shop, and collision repair. Many of the students are full-time and once they complete the required hours for a certification they expect to go directly into the workforce, not on to a higher-level degree. Nissan uses the facility to train supervisors, engineers and maintenance. On one side of the facility is a tremendous amount of equipment that resembles automation and robotics directly on the production line. In many instances this equipment is not used and has the capability of offering students at every level a unique opportunity to gain an understanding and interest in robotics and technology. In the past Nissan has facilitated after school programs where students were able to program and run the robotics, but they currently do not have the individuals employed to help with such an endeavor.

5.5.4 Observations of TCAT Programs

These programs offer specific vocational skills and are not expected to transfer to different programs. However, Motlow State Community College has recently entered into an agreement with TCATs to allow up to 27 hours of credit if they take specific paths with their TCAT education. This equates to close to half of an Associate of Applied Science Degree (See Section 5.6.3 for more information).

The TCAT programs are an excellent way to develop skills for the IT workforce. The partnership with Nissan at the Smyrna location is a perfect example of how an apprenticeship program could get started. At this time, Nissan is using the facility for their own employees but not using it for a pipeline of new IT or vocational talent. But to follow the model of South Carolina, where they do use their technical schools as the playground for developing skills, TCATs could offer the necessary skills prior to, during, or after a student attains an education.

5.6 Motlow State Community College

5.6.1 Overview of programs at Motlow State Community College

Motlow State Community College offers two different types of degrees that pertain to information technology. The information systems associate of science degree that follows the Tennessee Transfer Pathway[29] offers students a direct pathway to a four-year institution. Although a student does not take many courses in information systems at Motlow, they do transfer seamlessly to a four-year institution like MTSU upon degree completion.

The other type of program is and associate of applied science degree which is intended for the student that does not expect to pursue a four-year degree, but instead would like to quickly enter the workforce.

These two different degrees lead to different types of jobs and fields based on the industry they would like to pursue. Therefore, a student should choose carefully after completing their high school education.

Also, worth noting is that many students attend Motlow State Community College with several credits already earned. For example, a student may have 12 credit hours from a TCAT that can be a complied to their degree. A student may also have earned several credits in high school through dual enrollment and advanced placement, which also lessens the time for a student to start and finish an Associate or Applied Associate Degree.

[29] http://www.tntransferpathway.org/

5.6.2 Information Systems A.S. Tennessee Transfer Pathway

The Associate of Science degree in Information Systems is a program designed to prepare students for successful transfer to a four-year college or university. This degree program is a great choice for students interested in learning more about the use of computers and information for increased creativity and productivity. In addition to core curriculum, the Information Systems path introduces students to the following:

- the history and evolution of computing devices
- an understanding of software applications that make computers capable of performing specific tasks
- computer concepts that can be used in schools, private business or in government
- current programming languages
- the concept of data structures and sorting techniques
- other curriculum necessary in preparation for bachelor's degree completion at any one of Tennessee's colleges or universities

Practical Experience

Students will be engaged in the learning process through activities like:

- critical thinking
- in-depth research and analysis
- interaction with students and instructors
- exposure to fascinating coursework, lectures and classroom interaction

Career Opportunities

The A.S. degree prepares students for transferring to a Tennessee public university or select regionally accredited, non-profit, Tennessee private colleges and universities to complete their baccalaureate degree. Upon graduation with a B.S., students can work in a variety of fields such as a database administrator, IT consultant, multimedia programmer, systems analyst, and systems developer.[30]

List of courses:
https://www.mscc.edu/documents/programs/checklists/Information-Systems-TTP-AS.pdf

[30] https://www.mscc.edu/programs/information-systems.aspx

5.6.3 Business Programming Concentration A.A.S.

The A.A.S. in Business, with a concentration in Programming, provides the student with the education necessary to work as a basic entry-level computer programmer in a business environment. The Programming concentration is for students interested in pursuing a programming career in business-related data processing applications.

The two-year program is designed for the student who does not intend to transfer to a four-year institution.[31]

List of courses:
https://www.mscc.edu/documents/programs/checklists/Programing-Concentration-AAS.pdf

Cyber Defense Concentration: Program Available Spring 2018

The A.A.S. in Computer Information Technology with a Cyber Defense concentration is designed for students desiring a two-year, non-transfer degree program to prepare them to enter the workforce, sustain their career, or seek career growth opportunities in the field of entry-level cybersecurity.[32]

List of courses:
https://www.mscc.edu/documents/programs/checklists/cyber-defense.pdf

[31] https://www.mscc.edu/programs/business-programming.aspx

[32] https://www.mscc.edu/programs/cyber-defense.aspx

5.7 Nashville State Community College

Nashville State Community College is similar in its offerings to Motlow State Community College. However, they have more concentrations in specific IT related fields. For example, Motlow offers an Associate of Applied Science Degree in cyber security where Nashville State offers concentrations in cyber defense, networking, programming, systems analyst, and systems administration and management.

The information systems A.S. Degree is identical for Motlow and Nashville State since this is a statewide initiative for an easy transfer pathway from a two-year school to a four-year school. The following is a brief summary of the technology-related degrees at Nashville State Community College.

5.7.1 Computer Information Technology A.A.S.

The Computer Information Technology AAS degree prepares you for employment in the information technology field. Choose from five degree concentrations: Systems Administration & Management focuses on the design, implementation, management and troubleshooting of computer systems. Cyber Defense focuses on cyber security and digital forensics. Programming and Systems Analyst focus on information technology infrastructure maintenance and growth within an organization. Networking prepares students to design, install, monitor, maintain, and enhance network infrastructure.[33]

The CIT A.A.S degree offers 5 concentrations:

- Cyber Defense Concentration[34]
- Networking Concentration[35]
- Programming Concentration[36]
- Systems Analyst Concentration[37]
- Systems Administration and Management Concentration[38]

[33] https://www.nscc.edu/academics/degrees-certificates/computer-information-technology-a-a-s
[34] http://ww2.nscc.edu/depart/docs/citc/Adv_CITCnetworkingAAS.pdf
[35] http://ww2.nscc.edu/depart/docs/citc/Adv_CITCnetworkingAAS.pdf
[36] http://ww2.nscc.edu/depart/docs/citc/Adv_CITCprogrammingAAS.pdf
[37] http://ww2.nscc.edu/depart/docs/citc/Adv_CITCsys-admin-mgmtAAS.pdf
[38] http://ww2.nscc.edu/depart/docs/citc/Adv_CITCsys-admin-mgmtAAS.pdf

5.8 Middle Tennessee State University

MTSU offers several programs that relate to technology. If a student is interested in programming or development they can pursue computer science at the undergraduate and graduate level. A student that is more interested in the hardware or robotics side of technology, they can major in computer engineering or mechatronics. If a student is more interested in content development and digital media they can pursue a degree from the College of Media and Entertainment that focuses on digital media. Finally, a student that is interested in technology or in data may pursue a degree in information systems which is in the college of business.

Table 3 that shows the different departments and what professionals in those fields do the typical attributes of those professionals. Each of these areas have undergraduate and graduate degrees and offer seamless transitions from community college. Therefore, an individual may pursue an associate's degree at a community college that follows a Tennessee Transfer Pathway and all 60 hours of degree will transfer to MTSU.

As shown in Table 4, MTSU has Tennessee Transfer Pathways with all community colleges in the state of Tennessee. This gives students an opportunity to pursue a four-year degree after attaining an associate's degree from one of the community colleges listed. If a student uses Tennessee Promise[39], which gives them free tuition for the first two years, and then also continues to use the Hope scholarship benefits they can receive a bachelor's degree for less than $10,000 in tuition.

The recurring theme is that a four-year degree is too expensive, however because of the incentives and resources within the state of Tennessee, the cost is more affordable than ever. Although a four-year degree is not for everyone, it is one particular path that continues to be a differentiator for higher salaries and opportunities within the technology field.

[39] http://tnpromise.gov/

Table 3: MTSU Programs that are in Technology

Department/Major	What professionals in this field do	Typical Attributes of professionals in this field
Computer Engineering Technology[40]	Computer Engineers primarily focus on the hardware. Their job is to design and develop computer hardware from embedded systems to VLSI chips to peripheral devices.	Computer Engineers should have inquiring and inventive minds, be good with detail work, have good problem-solving skills, and be good in math and science.
Information Systems and Analytics[41]	Information systems is where business meets technology. Individuals are exposed to a variety of opportunities that range from creating and managing web applications to projects involving the design and implementation of network environments. Individuals work in positions such as web developer, application developer, business or systems analyst, project manager, database analyst or administrator, network manager or network administrator, information systems auditor.	Information systems professionals work to solve the needs of organizations of all types and sizes. They are responsible for taking business needs and designing and creating solutions to those needs with the use of technology. These roles combine expectations of teamwork as no successful system can be designed in isolation. Individuals can take on the roles mentioned in the previous column. Expectations of the field in general are 1) to expect things to change and 2) to be motivated by that environment.
Computer Science[42]	Computer Scientists write computer programs. These could be anything from mobile apps to complex databases to websites to high performance scientific computing and more. While they frequently have to work in teams to develop these programs, they may also spend long hours working independently to debug and develop the software.	Computer Scientists are first and foremost problem solvers. While they must be able to work in teams, they must also be extremely capable of solving problems on their own and teaching themselves new technologies. While it is not a necessary attribute, it is interesting to note that many Computer Scientists are also accomplished musicians and/or mathematicians.

[40] http://www.mtsu.edu/et/computerengineering.php
[41] http://www.mtsu.edu/isa/index.php
[42] http://www.mtsu.edu/csc/index.php

Table 3 (continued): MTSU Programs that are in Technology

Department/Major	What professionals in this field do	Typical Attributes of professionals in this field
Interactive Media[43]	The professional fields covered by the Interactive Media department include: ▪ Video & Film Production ▪ Multimedia Journalism ▪ Animation (for TV, movies, games, etc.) ▪ Media Management	Professionals working in these diverse fields have a passion for working in and creating media. This is a highly collaborative arena with many specialized functions as exhibited by the extensive credits one can see in the credits for movies, TV shows, and video games. These fields are in a constant state of change, so the ability to adapt and continually learn new things is important.
Media Arts[44]	The New Media Communication program helps prepare students to embrace the technology changes that are happening nearly every day. Are you wired into the landscape of social and mobile media, websites, blogs, and apps? Advances in hardware and software and new forms of distribution are causing the greatest explosion of creative activity in human history. Anyone can be a publisher today, and business is scrambling to find enough of the right people to fill the new jobs that are being created. Our New Media program is all about combining the fundamentals of effective communication with new techniques and technologies.	New Media Communication specialists focus on the human side of media; messaging, user experience, and communication strategy. Creation of media content; text, audio, video, graphics; for websites, social media, and mobile applications is a major part of the work done in this field. Graduates work in anything from a small boutique advertising firm or software startup to Fortune 500 corporate communications departments.

[43] http://www.mtsu.edu/programs/interactive-media/
[44] http://www.mtsu.edu/mediaarts/index.php

Table 4: TN Transfer Pathways and Articulation Agreements between MTSU and Community College

Community College	Computer Science[45]	Engineering Tech[46]	Information Systems[47]	Media and Ent.[48]
Chattanooga State		TTP	TTP	TTP
Cleveland State		TTP	TTP	TTP
Columbia State		TTP, AA	TTP	TTP
Dyersburg State			TTP	
Jackson State		TTP	TTP	TTP
Motlow State	TTP	TTP	TTP	TTP
Nashville State	TTP		TTP	
Northeast State	TTP		TTP	TTP
Pellissippi State	TTP		TTP	TTP
Roane State	TTP	TTP	TTP	TTP
Southwest TN			TTP	
Vol State		TTP	TTP	TTP
Walters State		TTP	TTP	TTP

Note: TTP refers to Tennessee Transfer Pathway
AA refers to Articulation Agreement

It is important to realize that not all students know at a young age what they want to do for their career. Too often young adults struggle to find opportunities and feel pressured to choose a specific pathway. A comprehensive four-year university gives students an opportunity to explore different areas without adding any or little time to their path for an education. For example, a student that likes technology but may not want to be a programmer will not know what opportunities exist for that individual until finding a degree like information systems in the college of business. If the student has followed the correct path, which means they've taken their general education requirements in the beginning, this gives them the time to explore many different areas until they find their true path for their career.

[45] http://www.tntransferpathway.org/majors/computer-science
[46] http://www.tntransferpathway.org/majors/engineering-technology
[47] http://www.tntransferpathway.org/majors/information-systems
[48] http://www.tntransferpathway.org/majors/mass-communication

5.8.1 The Information Systems Degree at MTSU

The following is a summary of the degree plan for a student that majors in information systems at MTSU. In most instances, the bachelor's degree in information systems at MTSU is considered a discovery major, which means students do not know about information systems until they arrive at the university. However, it does capture the fringe IT student (See Section 6 for a definition of the fringe It student), which includes a more diverse and larger population for the technology community.

Degree Requirements for Information Systems

General Education (41 hours)

General Education requirements (shown in curricular listings below) include courses in:

- Communication
- History
- Humanities and/or Fine Arts
- Mathematics
- Natural Sciences
- Social/Behavioral Sciences.

The following General Education courses are required for this major:

- MATH 1630 or 1810 (Math)
- ECON 2410 (Soc/Beh Sci and core course)

College of Business Core (42 hours)

- All students must complete the College of Business Core which requires 42 hours with a 2.000 GPA. ECON 2410 is included in the core and will also satisfy 3 hours from the Social/Behavioral General Education requirement.

Information Systems Major Requirements (30 hours)

- INFS 2400 - Web Development 3 credit hours
- INFS 2600 - Introduction to Software Development and Programming 3 credit hours
- INFS 3400 - Object Oriented Programming with C#.NET 3 credit hours
- INFS 3800 - Information Systems Analysis and Design 3 credit hours
- INFS 4300 - Security Assurance for Information Systems Audit 3 credit hours
- INFS 4790 - Database Design and Development 3 credit hours
- INFS 4900 - Business Data Communications 3 credit hours
- INFS 4950 - Advanced Web-Enabled Application Development 3 credit hours
- Electives (6 hours)

Section 6
Pathway from secondary to post-secondary to employment

It has become evident that the path from secondary to post-secondary can be improved. The glaring weakness in secondary education is the lack of opportunities for students that would be considered a ***fringe IT student***. The fringe IT student is an individual that has an aptitude for technology but has not gained an interest due to a lack of exposure. They may also be an individual that does not consider themselves a hard-core techie. However, if they knew of the opportunities in the information technology field, they be interested in pursuing this career path. Too often, students in middle school and high school are exposed to coding and networking only and do not see the other sides of technology that might be of interest to them.

Therefore, the challenge is to identify students with an aptitude for technology and then expose them to all of the possibilities of a future within this growing field. Once the students have been identified, they can then follow one of the following five paths to attaining knowledge skills and abilities.

The following is a list of paths that a student may choose in pursuing a technology related career. For Section 6.1 and beyond, the following are definitions:

What is a Fringe IT Student?

A student that likes technology as a consumer or as a casual user. If they are exposed to more technical careers, like networking or coding, they may not be interested. But, if they show an aptitude for technology and are exposed to other areas that lend more to their interests, they may be motivated to pursue a career in IT. These types of individual may like data, analytics, management, organizational processes, communication, etc.

Knowledge:

The content and soft skills attained through an education of work experience. Since our models refer to the post-secondary educational experience, knowledge is gained from the education path that they choose. This includes theoretical and practical content, soft skills (communication, teamwork, etc.), problem solving, and the ability to learn on your own.

Skills

The technical skills attained within an educational path. This includes programming, database, networking, and other areas that pertain specific to a technology. Although it can be assumed that a student can attain knowledge (as described in this report), it is only a byproduct of learning technical skills and not the intent of the educational experience. Therefore, a student may learn technical skills without understanding how it applies to a business, how to debug or problem solve, or how to communicate solutions within a business environment.

Table 5: Pathway Options for Individual to Secondary to Post-Secondary

Path	Option	TCAT	Two-year	Four-Year	Graduate	Knowledge[B]	Skills[C]
Path 1		Yes				Low	Medium
Path 2			A.A.S. Degree			Medium	Medium
Path 3			A.S. Degree			Medium	Low
Path 4	Option A		*A.S. Degree*[A]	Bachelor's Degree (IT related)		High	Medium
	Option B			Bachelor's Degree (non-IT)		High	Low
Path 5	Option A		*A.S. Degree*[A]	Bachelor's Degree (IT related)	Master's Degree (IT related)	Highest	Medium
					Master's Degree (non-IT)	Highest	Medium
	Option B			Bachelor's Degree (non-IT)	Master's Degree (IT related)	Highest	Medium
					Master's Degree (non-IT)	Highest	Low

Note:

[A] *A.S. Degree may be earned prior to pursuing a four-year degree.*

[B] *Knowledge refers to the content knowledge and soft skills gained from the learning process.*

[C] *Skills refers to the technical skills attained, such as programming languages, networking and cyber-security.*

6.1 Post-Secondary Paths to an IT Career

Path 1 - TCAT to Skills

- Attend a TCAT and earn a certificate. Then proceed to attaining more skills through other skills training.
- It can be assumed that a student attains certain skills.

Path 2 - Associate of Applied Science Degree (A.A.S.) to Skills

- Attend a two-year community college and earn an A.A.S Degree. An A.A.S. Degree is meant to be a terminal degree that prepares students for the workforce. After receiving their degree, the student can proceed to attaining more skills through other skills training.
- It can be assumed that a student attains a certain level of knowledge and skills.
- Through a new agreement Motlow State Community College will accept up to 27 hours from a TCAT for an A.A.S. Degree.

Path 3 - Associate of Science Degree (A.S.) to Skills

- Attend a two-year community college and earn an A.S Degree. An A.S. Degree is intended for students expecting to pursue a four-year degree. After receiving their degree, the student should attend a four-year institution and complete Path 4. However, a student may proceed to attaining more skills through other skills training.
- It can be assumed that a student attains a certain level of knowledge and possibly skills, however several pathways focus on knowledge (general education requirements).

Path 4 - Bachelor's Degree to Skills

- Earn an A.S Degree from a two-year school or enter a four-year institution directly from high school then proceed to a four-year institution to earn a Bachelor's Degree.
    - Option A: If the degree is a in a ***technical field*** (Computer Science, Information Systems, Computer Engineering, etc.) it can be assumed that the student has received a high level of knowledge and medium skills.
    - Option B: If the degree earned is a ***non-technical field***, then it can be assumed that the student received a high level of knowledge but a low level or no skills.

Path 5 - Master's Degree to Skills

- Earn an A.S Degree from a two-year school or enter a four-year institution directly from high school and earn a Bachelor's Degree then pursue a Master's Degree
    - Option A (Earned a Bachelor's Degree in a technical field):
        - If the Master's Degree is a in a ***technical field*** (Computer Science, Information Systems, Computer Engineering, etc.) it can be assumed that the student has received the highest level of knowledge and medium skills, since it is assumed that a Master's Degree will not drastically improve your technical skills to go from medium to high.
        - If the degree earned is a ***non-technical field***, then it can be assumed that the student received a high level of knowledge but a low level or no skills.
    - Option B (Earned a Bachelor's Degree in a non-technical field):
        - If the Master's Degree is a in a ***technical field*** (Computer Science, Information Systems, Computer Engineering, etc.) it can be assumed that the student has received the highest level of knowledge and medium skills.
        - If the Master's Degree earned is a ***non-technical field***, then it can be assumed that the student received the highest level of knowledge but a low level or no skills.

Attaining more skills

In order to gain a high level of technical skills, a student would need a lot of time within a specific discipline. This can only be attained through some type of work experience, which could be full-time employment or an apprenticeship program. Therefore, an ideal situation is for an individual to gain knowledge and social skills and continue to learn technical skills, but in order to truly gain a high level of competence within a specific technical field that work experience is needed.

"Therefore, an apprenticeship program would the ideal opportunity to gain a high level of technical skills after some other form of education (not in place of an education)."

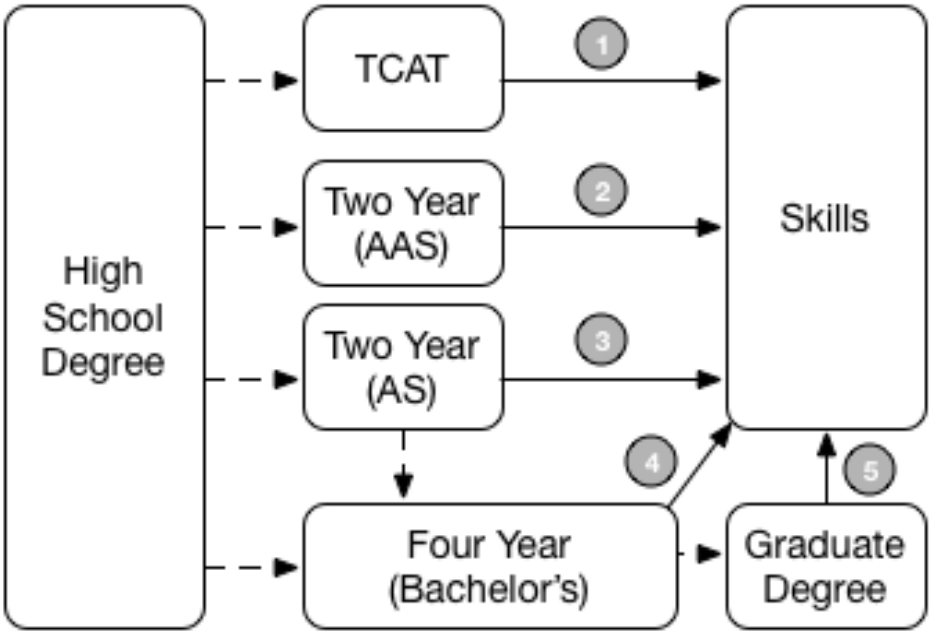

Figure 5: Diagram of the different paths to achieving skills

To achieve skills for a technology related career, it is important to also understand that just providing technical skills only will not solve the technology workforce shortage. Through meetings for this study, it became apparent that employers are more interested in the soft skills or knowledge. They feel that technical skills may be learned on the job, where problem solving or communications skills must be learned over time and prior to employment (See Sections 1.1.2, 1.2.2, and 1.3.2).

Therefore, it is also important to understand what knowledge is learned at the different paths and how it prepares the student for a career in technology (See Table 5). For example, if a student foregoes an education in a two-year or four-year college and attains a medium level of skills from a TCAT, will they have enough knowledge and soft skills to thrive in a corporate environment? This assumption of low knowledge and medium technical skills is an important distinction to make, since most companies continue to stress the importance of knowledge and soft skills.

As shown in Figure 5, there are several paths to attaining skills at a varying degree of competency, which are denoted at high, medium, and low (See Table 5).

Section 7
Implementation plan for piloting recommendations in Tennessee

The path for attaining the necessary skills needed to excel in a technology related career starts in K-12 education and extends through a post-secondary education. However, in most instances the post-secondary education will not allow a student to attain a high level of technical skills. This is not to the fault of a post-secondary education, but it instead is due to a lack of actual experience. Although many of the paths shown in Table 5 indicate a development of skills, it is assumed that work experience while going through an educational path is not required. Therefore, the steps to attain a high level of knowledge and skills is indicated in Figure 6.

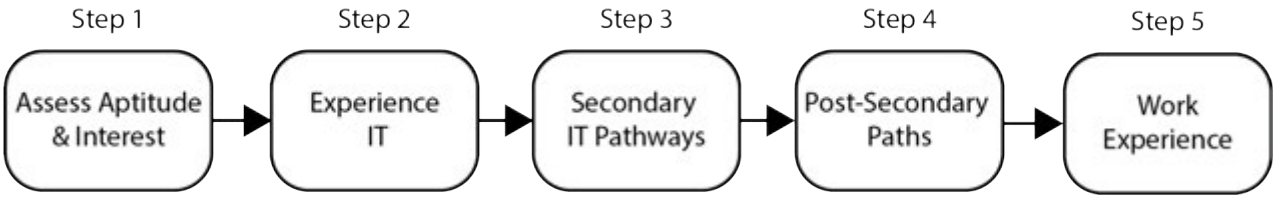

Figure 6: Steps from K-12 to Work Experience to attain Knowledge and Skills

7.1.1 Steps from Secondary to Work Experience

Step 1 – Assess Aptitude and Interest

There is a difference between aptitude and interest and too often students are only assessed using self-reported interest tests. When self-reported interest is the only benchmark for identifying a particular pathway for a student, it seems to negate certain types of students, especially the fringe IT student.

For example, YouScience[49] has developed a tool that incorporates "brain games" to measure aptitude. They also incorporate measures for identifying interest and have had striking results. For example, in Figure 7, for computer systems analysts for the Graduation Year 2018, it states that 303 students have an interest and 315 have an aptitude for this discipline. But, when you look at the differences in gender, only 41 females are interested, where 188 actually have an aptitude, which is higher than the number of males that have an aptitude for computer systems analyst (127).

Career	Type of High Fit	Graduation Year 2018			Graduation Year 2019		
		Female	Male	Total	Female	Male	Total
Business Intelligence Analyst	Interest	210	353	563	186	273	459
	Aptitude	254	182	436	148	136	284
Computer Network Architect	Interest	60	317	377	55	248	303
	Aptitude	532	407	939	363	288	651
Computer Systems Analyst	Interest	41	262	303	37	200	237
	Aptitude	188	127	315	100	83	183
Geographic Information Systems Technician	Interest	39	275	314	33	215	248
	Aptitude	566	511	1077	375	370	745
Geospatial Information Scientist and Technologist	Interest	48	267	315	44	213	257
	Aptitude	574	470	1044	408	344	752
Information Security Analyst	Interest	19	182	201	20	147	167
	Aptitude	863	581	1444	674	438	1112

Figure 7: Results from a school that administered the YouScience test[50]

It is our conclusion that identifying individuals (at the 7th or 8th grade level) that have an aptitude AND/OR interest in a technology related field and experience the possibilities in IT would lead to a more diverse and larger population of students willing to pursue an IT pathway.

For this to become actionable, students must be assessed at the middle school level to measure their aptitude and interest using a tool similar to YouScience.

"If someone has an aptitude for IT and are exposed to the possibilities – it may turn into an interest and a pathway for an IT career."

Step 2 – Experience IT

Just having the aptitude for IT is not enough to start a student down the path for an IT career. They must also have an experience that exposes them to the different aspects of technology. Too often students consider "technology" classes as coding or networking only and if they do not have an interest in one of those areas they stray away from IT. Therefore, by creating an

[49] https://www.youscience.com/

[50] Results are shown with permission from YouScience

opportunity to experience IT in an external event or program, students will gain an appreciation and love for all of the different aspects of technology.

Based on the feedback from the schools and employers, fusing this into the schools is not feasible. It needs to be an extension of school (after school program) or external events.

For example, the creation of a competition/showcase of technology that teams of students could participate in that include all aspects of solving a problem in IT. Through the workshop that was conducted with Rutherford County teachers (see Section 5.2.2), it was proposed to create a 6-week program where it culminated with a showcase/competition to show the ideas and prototypes of the students.

The 6-week program would start with a problem that needs to be addressed with technology and then the schools would devise a solution which includes all aspects of the problem, such as:

- Hardware
- Software
- Marketing
- Finance
- Project Management
- Prototyping
- Other key aspects of a business

Pilot 6-week showcase/competition with Rutherford County Schools

Innovate IT – a tech solution to conserving energy in the home

The students would be presented a problem of an overuse of electricity in the city of Murfreesboro. It is their mission to create a solution that uses "smart home" technology (IoT) to reduce the amount of electricity consumed within a household. The solution would include how they would market this product to homes or government agencies and include feasibility, financing, and project management principles. The presentations can take on a "Shark Tank" mentality of trying to find an investor.

If the showcase was held on March 23rd, student could be presented the problem on February 2nd, which includes guidelines, lists of materials, a small stipend, and other guidance. The students would then be expected to present and display their solutions on March 23rd.

By offering this opportunity to students that have an aptitude for technology, we will get more students interested and pursuing an IT pathway.

By incorporating all of the above aspects of the problem, it allows individuals that are not relatively interested in IT, but not wanting to program or create a network. They can instead work on marketing the prototype.

Step 3 - Secondary IT Pathways

Based on the assessment of what is currently being taught in the high schools, it is apparent that the current programs of study are being taught quite well. ***Yes, the high schools are doing an excellent job and the teachers are amazing at what they do.*** But, the restrictions on the fields and limited resources makes it hard for a school to attract a diverse and large population of students into a tech-related pathway. For example, many schools offer networking, which is a very narrow component of IT. It is also a part of the discipline that is quite different than other aspects of IT. According to Geoff Edwards - Manager of Network Infrastructure Engineering at Tractor Supply Company, "to be good at networking is an entirely different and unique skillset separate from other areas of IT".

The state of Tennessee currently includes four Programs of Study in Information Technology[51]:

Cybersecurity

- Level 1: Computer Science Foundations
- Level 2: Cybersecurity I
- Level 3: Cybersecurity II
- Level 4: Cybersecurity Practicum

Networking Systems

- Level 1: Computer Science Foundations
- Level 2: Computer Systems
- Level 3: Networking
- Level 4: Cabling and Internetworking -and/or- IT Clinical Internship

Coding

- Level 1: Computer Science Foundations
- Level 2: Coding I
- Level 3: Coding II -or- Mobile App Development
- Level 4: Coding Practicum -and/or- AP Computer Science -and/or- AP Computer Science Principles

Web Design

- Level 1: Computer Science Foundations
- Level 2: Web Design Foundations
- Level 3: Web Site Development
- Level 4: Web Design Practicum -and/or- AP Computer Science

[51] https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-information-technology.html

Unfortunately, this is not in line with job needs and is not an interesting path for the fringe IT student. Therefore, it can be reviewed to incorporate more tech-related programs of study that could attract other types of IT students, for example data science or business applications.

It is also important to look at other CTE pathways and identify opportunities to incorporate technology courses within those disciplines. Such as marketing or healthcare management. By opening the scope or by including technology classes with other non-IT CTE pathways, you may get more students into a pathway at the post-secondary level of education.

Step 4: Post-Secondary Paths

As stated in Section 6, there are five main paths to attaining the education needed to start in a technology related career. It is assumed that no student attains a high level of technical skills without work experience. A certification from a TCAT may lead to a medium level of technical skills, but not much in terms of knowledge. However, a Master's Degree would lend itself to the highest level of knowledge but may lead to only a medium or low level of technical skills.

It is also concluded that a future IT professional is best prepared when they have a high level of knowledge (which includes soft skills, problem solving, and content) and a medium level of technical skills. This was further validated from the employers that were used for this report (See Sections 1.1.2, 1.2.2, and 1.3.2).

Step 5 – Work Experience

No education which includes knowledge and skills would be complete without practical experience. Therefore, the ability to work while attaining skills (apprenticeship model) or after, in order for an individual to earn a high level of technical skills.

To attain a high level of technical skills, an individual needs time perfecting their trade. There is only so much that can be done in an academic environment. To attain a high proficiency within a specific technology, there is no better way than to work on a full-time basis. Therefore, work experience is the only way to truly attain a high level of technical skills. This can be accomplished through specific pipelines that allow students to attain an education and then a full-time job (similar to the traditional model of higher education), or a new approach using apprenticeship models.

7.1.2 Conclusion for Apprenticeship Engagement

The purpose of this study was to try identifying the pathways from secondary to post-secondary to apprenticeship type programs. It was intended to focus on K-12 since it is vitally important to get students into technology related careers. Based on the observations for this study, secondary schools are doing an excellent job of educating students that have an interest in technology. What is missing is identifying students that have the aptitude for technology but have yet developed an appreciation or interest for pursuing the technology related career.

Therefore, this study has identified five steps to get individuals ready for an optimal work experience (Figure 6). First it must start with identifying aptitude and interest, not just interest alone. Once the students are identified, giving them an experience in IT that is positive and that showcases their talents would be an opportunity to find the fringe IT student. The fringe IT student is an individual and has an aptitude for technology you may not want to pursue a career in a more technical field like coding or networking. But, they may be interested in a career in technology that focuses on data, management, or business processes. All areas that are in demand in the state of Tennessee.

Once students are identified, pathways in secondary schools are meant to continue to teach the knowledge and skills required for a technical career but should assume that a student will need more education. Therefore, pathways should focus on areas that would interest students and motivate them to want to pursue a technology related career.

Finally, it became important to distinguish between knowledge and skills and how both are important for an education. The knowledge learned in an academic environment allows for the development of soft skills, accumulation of content, and develop technical skills. All three areas are important and are achieved through different types of education paths. In any case, the ability to develop a high level of technical skills in an academic environment is not feasible and must have a work experience component, which could be offered by an apprenticeship program.

Therefore, students must be identified to have the aptitude and interest (Step 1) and then offer them an opportunity to learn about the possibilities (Step 2). After gaining an interest in technology, the student can learn more about it in a secondary pathway (Step 3) and then follow a path through a post-secondary education to develop knowledge and skills (Step 4). Finally, to attain a high level of technical skills to go along with their education, an opportunity to work in a full-time capacity or through an apprenticeship program will enable a student to take their education and technical skills and become an IT career ready professional.

Appendix A: List of Meetings

Date	Destination	Description
3/29/2018	Tractor Supply Company	Met with several employees at TSC to discuss the qualities needed to succeed as an IT professional.
4/5/2018	Rutherford Chamber of Commerce	Discussed pathways within HS that would entice students to pursue IT. Individuals from RC Chamber and RCS CTE Director.
4/6/2018	HCA	Met with individuals from Enterprise Architecture and Physician Services.
4/11/2018	Trinisys	Individuals from HR and their executive team met to discuss the mentoring, what skills are important, and how to get into IT.
4/11/2018	UT – Center for Industrial Services	Learned more about UT's CIS program and how it can relate to IT.
4/12/2018 – 4/14/2018	Southern Data Science Conference	Attended the conference to learn more about the data science discipline and how it can be pursued as a career.
4/18/2018	Rutherford Works Technology Council	Learned of YouScience and also proposed to work with RCS teachers.
4/19/2018	Nashville Technology Council	Attended the NTC quarterly board meeting and was able to discuss the grant and how they can help.
4/28/2018	TCAT Murfreesboro - Nissan	Toured the facility and learned about the partnership between TCAT and Nissan.
4/20/2018	Williamson County Schools	Met with CTE and Asst. Superintendent to discuss new pathways for secondary CTE.
4/26/2018	Steve Anderson – Alum and former Managing Partner at Accenture	Discussed the mentoring side of finding a path. The importance of a mentor in helping a student make the decision.
4/28/2018	Rutherford County Teacher Workshop	A workshop with RCS teachers to discuss their challenges and future directions. The proposed IT innovation showcase was created.
4/30/2018	Nashville Technology Council Advocacy Retreat	Brought apprenticeship and workforce up as the #1 priority for the advocacy committee.
5/2/2018	Tech Pathway Alignment	Met with Motlow State Community College, two campuses from TCAT, CTE at RCS, and the RC Chamber to identify pathways.
5/7/2018	NTC - Building a Seamless Tech Pipeline from Middle to High School to College	Hosted a summit with Motlow, Nashville State, TCAT, Volunteer State, and the NTC.