Florida IT Career Alliance Pathways Assessment
Final Report

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FITC Assessment Final Report

Executive Summary

The Information Institute at Florida State University assessed the technology and computing education pipeline to career pathways for students from high school through four-year institutions that participated in the Florida Board of Governors (BOG) TEAm grant known as the Florida Information Technology Career (FITC) Alliance. Researchers examined the curricula of participating institutions' information technology (IT), computer engineering (CE), computer science (CS), and information systems (IS) programs; analyzed job postings from two of the college campus career resource centers; analyzed internship posting from one university career center; analyzed 29 IT industry certification standards; and analyzed 16 interviews with individuals who employ IT personnel in their organizations.

At the conclusion of the analyses, the researchers reported that the two year and four year programs under study imparted key technical skills required by Florida Department of Education (FLDOE) Career and Technical Education (CTE) frameworks and Association for Computing Machinery (ACM)/Institute of Electrical and Electronic Engineering (IEEE) recommendations for IT curricula. These skills were also required to prepare candidates to qualify for high need IT jobs delineated by the Florida BOG in their Gap Analysis report: Computer Network Architects; Computer Systems Analysts; Computer Programmers; Applications Software Developers; Systems Software Developers; and Graphic Designers. However, complementary research activities including literature review, regional job posting analyses, internship posting analyses, and employer interviews suggested that applied skills such as critical thinking, problem solving, teamwork, and written and verbal communications were just as important as technical skills. These skills are more difficult to detect as learning outcomes, but the determination of the extent to which the examined programs foster these skills presents a fertile area for subsequent research. The specific role of high school programs in readying students for IT careers is also an area for further examination.

The researchers employed a process that began by identifying academic curriculum standards used by the various schools involved. The research team employed the standards from FLDOE for Information Technology for both secondary and post-secondary education; and the ACM and the IEEE computing standards for Information Technology, Computer Science, and Computer Engineering. The standards published by the ACM and the Information Systems Association (IAS) were employed for the Information Systems program. These standards represent just one method of assessing curriculum learning outcomes and are not the only standards available, especially for higher education.

The research team analyzed a total of 245 syllabi from the following programs:

- FSU IT: 26 syllabi
- FSU CS: 29 syllabi
    - B.A. in CS: 12 syllabi
    - B.S. in CS: 17 syllabi
- FAMU CS: 15 syllabi
- FAMU IT: 15 syllabi
- FAMU CE (combined program with FSU): 21 syllabi
- FAMU IS: 14 syllabi

- FSCJ: 125 syllabi
  - A.S. in Computer Information Technology: 31 syllabi
  - A.S. in Networking Systems Technology: 50 syllabi
  - B.A.S. In Information Technology Management: 24 syllabi
  - B.A.S in Comp. Systems Networking & Telecom 20 syllabi

The researchers then examined job and internship postings extracted from the FSU Career Center and provided by FSCJ. The job posting and internship analyses includes the following detail:

FSU IT Full Time	66	Internship	48
FSU CS Full Time	126	Internship	73
FSU CE Full Time	82	Internship	30
FSU IS Full Time	33	Internship	17
FSCJ Full Time	73		

Most of the job and internship postings were common in all the 4 programs. So, after combining these data, a total of 82 internship postings and 134 job postings were analyzed.

Finally, the employer interview analysis was conducted using the ACM/IEEE 2008 IT framework with additional high-frequency competencies added in from the job posting analysis. A convenience sample of 16 interviews were recorded, transcribed and coded using NVivo qualitative software analysis that provided a list of competency frequencies that was then compared to the competencies derived from the job posting analysis.

The work herein presented represents the preliminary findings of three methods and a description of the methodology in the following 14 independent reports:

Curriculum Analysis

1. Florida A&M University and Florida State University Combined Computing Engineering Curriculum Analysis
2. Florida A&M University Computer Science Curriculum Analysis
3. Florida A&M University Information Systems Curriculum Analysis
4. Florida A&M University Information Technology Curriculum Analysis
5. Florida State College at Jacksonville Information Technology Curriculum Analysis
6. Florida State University Computer Science Curriculum Analysis
7. Florida State University Information Technology Curriculum Analysis
8. Select North Florida High School Curriculum Analysis

Information Technology Job Posting Analyses

9. Florida State College at Jacksonville Career Resource Center Job Posting Analysis
10. Florida State University Career Center Job Posting Analysis

Internship Posting Analysis

11. Florida State University Career Center Internship Posting Analysis

Employer Interview Analysis

12. FITC Employer Interview Analysis

Certification Analysis

13. FITC Information Technology Selected Industry Certification Analysis

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1. Overview

1.1 About the Florida IT Career Pathways Alliance

The North Florida IT Career (FITC) Pathways Alliance[1] is a Florida Board of Governor's supported partnership between Florida State University (FSU) and Florida Agricultural and Mechanical University (FAMU) that will:

- Engage the K-20 education system in recruiting, retaining and placing qualified graduates for IT and computing professions;
- Enable FSU and FAMU to cooperate with academic and industry partners to assess and implement courses that help prepare computer occupation students to successfully complete critical industry standard certifications; and
- Establish a strong partnership between industry and North Florida's educational institutions for IT and computing career development and placement.

The FITC Pathways Alliance currently includes a number of Leon County high schools, FSU, FAMU, and an initial group of industry partners. Future participants may include Tallahassee Community College, Florida State College in Jacksonville, and additional North Florida high schools, community colleges, 4-year colleges and universities during the five year effort.

As part of the Targeted Educational Attainment (TEAm) grant program, of the FITC Alliance project's goals is to streamline the transitions students make among institutions (e.g., high schools to universities or community colleges to universities). The FITC Alliance members will achieve these goals by aligning and sharing degree requirements, as well as by encouraging and enabling prerequisite acquisition prior to entering post-secondary programs and by articulating and aligning certification preparation between institutions. This intended result of this close cooperation and alignment of FITC members' 9-16 IT programs is to reduce graduation time through dual enrollment and improve graduation rates for many students by increasing the real world relevancy of their learning experiences.

1.1.1 Foundational Work: Board of Governors' Gap Analysis

The need for TEAm grant-funded research arose from results of the Commission on Higher Education Access and Educational Attainment's 2013 *Aligning Workforce and Higher Education for Florida's Future* final report[2] that identified critical gaps between Bachelor's degree graduates and future workforce needs in the state of Florida. The findings of this gap analysis identified Computer Occupations as a critical gap area, specifically in candidates prepared to be Computer Network Architects; Computer Systems Analysts; Computer Programmers; Applications Software Developers; Systems Software Developers; and Graphic Designers. In fact, the analysis projected an under-supply of more than 2,000 qualified graduates

[1] http://fitc.cci.fsu.edu

[2] Commission on Higher Education Access and Educational Attainment [CHEAEA] (2013, November). *Aligning workforce and higher education for Florida's future: Final report*. Retrieved from http: www.flbog.edu about _doc commission-materials Access-and-Attainment-Comm-FINAL-REPORT-10_29_13_rev.docx.

to meet occupational demands in this area. In order to explore their roles in solutions to this looming shortage, FSU and FAMU were funded to expand outreach to potential students, increase retention, and enhance the employment placement of graduates.[3]

1.2 Summary of Institute Assessment Project

The Information Institute Florida IT Career Alliance Pathways Assessment project developed and implemented a number of school-to-career pathways assessment techniques and analyses to support FITC Alliance members' efforts to enhance recruit, retain, and place qualified Information Technology (IT) and computing workforce graduates. The assessment strategies included examining course syllabi from FITC Alliance members from six North Florida high schools, Florida State College at Jacksonville [FSCJ], FSU, and FAMU. In addition, the Institute researchers examined regional technology job postings and gathered needs perceptions from local technology workforce employers through interviews.

The study employed both formative and summative assessment strategies:

1) Measuring student learning outcomes specified in technology course syllabi using the Association for Computing Machinery (ACM) Institute for Electrical and Electronic Engineers (IEEE) Curriculum Standards and Florida Department of Education (FL DOE) Curriculum Computing Frameworks;

2) Assessing selected industrial technology certifications; and

3) Evaluating employer needs by analyzing their regional job postings and conducting employer surveys and semi-structured interviews.

These techniques were study team used these techniques to explore two overarching research questions.

1.3 Research Questions

RQ 1: To what extent do technology curricula, internships, IT industry certifications, and employer perceptions reflect stated job requirements?

RQ2: What are the different pathways available to students as they move from school to career?

In this report, we present the research foundation underlying these questions; the methods used to explore the research questions; summaries of each phase of the research findings; and conclusions in light of the questions posed here. We conclude with possible directions for future research.

2. Literature Review

[3] http: www.flbog.edu about teamgrants.php

Each step of the Florida IT Career Alliance Pathways Assessment project research questions, strategies, and analyses were grounded in a substantial foundation of published research.

2.1 High School Level Effect*s*

High school has been cited as a linchpin time in STEM career interest development (Bottia, Stearns, Mickelson, Moller, & Parker, 2013). Course experience, guidance, and informal learning experiences all present opportunities for students to be exposed to STEM fields and cultivate a passion for the area.

Students who develop an early interest in mathematics are more likely to pursue a STEM major. A number of current researchers (e.g., Iskander, Gore, Bergerson, & Furse, 2012; Ullman, 2012) have reported that high school technology education can bridge to expand post-secondary student participation in STEM (science, technology, engineering, and mathematics) because high school is a pivotal time for students to "become aware of potential STEM careers and connect these career decisions to their educational decisions" (Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011, p. 41)

High school course selection is an extremely important factor in raising STEM career interest. Students who receive appropriate guidance with course selection early on in their high school careers develop early and sustained interest in STEM fields (Wang, 2013). Especially for underrepresented and minority students, having an awareness of programs offered at a particular school is much more likely to result in engagement with a STEM discipline (Lichtenberger & George-Jackson, 2013). Taking physics, attending a school with a math and science focused program and intending to major in STEM during high school are the variables most closely associated with students' choice of STEM as a major (Bottia et al., 2013)

This relationship between exposure, enrollment, and sustained interest also suggests a strong need to advance training and knowledge among high school counselors so that they better understand the importance of the college choice process in facilitating STEM interests, particularly educating students about STEM programs (Perna, Rowan-Kenyon, Thomas, & Bell, 2008). A recent report by the Southern Regional Education Board has called for states to "[c]reate guidance systems that include career information, exploration and advisement and engage students in ongoing career and college counseling beginning in the middle grades (SREB, 2015). This has broad implications for college guidance counselors and college admissions representatives and suggests that the college search process needs to be augmented by additional presentations and materials that highlight specific programs in the STEM disciplines (Engberg & Wolniak, 2010).

Because STEM is a field in which hands-on learning is especially effective, professional development opportunities and instructional resources that help to move teachers away from direct instruction toward pedagogy that emphasizes inquiry-based learning infused with creativity and real world problem-solving is especially important (Engberg & Wolniak, 2010). The need for encouraging new pedagogical approaches is especially clear in K-12 computing education in which students become more familiar with computing concepts and prepared for post-secondary education or career attainment in the technology industry (Randolph, 2008). Although technology education has been cited as one of the areas that must be improved in order for the United States to remain technologically competitive, technology courses such as computer science (CS) are not only offered in all public high schools, but also the schools that do offer computing courses tend to focus on "rudimentary user skills" as opposed to more advanced topics such as problem solving (Cantrell & Ewing-Taylor, 2009; Randolph, 2008; Ryoo, Margolis, Lee, Sandoval, & Goode, 2013). Furthermore, high school computing teachers are often under-prepared to teach more advanced technology concepts, and they have few opportunities to develop their content knowledge or pedagogical strategies (Ryoo et al., 2013).

High school students' career interests are also compellingly engaged with hand-on experience. Professionals in STEM careers, particularly those with careers in the physical sciences, attribute their early decisions to take high school STEM electives and choose a college major to positive childhood experiences with science (Dorsen, Carlson, & Goodyear, 2006). Informal STEM activities help to maintain students' positive attitudes about STEM throughout middle school and high school; for example, students who study the sciences in college were more likely to have visited science museums than other students (Fenichel & Schweingruber, 2010; National Research Council [NRC], 2009). Informal education activities can increase young people's STEM self-efficacy. In an evaluation of the FIRST Robotics program for high school students, participants reported a sharp increase in self-confidence and an increased motivation to do well in school. Raising students' levels of self-efficacy through out-of-school learning experiences is particularly important when trying to keep girls in the STEM career pipeline (Dorsen et al., 2006).

2.2 College Level Effects

Students are more likely to persist in STEM fields if they attend postsecondary institutions that emphasize undergraduate teaching and research rather than graduate education in a more general sense (Wang, 2013). Extracurricular activities and broad study have demonstrated great value in exposing students to new perspectives and opportunities. For example, in a recent study of STEM-field persistence based on two national data sets, researchers found evidence that suggested that focused STEM learning experiences complemented with strong first-year grades in STEM-related coursework were particularly important in helping college students persist in STEM majors (Wang, 2013).

Many other initial college experiences directly shape students' decisions to pursue STEM fields of study. College student interaction with faculty and academic advisors positively influences numerous student outcomes. These interactions may provide necessary support for students to clarify and confirm their choice of major field of study. For many students, remediation is a necessary part of the curriculum. Unfortunately, little research has been done on the relationship between remediation and student choice of STEM coursework, sustained interest, and career aspirations (Wang, 2013)The receipt of financial aid also affects students' academic choices and the external demands that students may need to deal with, such as having family obligations and full time jobs, may redirect them from pursuing challenging STEM fields (Wang, 2012).

Once students are enrolled in coursework, the content of that coursework becomes a factor in workplace preparedness. Curriculum examination and revision are important ways to ensure that an educational program remains relevant and attractive to potential students. The literature emphasizes the benefit of having a standardized Body of Knowledge (BOK) as a reference point in program design and assessment; curriculum models that define a discipline's BOK—such as the models developed by the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE)—provide modern curricular guidance for undergraduate computing related programs internationally (Agresti, 2008). One indicator of a program's success is the employability of its graduates (Khan, 2011; Woodward, Imboden, & Martin, 2013). Because of the rapidly changing technology industry, educational programs must undergo frequent evaluation in order to prepare graduates to enter this dynamic industry, and previous research also highlights that this curriculum evaluation must be informed by industry expertise (Hwang & Soe, 2010).

2.3 Industry Certifications

In addition to allowing recipients to obtain skills in a self-directed, self-selected "stacked" or "latticed" format, industry certifications offer a way for academic programs to remain current with industry demands (Fedak et al., 2011). The growing demand for IT knowledge and skills from industry and the government is motivating academic institutions to produce graduates who have the necessary skills to be productive as they join the workforce (Al Rawi, Lansari, & Bouslama, 2005). Often in the hiring process, individuals who have acquired certain credentials are determined to possess a baseline of skills associated with that credential (Hunsinger & Smith, 2009; Hunsinger, Smith, & Winter, 2011; Wierschem, Zhang, & Johnston, 2010).

Certifications also may function as a signal to employers that a potential employee has the ability to remain current with a certain technology and is committed to continuing professional and skill development, as many certifications require eventual recertification; research also indicates that employers perceive certification-holders as individuals who will require reduced training time (Wierschem et al., 2010). Previous research suggests that students pursuing IT disciplines perceive that certifications enhance their employability and set them apart from other candidates because employers view certifications as a substitute for real-world experience (Hunsinger & Smith, 2009; McGill & Dixon, 2005).

2.4 Pipeline Becomes Pathway

Formal STEM education, internships, externships, and other immersive workplace activities form the pipeline of interested candidates exiting high school that resolves into a STEM career pathway of qualified candidates after college. STEM pathways are multifaceted and often difficult to define in part because they change and evolve over time, but defining STEM pathways is crucial to sustain the STEM workforce (Engberg & Wolniak, 2013).

Whereas IT career development has tended to involve stringently linear upward "ladder" ascensions, contemporary developments such as virtual offices, flat organizations, and an accelerating pace of technological change are leading to a lateral, nonlinear progression or "lattice." In the lattice model, traditional formal education, professional certifications, trade schools and the on-the-job training are all valued elements of career success (Deloitte, 2011; Farren, 2008). A latticed IT career may involve any number of combinations of professional experiences such as:

- Semi-Skilled Work: e.g., Coders, Installers;
- Single Function Career Paths: e.g., Network Engineers;
- Cross-Functional Career Paths: e.g., Software Support Technicians who perform Network Design;
- Multi-Functional Career Paths: e.g., professionals who perform web site development, application development, and IT training within one organization;
- Profession-Centered Career Paths: e.g., Health IT professionals for one health care system;
- Purpose-Centered Career Paths: e.g., Data management experts (Case, Gardiner, Rutner, & Dyer, 2012; Joseph, Fong Boh, Ang, & Slaughter, 2012).

Many studies classify skills into two types: technical skills and non-technical skills. Technical skills typically include skills such as programming, systems design, and network administration. Non-technical skills typically include customer support skills, decision-making skills, communication skills, logical reasoning skills, etc. Many studies have reported that these skills are more important than technical skills (Fang, Lee, & Koh, 2005; Kovacs, Davis, Scarpino, & Kovalchick, 2011; S. Lee, Yen, Havelka, & Koh, 2001; Young, 1996). However, technical skills are more influenced by business and industry requirements (Fang et al., 2005).

With this range of potential latticed career pathways, the pipeline also must be flexible to enable students to pursue degrees, certifications, immersive experiences, and ongoing education (Joseph et al., 2012; Missouri Economic Research and Information Center, 2014). Some researchers have suggested that formal and informal educational programs that aim to enhance any or all of these paths can be strengthened by ensuring that career pathways include (Social Policy Research Associates, 2011):

1. Cross-agency partnerships with clear roles defined for those relationships;
2. Engaged employers in identified industries;
3. Up-to-date education and training programs specific to those employers' and industry needs;
4. Articulated budget needs with adequate funding support;
5. Alignment between policies and programs that span the pathway; and
6. Established methods and metrics to evaluate performance and make adjustments.

Multiple methodologies exist to examine IT competency alignment with employer needs and student success but ultimately employers' feedback has been considered to have the most weight (McMurtrey, Downey, Zeltmann, & Friedman, 2008). Often, employers struggle to recruit and retain qualified IT personnel, and employers have found that new entrants to the workforce lack skills that are critical to job success (Debuse & Lawley, 2009). Additionally, previous research conducted to determine IT employer needs supports the argument that these employers are looking for individuals with specific technical skills but universal applied skills (Hunt, Crews, Feather-Gannon, Hunt, & Smith, 2011; C. K. Lee & Han, 2008). According to a systematic review of employer perceptions of workforce preparedness, findings suggested that applied skills like critical thinking problem solving, communication skills, and leadership are more important than basic knowledge skills such as math, science, or reading comprehension (The Conference Board, Corporate Voices for Working Families, Partnership for 21st Century Skills, & Society for Human Resource Management, 2006).

To meet regional industry employer needs, it is helpful to seek collaboration with industry partners and understand the skills that employers seek in prospective employees (Woodward et al., 2013). However, there is a lack of consensus on which skills can be considered critical (Fang et al., 2005) as there is a difference in the IT skills needed for entry-level employment, and those that prepare a student for long-term career development (Downey, McMurtrey, & Zeltmann, 2008).

3. Methodology

3.1 Curriculum Analysis

In order to gain an understanding of the computing curricula taught at FAMU and FSU, the researchers analyzed syllabus content. Using Python programming language to automate text processing and keyword extraction, learning outcomes were identified in the syllabi for each program included in the analysis. The extracted learning outcomes were compared to the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) (hereafter ACM IEEE) undergraduate computing curriculum guidelines. The ACM IEEE organizations jointly sponsor curriculum volumes on undergraduate computing curricula at the four-year university level, which aim at providing modern curriculum guidelines for undergraduate technology and computing programs internationally. Beginning in 2001, this volume was fragmented into five disciplines: computer science (CS), computer engineering (CE), information systems (IS), information technology (IT), and software engineering (SE). The effort behind publishing curriculum guidelines is to help train future generations of computing professionals. Figure 1 provides an overview of the syllabus analysis process.

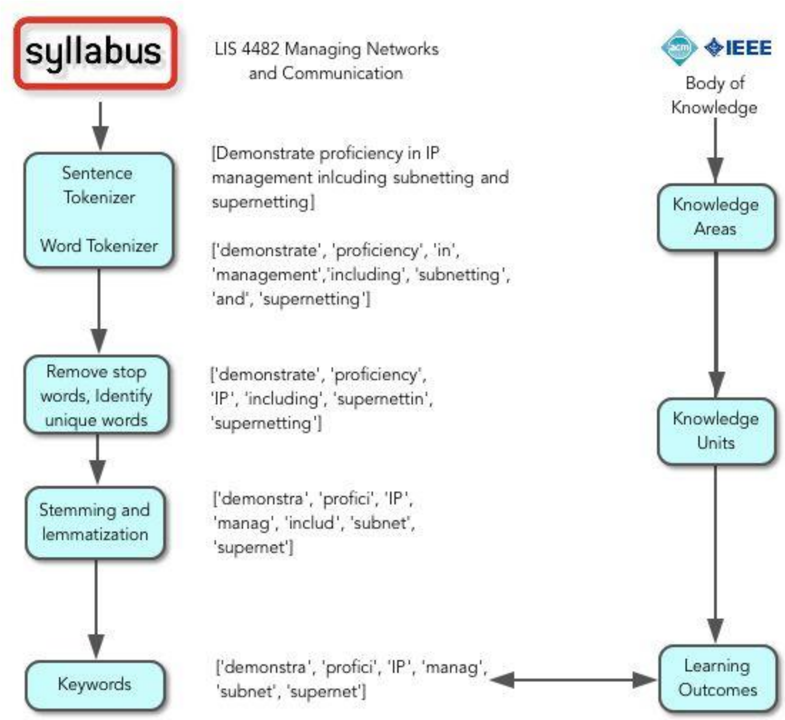

Figure 1. Overview of syllabus analysis process

Figure 1 shows that as with the syllabi, Python script was used to extract key words and phrases from the curriculum guidelines. These were then compared to the learning outcomes from the syllabi to determine any similarity between the syllabi and the curriculum guidelines.

Because the ACM IEEE curriculum guidelines are intended to provide direction for four-year undergraduate technology and computing programs, they were not a suitable standard against which to compare the high school syllabi or the FSCJ syllabi. The FLDOE establishes curriculum framework standards for Florida's Career Technical Education (CTE) programs, which include technology and computing disciplines, offering a suitable standard for comparison.

The FAMU Information Systems (IS) curriculum analysis employed syllabus assessment to examine alignments between learning outcomes specified in the program syllabi and selected IS curriculum frameworks—the Association for Computing Machinery (ACM) and the Association for Information Systems (AIS) 2010 IS curriculum guidelines (hereafter ACM AIS).

The FLDOE organizes the Career and Technical Education (CTE) frameworks using the U.S. Department of Education "career clusters." The career clusters are further broken down into individual programs such as Digital Media Technology or Engineering Pathways. Within each of these programs, courses are identified that satisfy the program's learning outcomes. For example, Digital Media Fundamentals is one of the courses included in the Digital Media Technology program within the Information Technology career cluster. For each program, the FLDOE lists competencies that the student will ideally be exposed to in the course. Each career cluster in the FLDOE contains several programs related to that cluster. The programs are further broken down into courses, for which the FLDOE specifies certain course standards, learning outcomes, or core competencies that a student should achieve upon completion of the course. The results of the syllabi analyses are summarized in the Findings section of this report and present in depth in Appendices G-L.

The automatic text mining approach was not suited to analyze the diverse structure of the high school syllabi so these were manually analyzed. For each high school syllabus, learning outcomes were extracted from sections that included “Course Objectives,” “Course Goals,” and “Class Activities” among others. The learning outcomes were then compared based on keyword matches in the program standards learning objectives course competencies listed by the FLDOE for the corresponding course by examining the percentage of similarity between the course syllabus and the FLDOE curriculum frameworks. This method was also used for the FSCJ IT program analysis; however that analysis employed the automatic text mining approach to compare the course learning outcomes with the FLDOE CTE frameworks. The results of the syllabi analyses are summarized in the Findings section of this report and present in depth in Appendices G-L.

3.2 Industry Certification Analysis

The researchers analyzed the content of 15 certifications recommended by the participating programs. All IT certifications feature specific objectives and require mastering certain skills that are not necessarily included in IT curricula (Al Rawi et al., 2005). IT program courses have specific objectives and outcomes that need to be achieved in order to pass the course and fulfill the graduation requirement. According to *Information Technology 2008: Curriculum Guidelines for Undergraduate Degree Programs in Information Technology*, “many certifications are specific to a given vendor and are very narrowly focused. They therefore usually do not meet the learning outcomes defined in IEEE Curriculum Guidelines document” (Association for Computing Machinery [ACM] & IEEE Computer Society, 2008, p. 48). Similar to previous research conducted by Bouslama et al. (2005), this study sought to determine the content overlap between industry certifications and program courses by extracting and comparing the certification objectives to the learning objectives from IT program courses. It examines specific areas of potential certification integration from selected programs of FSU and FAMU.

Once the researchers identified certification objectives, FSU and FAMU IT program courses that cover these objectives were analyzed to identify if the learning objectives from courses are covered in certifications, suggesting that the certification could be logically integrated into the course. For each certification, all potentially relevant courses in the FSU and FAMU undergraduate IT programs were considered. A list of all concepts or topics, if any, not included in the courses was then developed. If all the certification topics were covered in the course or courses analyzed, a complete content match was determined to exist between the course(s) and the specific certification.

3.3 Job and Internship Posting Analyses

The FSU Career Center provided the researchers copies of 134 jobs and 82 internships posted between January 2014 and December 31, 2014. The researchers employed Leximancer software to analyze the job postings, removing the posters' contact information and company demographic information. As a powerful software tool designed for analyzing natural language text data, Leximancer can visually generate main themes of concepts in context. As Bozkurt and Helm noted, "these concepts are not just keywords that occur frequently, but words that 'travel together' throughout the text" (p. 340), meaning they are often paired together throughout the text. Leximancer generates themes to indicate the terms' relative connectedness by their proximity to each other. All of these visuals help identify main themes in job postings and required skills specified in the job postings.

In addition to the visual concept map, Leximancer also automatically generates a list of the most frequently occurring concepts themes in the text. These concepts were manually grouped based on the concepts' original meaning in the job ad and were further analyzed to determine the principle concepts related to them. The analysis then compared the job postings with the selected syllabi to assess how well the academic programs are preparing students to meet the needs of employers within the local technology industry. The researchers employed a similar process to analyze the internship postings (N=82) for the same one year period of time.

3.4 Employer Interviews

The researchers recruited 54 employers from the FITC Career Fair on October 7th, 2014. Employers from the North Florida region were sent a web-based survey concerning employee competencies and hiring practices, as well as an invitation to participate in a follow-up interview. The survey collected employer interviewees' personal demographic information, organizational information, and information about hiring practices and perceptions of specific entry-level technology employee competencies.

The researchers used the voluntary follow up interviews to identify the specific knowledge and skill sets employers need and their perceptions of how each education tier can develop effective academic programs that support students' technology career pathways. Each interview lasted approximately an hour.

The interviews were recorded, transcribed, and analyzed through an iterative process using open and axial coding to develop a list of required technology knowledge and skill sets for new entry-level employees.

3.5. Preliminary Pathway Identification

At the conclusion of the data analysis, we used the National Association of State Directors of Career Technical Education Consortium (NASDCTEc) IT Career Cluster Framework Knowledge & Skills Statements[4] and Plan of Study[5] to link the high need careers identified by the Board of Governors Gap Analysis report to identify potential educational pathways. Those job titles are Computer Network Architects; Computer Systems Analysts; Computer Programmers; Applications Software Developers; Systems Software Developers; and Graphic Designers. Figure 2 illustrates the process used to map educational experiences to those careers.

[4] http: careertech.org sites default files K%26S-CareerCluster-IT-2008.pdf
[5] http: careertech.org sites default files PlanStudy-CareerCluster-IT.pdf

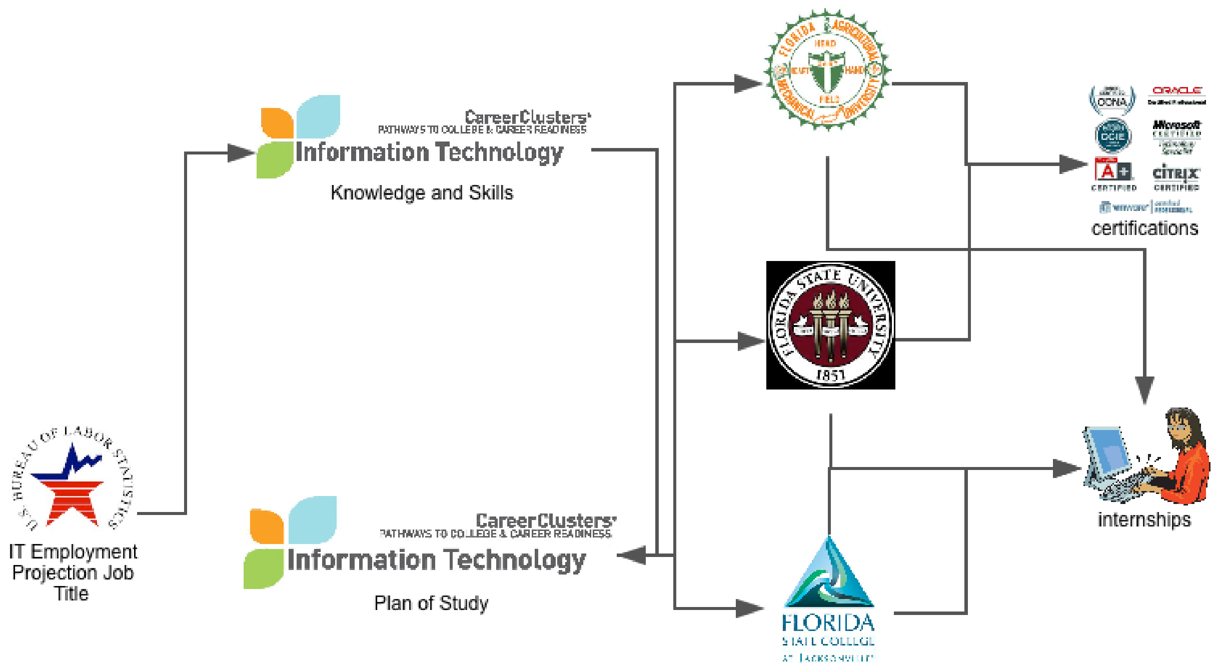

Figure 2. Preliminary pathways identification process

As Figure 2 suggests, the study team started with the high need job title from the Board of Governors' GAP analysis (which are presented as Bureau of Labor Statistics job titles), reviewed the Knowledge and Skills for relevant learning outcomes and Plan of Study documents for the points at which those learning outcomes should be imparted. These learning outcomes were then matched to the curriculum components in the FSU, FAMU, and FSCJ syllabi as well as the contents of internship experiences and industry certifications.

4. Findings Summaries

4.1 Employers

4.1.1 Interview Results

The study team analyzed 16 employers' perceptions of how employees working in IT roles in their workplaces can best be prepared for success on the job. Several concerns and shared beliefs emerged from these conversations:

- IT education must be continuously assessed to remain relevant to changing workplace needs, especially in dynamic technology fields. Most of the employers emphasized that those schools with "deep partnerships between the local industry and the colleges" are more adept at meeting the needs of employers. One employer suggested that his situation is so ideal that it "should be institutionalized across the state."

- Professional ,"soft", or applied, skills must be incorporated into the curriculum, either in the coursework or through some type of experiential learning mechanism. Business fundamentals skills ranked in the top five skills by three of the employment sectors; overall, general skill development is an invaluable outcome of experiential learning opportunities. Further, internships provide a context in which employers and students can 'test the waters' without any long term commitment, allowing employers to assess interns' 'fit' while allowing interns to gain a better understanding what will make them happy on the job.

- Employers overall were clear that professional industry certification in a technology their company values was a nice benefit for an applicant and, all other things being equal, would give an applicant marketability that others lack. However, applicants' job experience outweighed this competency, as most employers acknowledged that their needs are constantly changing and that certifications generally provide proof of skill sets that may become quickly obsolete.

- One employer's view was that technology competency can be compared to a three-legged stool: education, certification, and experience, a profile that describes the ideal new employee. Not having participated in internships puts a graduate "at a disadvantage for a job."

- Many employers stated that the entry-level employees begin their careers in a customer service role, and therefore communication and interpersonal skills are "high on the list" of desirable competencies.

Many employers emphasized that good internship opportunities were challenging to provide, requiring structure and mentoring resources on the part of the employer. This is an even larger problem in a rural context: the two nonmetropolitan interviewees stressed that they do not have the means to provide internships regularly. The need for further study into the challenges of the nonmetropolitan setting is demonstrated by the fact that very few nonmetropolitan employers participated in this study.

4.1.2 Job Posting Analysis Results

The job posting analysis included 134 jobs in the sectors of E-Commerce (8); Education (1); Engineering (7); Financial (9); Government (13); Health Care (2); Insurance (2); Railroad (3; Research (1); Retail (2); Telecommunications (1); and Technology (85). Table 1 depicts the summary of the job posting analysis by the 968 mentions of specific ACM IEEE IT knowledge domain, as well as the ratio between job and knowledge domain area.

As Table 1 shows, each job included 7.23 mentions of specific knowledge domains with the most frequent occurrences in the System Integration and Architecture (SIA) knowledge domain across all sectors at 1.17 mentions per job, followed by Programming Fundamentals (.69 per job); System Administration and Maintenance (SA) (.65 per job); and Information Management (IM) (.63 per job). Note that although Social and Professional Issues are broken into detail, they comprise the largest area of knowledge domains at 2.42 per job. This knowledge domain is difficult to code because Social and Professional Issues are affective and interlinked; for this reason, we recommend interpretation at a higher level of conceptual granularity.

Table 1. Summary of Job Posting Analysis' Knowledge Domain Mentions by Industry Sector

IEEE ACM Knowledge Domain	Mentions by Sector (n jobs) (N=134)													
	E-Commerce (8)	Education (1)	Engineering (7)	Financial (9)	Government (13)	Health Care (2)	Insurance (2)	Railroad (3)	Research (1)	Retail (2)	Telecomm (1)	Technology (85)	Total (134)	Ratio per Job
Human Computer Interaction (HCI)	9	0	1	2	21	3	0	0	0	2	0	29	67	1:.50
Information Assurance and Security (IAS)	0	0	0	0	10	0	0	0	0	0	0	6	16	1:.12
Information Management (IM)	6	1	2	6	20	0	0	4	1	3	1	41	85	1:.63
Integrative Programming & Technologies (IPT)	4	0	2	3	0	2	0	3	0	0	0	22	36	1:.27
Math and Statistics for IT (MATH)	0	0	0	2	4	0	0	1	0	0	0	0	7	1:.05
Networking (NET)	0	0	0	1	15	0	0	1	0	1	0	0	18	1:.13
Programming Fundamentals (PF)	7	11	0	1	5	0	1	5	0	4	2	56	92	1:.69
Platform Technologies (PT)	0	0	0	1	6	0	1	2	0	3	0	10	23	1:.17
System Administration and Maintenance (SA)	0	0	11	2	26	1	1	6	2	3	1	34	87	1:.65
System Integration and Architecture (SIA)	0	4	6	7	18	2	1	4	0	8	2	105	157	1:1.17
Social and Professional Issues-Business Fundamentals (SP-BF)	0	3	4	2	11	0	1	1	0	3	0	39	64	1:.48
Social and Professional Issues-Communications (SP-COM)	0	0	2	3	8	2	1	1	0	2	0	23	42	1:.31
Social and Professional Issues-Customer Service (SP-CUS)	0	0	2	1	13	0	0	0	1	1	0	39	57	1:.43
Social and Professional Issues-SP-FL	2	1	3	2	4	0	0	1	0	2	0	18	33	1:.25
Social and Professional Issues (SP-IS)	0	0	0	1	0	0	0	0	0	0	0	7	8	1:.06
Social and Professional Issues-Problem Solving (SP-PS)	1	0	2	0	8	0	0	4	0	0	0	16	31	1:.23
Social and Professional Issues SP-SM	4	1	0	1	4	2	0	0	0	0	0	23	35	1:.26
Social and Professional Issues SP-TW	0	1	1	1	5	1	0	2	2	0	0	41	54	1:.40
Web Systems and Technologies (WS)	0	0	1	2	12	6	0	2	1	1	1	30	56	1:.42
Total	33	22	37	38	190	19	6	37	7	33	7	539	968	1:7.23

4.2 Four Year (Bachelor's Level) Programs

4.2.1 FAMU Computer Engineering (CE)

The syllabi analyzed contained Knowledge Units from 15 out of 18 (over 80%) ACM and IEEE CE Knowledge Areas. When the learning outcomes extracted from the FAMU CE syllabi were compared to the ACM IEEE Knowledge Areas in the CE curriculum guidelines, it was observed that there was much similarity between the two for certain Knowledge Areas. The Knowledge Areas that had more than 60% Knowledge Unit coverage in the FAMU course syllabi are: Computer Architecture and Organization (CAO), Circuits and Signals (CSG), Digital Logic (DIG), Discrete Structures (DSC), Digital Signal Processing (DSP), Electronics (ELE), Embedded Systems (ESY), Operating Systems, Programming Fundamentals (PRF), and Probability and Statistics (PRS). The results of this analysis suggest that the FAMU CE program strongly reflects ACM IEEE curriculum guidelines.

4.2.2 FAMU Computer Science (CS)

Through a comparison between the FAMU CS course syllabi and the ACM IEEE CS curriculum guidelines, it was observed that there was much similarity between the learning objectives in the syllabi and ACM IEEE curriculum guidelines. From the analysis, the four Knowledge Areas were 100% covered in the FAMU CS syllabi were: Algorithms & Complexity, Information Management, Networking and Communication, and Operating Systems. The seven Knowledge Areas with partial (less than 100%) coverage of Core Tier-1 Knowledge Units were: Information Assurance & Security, Computational Science, Graphics and Visualization, System Fundamentals, Human Computer Interaction, Parallel and Distributed Computing, and Software Engineering. Similarly for the coverage of Core Tier-2 Knowledge Units, the four Knowledge Areas were 100% covered in the FAMU CS syllabi were: Information Management, Networking and Communication, Human computer Interaction, and Operating Systems. The seven Knowledge Areas with partial (less than 100%) Coverage of Core Tier-2 Knowledge Units were: Graphics and Visualization, Systems Fundamentals, Parallel and Distributed Computing, Intelligent Systems, Discrete Structures, Social and Professional Practice, and Algorithms & Complexity.

Based on the analysis, the study team determined that there is similarity between the FAMU CS courses and the ACM IEEE curriculum guidelines. The Knowledge Areas that were not represented in the course syllabi were: Intelligent Systems, Information Assurance & Security, Computational Science, Graphics and Visualization, Systems Fundamentals, Human Computer Interaction, Parallel and Distributed Computing, and Software Engineering.

4.2.3 FAMU Information Systems (IS)

The syllabus analysis found a great deal of similarity between the FAMU IS course learning outcomes and the core courses in the ACM AIS curriculum guidelines. The study team determined that 5 out of 7 (71.4%) suggested core courses demonstrated more than 60% learning outcome coverage in FAMU IS syllabi (N=14), meaning that more than 60% of the suggested learning outcomes in the ACM AIS curriculum guidelines were included in the course syllabi analyzed. There were no instances of a core course in which learning outcomes were not at least partially covered in the syllabi analyzed.

4.2.4 FAMU Information Technology (IT)

Our analysis demonstrated that there is a strong similarity between the FAMU IT course learning outcomes and the ACM IEEE IT curriculum guidelines. It was determined that 12 out of 13 (92.3%) of the Knowledge Areas specified in the ACM IEEE IT curriculum guidelines contained Knowledge Units that were more than 60% covered in the FAMU IT syllabi (N=15). Only one Knowledge Area had a percentage of Knowledge Unit coverage below 60%. This Knowledge Area is Integrative Programming and Technologies (IPT). There were no instances of a Knowledge Area whose Knowledge Units were not at least partially covered in the syllabi analyzed.

4.2.5 FSU Computer Science (CS)

The analysis of 12 course syllabi for required courses in the Bachelor's of Arts (BA) in CS and 17 course syllabi for required courses in the Bachelor's of Science (BS) in CS demonstrated strong similarity to the ACMIEEE curriculum guidelines in 17 out of 18 Knowledge Areas (94%). The Knowledge Areas that demonstrated more than 60% similarity to the ACM IEEE CS curriculum guidelines are: AL-Algorithms, AR-Architecture and Organization, DS-Discrete Structures, IAS-Information Assurance, IM-Information Management, NC-Networking and Communication, OS-Operating Systems, PD-Parallel and Distributed Computing, PL-Programming Languages, SDF-Software Development Fundamentals, SE-Software Engineering, SF-Systems Fundamentals, and SP-Social Issues and Professional Practice.

There was only one Knowledge Area for which no Knowledge Units and learning outcomes were listed in course syllabi, which was the knowledge area PBD-Platform-based development.

4.2.6 FSU Information Technology (IT)

Based on the syllabus analysis, we determined that there was similarity between the course syllabi learning outcomes and the ACM IEEE learning outcomes in 12 out of 13 (92%) Knowledge Areas. The highest level of similarity between the syllabi and the curriculum guidelines was observed in the Knowledge Areas ITF-Information Technology Fundamentals, IAS-Information Assurance and Security, IM-Information Management, NET-Networking, PT-Platform Technologies, SP-Social and Professional Issues, and WS-Web Technologies were covered in FSU syllabi.

Additionally, we observed some similarity between learning outcomes in course syllabi and the curriculum guidelines for these Knowledge Areas: Human Computer Interaction (HCI), Integrative Programming and Technologies (IPT), Programming Fundamentals (PF), Systems Administration and Maintenance (SA), and Social and Professional Issues (SP).

The Math and Statistics for IT (MS) Knowledge Area is the only Knowledge Area not represented in the FSU course syllabi analyzed.

4.3 Two Year Program

4.3.1 FSCJ IT

The FSCJ course syllabi follow a fairly uniform format that strongly reflected the FLDOE frameworks. The FSCJ IT curriculum is designed to include courses from career clusters outside of the FLDOE information technology career cluster. For example, the course MAN 2582—Introduction to Project Management has learning outcomes from the business administration framework which is included in the Business Management & Administration Career Cluster, and CGS 1100—Microcomputer Applications for Business and Economics is a course from the finance career cluster.

Of the 81 courses analyzed from the Associate's of Science (AS) in Computer Information Technology (CIT) and AS in Networking Systems Technology (NST), 69 (85%) courses belonged to the FLDOE information technology career cluster, 7 (9%) courses belonged to the business, management & administration career cluster, 3 (4%) courses were from the finance career cluster and 1 (1%) course each from Engineering & Technology Education and Arts AV Technology & Communication career clusters.

The study team's analysis suggests that that FSCJ IT curriculum strongly reflects many non-technical knowledge and skills reflected in high need job areas. FSCJ IT curriculum also appears to impart the technical requirements listed in job postings. However, the concepts grouped under business and people skills – communication skills and team building skills- were not listed as specific learning objectives in the syllabi.

4.4 High School

Our results suggest that there is some high school course syllabi follow the FLDOE frameworks closely while other high school programs reflect a looser match. Figure 3 depicts the distribution of IT course content in the participating high schools.

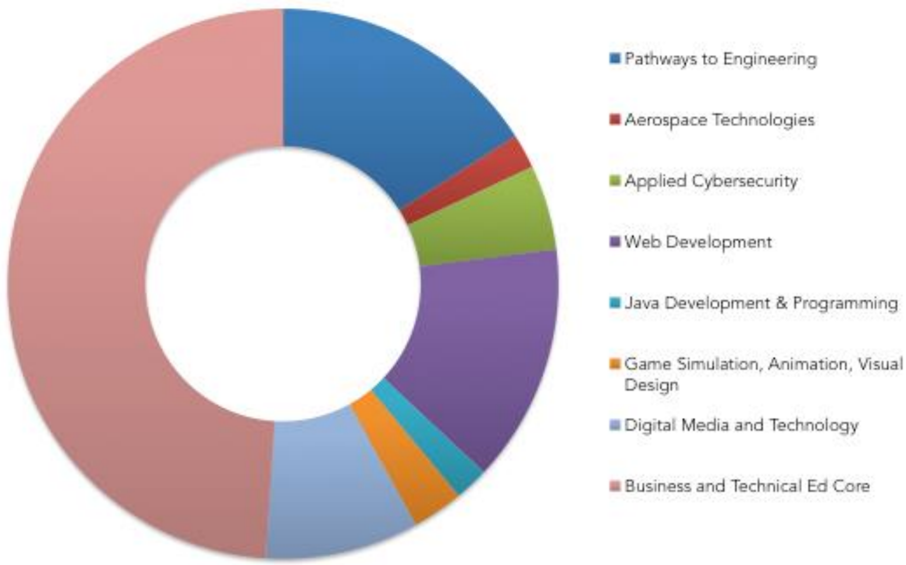

Figure 3. High school IT course content distribution

In some areas, the alignments were very close. For example, in many areas, the syllabi from Gulf County's high schools reflected a complete alignment to the FLDOE frameworks, with the Introduction to Information Technology courses most closely followed the FLDOE frameworks in all districts.

The FLDOE programs for the Information Technology Career Cluster that are not represented in the sample were: Applied Information Technology, Business Computer Programming, Computer Systems & Information Technology, Database and Programming Essentials, Database Application Development & Programming, Game Simulation Animation Advanced Applications, Game Simulation Animation Audio Video Effects, Game Simulation Animation Programming, Geospatial Geographic Information Systems Technology, .NET Application Development & Programming, Network Support Services, Network Systems Administration, Technology Support Services, and Web Application Development & Programming. These frameworks contain courses that present more advanced, specialized topics in information technology. Based on the syllabi provided, these programs are not being addressed at the high school level. Furthermore, there was only one course syllabus provided that contained learning outcomes related to coding (AP Computer Science). Coding and programming have been identified as important knowledge areas for high school students seeking to pursue computing careers (Ernst & Clark, 2012). Although there may be more similarly advanced courses in North Florida high schools, they are not present in the sample.

4.5 Internships

This analysis of internship postings found that students can expect to gain workplace experience and an exposure to technical and general competencies, which is consistent with previous research. Although much of the literature emphasizes the professional competencies (teamwork, communication, and professionalism skills, etc.), this analysis found that the internship postings greatly emphasized technical competencies over general competencies. From the 82 posts analyzed, 363 technical competencies were identified but only 114 general competencies were identified.

Web Systems and Technologies was the overwhelming most frequently identified technical competency. The job postings analysis found the share of this competency was 15.3% while the BSIT curriculum analysis reported it as 12.43%. According to the ACM IEEE 2008 IT curriculum guidelines that served as the codebook for this analysis, this knowledge area “covers the design, implementation, and testing of web-based applications including related software, databases, interfaces, and digital media. It also covers social, ethical and security issues arising from the Web and social software” (ACM & IEEE, 2008, p. 148). Web System specific technologies like HTML5, CSS, JavaScript, JQuery, PHP, XML, ASP and AJAX were identified from internship postings. Even though course technologies like HTML5, CSS, JavaScript, PHP were covered as part of curriculum, technologies like ASP, AJAX, JQuery were not part of BS IT program. So, the internships analyzed provide an opportunity for students to work on various technologies that are not covered in curriculum.

4.6 Certifications

From the analysis of 15 IT certifications and the related FSU and FAMU IT courses, it was determined that partial certification topics for 12 out of 15 certifications are covered in existing FSU courses, and 13 out of 15 certifications’ topics and exam contents are partially covered in existing FAMU courses.

The FSU courses covered all learning objectives and exam contents for three certifications; for FAMU, the number of certifications for which all learning objectives were covered in the courses was two. As with FSU, all certification exam contents were covered in existing FAMU IT courses for the W3Schools CSS and Oracle MySQL Database Developer industry certifications. These certifications easily fit into existing course contents and may provide students with the opportunity to prepare themselves to be certified in those areas.

Findings suggest that certifications for which the objectives were partially covered in FSU and FAMU IT courses can be made to fully provide certification contents with revisions and additions to the existing curricula. Based on the analysis, it was determined that the CAPM certification topics matched with some content in the FSU courses LIS 4910 (IT Project) and LIS 4708 (Perspectives on Information Technology) and the FAMU course CIS 4945 (IT Capstone Project). In order to incorporate the CAPM certification topics fully, a course particularly related to software project management that covers all the exam content could be introduced. Similarly, an operating systems course can be used to integrate and emphasize the ‘Operating Systems’ domain of the CompTIA A+ 220-802 certification objectives. The Network+ certification can be integrated if skills from network operations domain such as performance tracking tools, monitoring tools, and network architecture concepts like cloud technologies and virtualization can be integrated to the existing courses so that they meet certification objectives, as these were the certification domains that were determined to be not listed in the course syllabi analyzed. The CompTIA Security+ certification topics that could be included into existing courses include skills from application, data and host security, access control and identity management and cryptography domains. In order to remain current with the existing CSS certification requirements, revisions to course syllabi can be made to include the latest version of CSS. As we observed in Figure 3, the high schools included in the assessment also offer their students many of the certifications depicted in Figure 4.

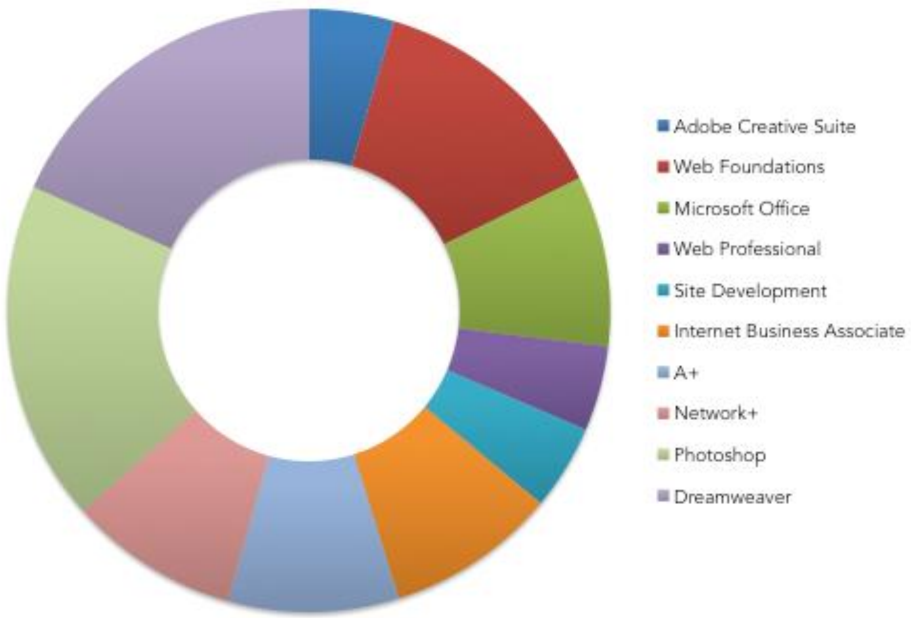

Figure 4. Certifications offered by participating high school IT programs

5. Emerging Pathways for GAP Analysis Areas

The final phase of the research analyses included attempting to map the high need IT job areas identified by the Florida Board of Governors' Gap Analysis (i.e., Computer Network Architect; Computer Systems Analyst; Computer Programmer; Applications Software Developer; Systems Software Developer; and Graphic Designer) to educational opportunities in attempt to link them to careers mapped in NASDCTEc's *IT Career Cluster*. In this analysis, we also considered candidate qualities mentioned by employers. In this section, we present the apparent pathways from school to career. In consideration for report length, we do not include the extent to which all of the programs we examined fit into the pathways; rather, consider these pathways as examples. Additional pathways can be mapped upon request.

These pathways all presume that secondary students meet their state's academic standards. All Essential Cluster and Pathway Knowledge and Skills are predicated on the assumption that foundational academic skills have been attained. Figure 5 provides an overview of the IT pathways resulting from our analyses.

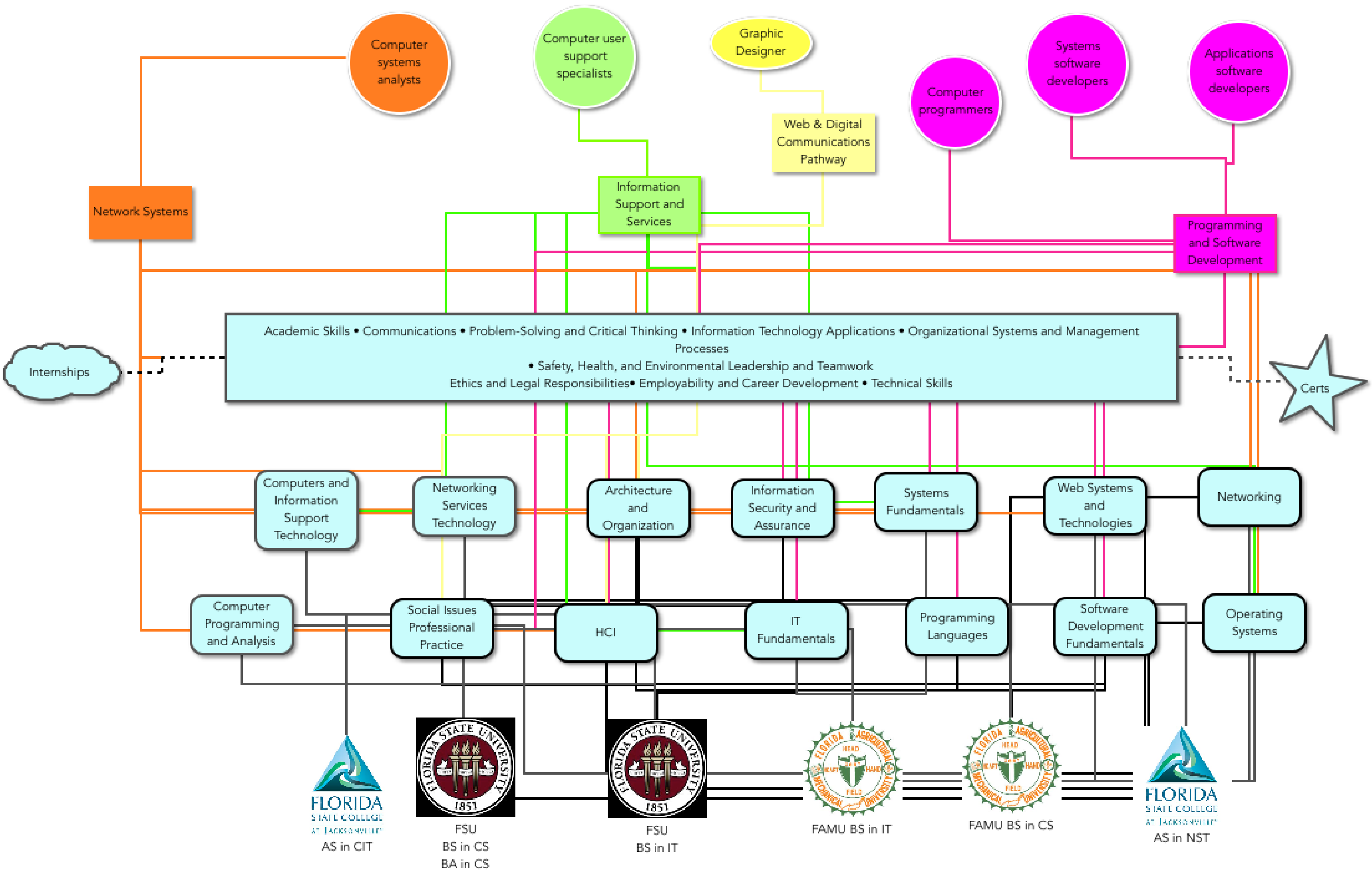

Figure 5. Overview of IT Career Pathways

Working from top down, Figure 5 links specific IT job titles to core academic competencies, then to disciplinary competencies, and finally to specific programs under study. Internships and certifications are placed along side coursework because they act as a complement to formal educational experiences.

Below, we present sample pathways. Not all programs are included, but these pathways represent examples of pathways that emerged from our analysis for each of the Board of Governors' Gap Analysis high need IT job areas.

5.1 Computer Network Architect and Computer Systems Analyst

Computer Network Architect and Computer Systems Analyst careers are part of NASDCTEc's *Network Systems Pathway*. These positions involve network analysis, planning and implementation, including design, installation, maintenance and management of network systems. Figure 6 illustrates the career pathways stemming from the FSU BSIT program.

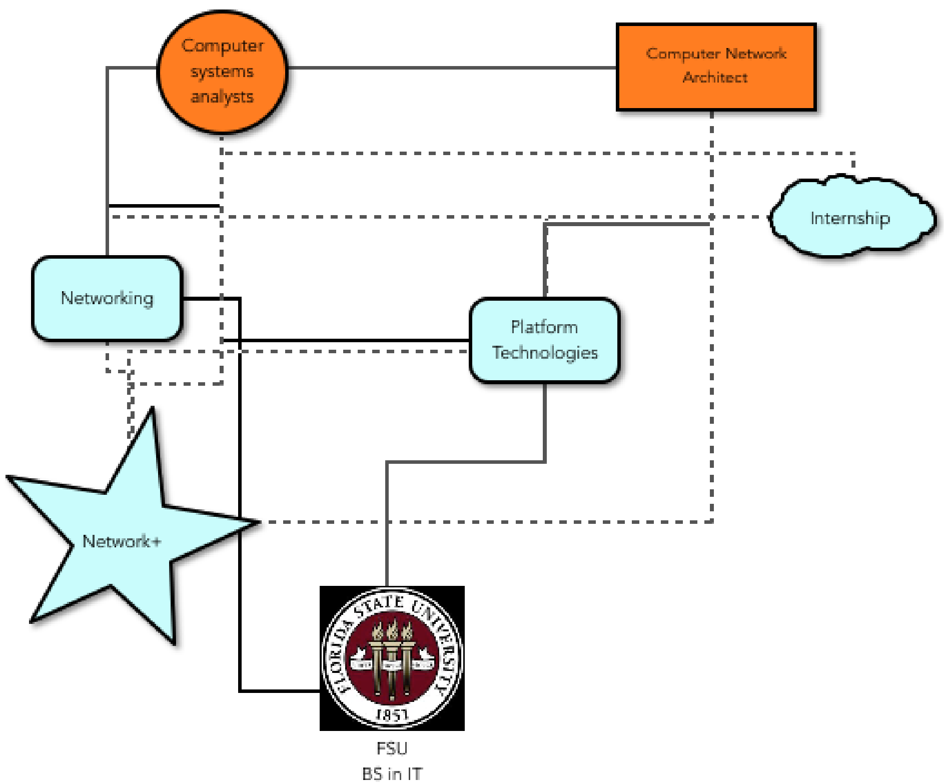

Figure 6. Network Systems Career Cluster Pathways

As Figure 6 shows, students interested in either Computer Network Architect and Computer Systems Analyst positions require a strong foundation in Networking and Platform Technologies, but also receive additional qualifications such a critical thinking and problem solving. Students who obtain a Network+ industry certification are able to add an additional optional appropriate layer to their preparation, as denoted by dashed lines.

5.2 Computer Programmer and Applications Software Developer

Careers in Programming and Software Development are part of NASDCTEc's *Programming and Software Development Pathway* and involve the design development implementation and maintenance of computer systems and software, requiring knowledge of computer operating systems, programming languages, and software development. People with expertise in programming and software development develop applications and tools for businesses and consumers.

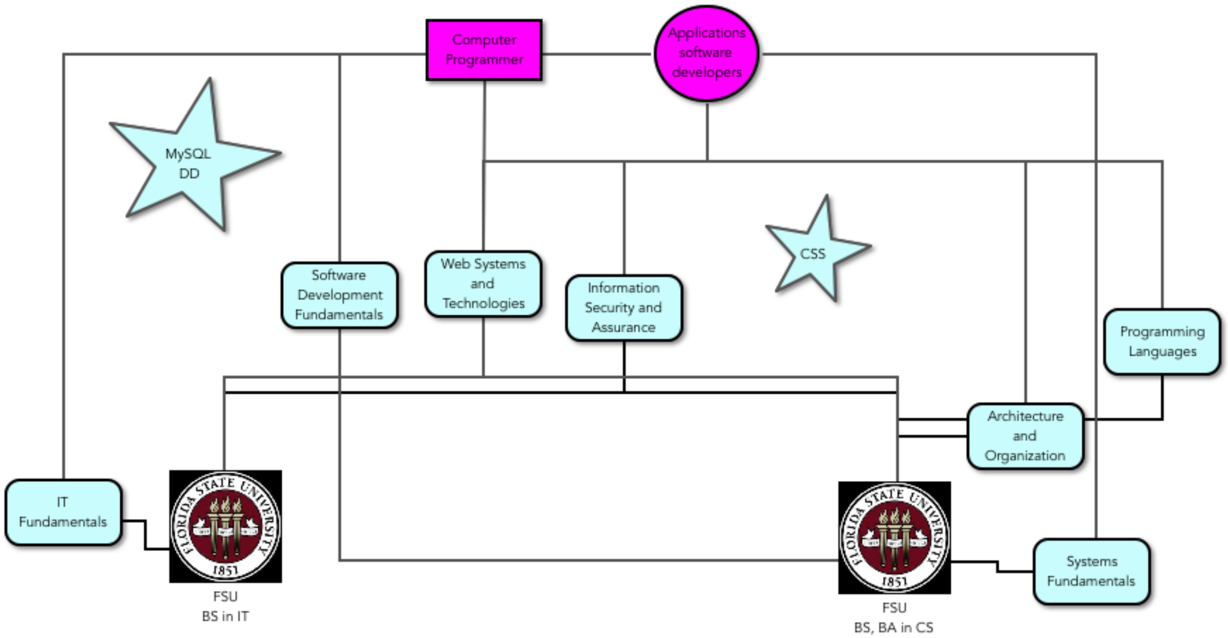

Figure 7. Computer Programmer and Applications Software Developer Pathways

As Figure 7 illustrates, both the IT and CS programs at FSU provide elements on the Computer Programmer and Applications Software Developer career pathways. Common to both degrees' pathways are Software Development Fundamentals, Web Systems and Technologies, and Information Security and Assurance. Students wishing to take a more enterprise support focus would follow the BSIT route and add IT Fundamentals to their foundational coursework while students who wished to focus more specifically on software development would add Architecture and Organization, Programming Languages, and Systems Fundamentals to their foundational coursework. In both instances, students can augment their coursework with certifications such as CSS and MySQL. Although not depicted here, internships also provide a complementary layer of preparation.

5.3 Systems Software Developer

Also part of part of NASDCTEc's *Programming and Software Development Pathway*, Systems Software Developers' work involves the design, development, implementation, and maintenance of computer systems and software. Professionals in these roles have knowledge of computer operating systems, programming languages, and software development. Figure 8 illustrates the career pathway in respect to FSU's BSIT program.

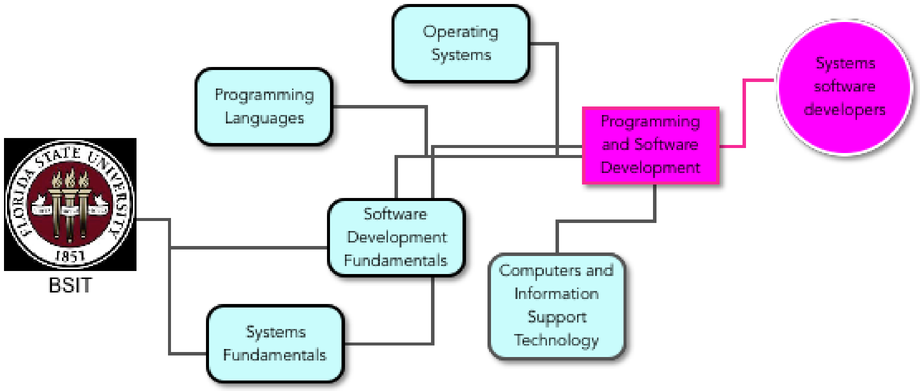

Figure 8. Systems Software Developer Career Pathway

Figure 8 illustrates a pathway that is based both on systems knowledge as well as software development processes. Students who take a program that balances both systems and development, but also includes an element of user perspective, meet the requirements of jobs in this area. Internships and certifications can be added to demonstrate hands-on knowledge and expertise in particular systems.

5.4 Graphic Designer

Because the Board of Governors' Gap Analysis included the Graphic Designer job title in the IT Career Cluster, we examined graphic design in the context of NASDCTEc's *Web and Digital Communications Pathway*. According to NASDCTEc, this career area involves creating, designing and producing interactive multimedia products and services, including development of digitally-generated or computer-enhanced media used in business, training, entertainment, communications and marketing. Figure 9 outlines a possible career pathway.

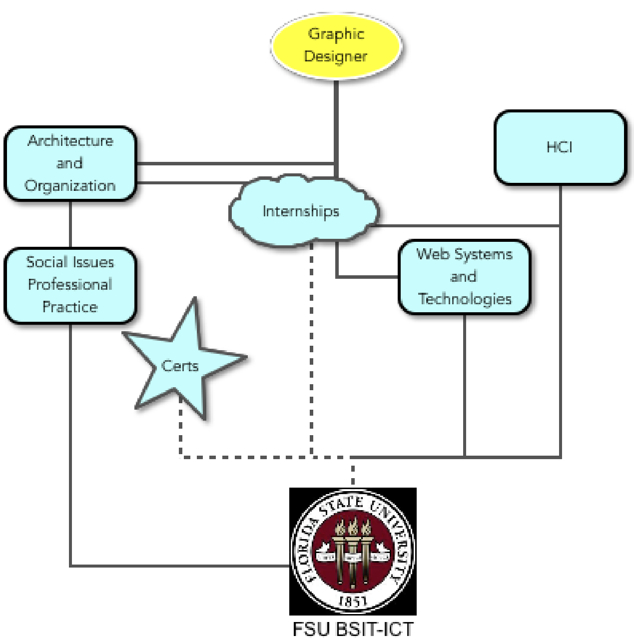

Figure 9. Graphic Designer Career Pathway

As Figure 9 shows, students in FSU's BSIT program, especially those students who take an Information and Communications Technology (ICT) focus are well positioned to follow a pathway to a Graphic Designer career. Again taking into account the optional complementary activities of internships and industry certifications such as the Adobe Creative Suite certifications, students' foundational knowledge would be gained through coursework centering on Architecture and Organization, Social Issues and Professional Practice, and Web Systems and Technologies.

6. Conclusion

6.1 Summary

In this assessment project, the study team sought to determine the extent to which the computing-related learning opportunities prepare students to fulfill high need IT jobs in Florida. Our work was driven by two questions for which we have reached preliminary conclusions:

RQ 1: To what extent do technology curricula, internships, IT industry certifications, and employer perceptions reflect stated job requirements?

Prior research about internships, certifications, and employer needs has suggested that, regardless of educational level, there appear to be several elements essential to getting and sustaining student interest in STEM study and careers: 1) attending schools with specific STEM-focused program; 2) being counseled into STEM courses; 3) accessing opportunities to engage with STEM topics in informal and out-of-school settings; and 4) learning how STEM education resolves into specific STEM careers. As students enter college, they often wrestle with mitigating factors such as the need to work, to rely on financial aid, and or competing responsibilities of home and family. In these instances, students benefit from responsive programs that help them to navigate these competing priorities.

The research we reviewed also reported that employers have articulated the skill sets that new entrants to the workforce, from recently hired graduates from high school, two-year colleges or technical schools, and four-year colleges—need to succeed in the workplace. Among the most important skills cited by employers: professionalism work ethic; oral and written communications; teamwork collaboration and critical thinking problem solving. In fact, the findings from recent studies have indicated that applied skills on all educational levels trump core curriculum area knowledge and skills, such as reading comprehension and mathematics. In other words, while the basic reading and writing skills are still fundamental to any new workforce entrant's ability to do the job, employers emphasize that applied skills like teamwork collaboration and critical thinking are "very important" to success at work.

The research literature the study team reviewed also indicated that employers also demonstrated an appreciation for a non-linear progression through careers resulting from stacking or latticing credentials through self-directed combination of workplace and internship experiences, industry certifications, and coursework. The demonstrated ability to have or pursue relevant knowledge appears to have equal or higher weight to a college diploma.

The large scale review of syllabi affirmed that by and large, two year and four year programs at FSCJ, FAMU, and FSU impart the IT and computing skills outlined in state and national frameworks. The extent to which high schools were also able to reflect state curriculum frameworks was less clear; the variance in high school course content was significant, suggesting that in many schools, IT is included in a broad career and technical education (CTE) block of courses which provide introductions to possible careers rather than explicit preparation for those careers. However, one high school's program was specifically designed to foster workplace-ready IT knowledge and that school's curriculum strongly reflected FLDOE IT framework content.

High school certifications reflected a similar diversity. The wide range of certifications available to students may indicate that at the high school level, certifications function as advanced or credit forward coursework, cultural artifacts that document professional dispositions, and self-directed opportunities to engage in deeper knowledge in a particular area. The role of certifications at the high school level was one area in which we identified a need for more research.

At the college level, the role of certifications was similarly open to interpretation. Employers provided relatively little context for the importance of certifications and seemed to consider them ways of sorting candidates by competency and evidence of self-motivation. However, certifications were not, by any means, positioned as requirements for IT job applicants.

Internships were a much more obvious complement to formal coursework. Internship postings were heterogeneous data that was relatively difficult to analyze, but the investigations we were able to complete suggested that internships, regardless of whether they were focused on social media, web development, or other kinds of supporting and development roles, provided opportunities for students to gain skills in teamwork, developing processes, engaging in customer service, learning to work with clients, and gain real work business experience.

Internship postings reflected many of the themes that emerged from our analyses of job postings, employer interviews, and employer survey results. Our research presented in this report has affirmed that employers focus on potential employee competency, regardless of its origin. Job postings predominantly emphasized workplace skills such as verbal and written communication; problem solving; ability to work independently as well as in teams; and self-motivation. Software and application skills in terms of programming and support were also present, but were often presented in terms of supporting roles, systems analysis, and customer service. Core technical knowledge such as HTML and SQL were also present, but functioned more as initial points of entry for job postings, as opposed to the major emphasis of posting content.

Regional IT employer interviews affirmed the content analyses and literature findings. The interview analyses revealed that employers sought candidates ready to be "plugged into" teams in their businesses. They wanted candidate who had workplace and or internship experiences that readied new employees to contribute to projects and take on supporting responsibilities as needed.

RQ2: What are the different pathways available to students as they move from school to career?

Prior research on career pathways has suggested that while pathways may be largely undocumented, knowledge of a specific pathway and guidance about how to enter, engage, and sustain involvement in the pathway are areas in which parents, guidance counselors, and instructors all have a valuable, albeit largely undercapitalized, role.

As Section 5 demonstrated, the programs we examined all provided important foundational coursework for high need IT careers. When this coursework is supplemented with internships and industry certifications, students may be able to craft a complete package of competencies for employers. Internships appear to provide particularly relevant real world experience. Basic IT competencies apply to a range of pathways; internships and certifications afford students opportunities to make themselves distinct and tailor their learning to their interests.

6.2 Next Steps

Although the work on the FITC assessment was extensive and thorough, it represents an initial step on a research agenda that could be further elaborated. We completed the research activities with a number of directions for further research:

1. To what extent do classroom activities represent the teamwork, collaboration, critical thinking, and problem solving skills employers require?
2. How can internship activities be more closely tracked and aligned with specific educational outcomes?
3. To what extent do employers in other locales face challenges relating to attracting and retaining qualified candidates?
4. At what point in a career pathway does an additional degree become important for job security and or advancement?
5. How can guidance counselors at secondary and post-secondary levels be best prepared and positioned to support students with IT career interests?
6. What venues other than certification and internship do candidates use to augment their skills with current, high need skills such as Python or app development? How do candidates demonstrate this additional mastery?
7. How might the techniques developed for this analysis apply to other degree levels and other disciplines?
8. To what extent would a large scale, perhaps statewide, analysis of job postings, curriculum, certifications, internships, and employer needs reflect the results of this analysis?

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FITC Assessment Final Report

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