Preliminary Report on Employer Interviews

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From July 2014 to December 2015, the research team conducted one-on-one interviews with employers who recruit and employ individuals in a variety of Information Technology (IT) positions in companies from diverse domains across the Northwest Florida Region. The research team interviewed 18 employers and analyzed the data using a codebook created from *Competencies Model for IT Program Management* (OPM, 2011) and *Career and Technical Education IT Frameworks* (FL DOE, 2013). The study team conducted these interviews as part of the National Science Foundation (NSF) Advanced Technological Education (ATE) project *Assessing Information Technology Educational Pathways that Promote Deployment and Use of Rural Broadband*.[1]

This phase of the research was guided by four of the project's previously stated research questions:

RQ 1 How do the IT/broadband skills graduates gain through two-year community college programs compare to the needs expressed by employers in nonmetro/metropolitan areas?

RQ 3 What, if any, gaps exist between the skill nonmetro/metropolitan employers report their IT/broadband employees need and the skill sets new professionals report they need to be successful as IT/broadband employees?

RQ 4 What, if any, differences are there between the skills needed for IT/broadband employees in nonmetro and metropolitan areas?

[1] More information about the project can be found at: http://www.ii.fsu.edu/Research/Projects/Assessing-Information-Technology-Educational-Pathways-that-Promote-Deployment-and-Use-of-Rural-Broadband-NSF

RQ 5 How can two-year community college IT/broadband program curricula be modified to best meet the specific needs of employers and IT/broadband employees in nonmetro/metropolitan areas?

This report addresses parts of the above research questions as they relate to what competencies employers perceive as necessary for their IT employees.

Related Literature

Education and IT Competency

In order to ensure that IT/IS programs remain relevant and attractive to potential students, the curriculum must be reviewed and improved. The success of the program can be measured by its graduates' employability (Khan, 2011; Woodward, Imboden, & Martin, 2013). As the technology industry rapidly changes, IT/IS programs must frequently be evaluated and undergo revisions to make sure graduates are prepared to enter the dynamic industry. In order for the curriculum evaluation to be successful, it must be informed by industry knowledge (Hwang & Soe, 2010). Seeking collaboration with industry partners and understanding the skills that employers value in prospective employees is important in meeting regional industry employer needs (Woodward et al., 2013).

Providing up-to-date curriculum in a constantly changing policy environment that emphasizes the need for technology skills as 'essential skills' or 'critical skills', educators will be challenged to ensure that these skills are those that will advance students in the job market (Crews, 2004; Gordon, 2013; Hunt, et al., 2011). These skills are as dynamic as the innovative workplace needs they are designed to serve and this makes the integrity and value of an IT curriculum subject to constant scrutiny (Downey, McMurtrey and Zeltmann, 2008).

Business Skills Gap

Researchers have shown that recent graduates are not only unprepared for the technical side of working in the IT/IS industry, but also lack the necessary business skills that the industry demands (Downey, McMurtrey & Zeltmann, 2008; Lee & Han, 2008). These researchers make it clear that there is a need for other business skills to be taught along with the IS/IT technical skills. They also make a call for further investigation to see how much IT/IS related business skills are part of IT/IS curricula alongside the technical skills.

Hunt et al. (2011) concluded that "the emerging information technologies are also requiring a new breed of IT professional - a person who understands the needs of the business as well as IT" (p. 5); these competing priorities further complicate the efforts of IT educators to prepare students for careers, not simply for their entry-level job, in a field that is highly dynamic and places great emphasis on innovation (Downey, McMurtrey & Zeltmann, 2008). This need is further exacerbated by the studies of end users who require significant support when using new business technologies (McClure, et al., 2011; Yellen, 2005), resulting in a "widening gap between a growing demand for and an insufficient supply of workers" (Hawk, Kaiser, Goles, Bullen, Simon, Beath, Gallagher, & Frampton, 2012, p. 2). These business and behavioral skills, often termed 'soft skills,' are increasingly in demand as much as are technical skills (Downey, McMurtrey & Zeltmann, 2008; Lee, 2005; Lee & Han, 2008).

Certifications

Researchers have reported that IT certifications may not be as important in the hiring process as students are led to believe in their preparation experiences. Required certifications are found in only a few job posts, and employers may prefer formal education along with experience (Anderson et al., 2005; Benham, 2006; Rob & Roy, 2013; Spears, et al., 2015). Cegielski and Hall (2009) as well as Hunsinger and Smith (2009) found that human resources professionals valued IT certifications more than IT professionals did in the hiring process; IT professionals do not necessarily see a direct relationship between an IT certification and specific job skills.

Value of Internships

Researchers examined undergraduate IT student internships' potential value to three main stakeholder groups: students in computing disciplines; IT employers; and postsecondary academic institutions (Galloway, et al., 2014; Ralevich & Martinovic, 2010; Venables & Tan, 2009). These researchers found that internships gave students the chance to develop soft skills in a workplace environment. Internships also allowed students to gain hands-on experience with the technical skills they learned in their courses (Vairis, Loulakakis, & Petousis, 2013). Internships also provided students with the opportunity to develop career goals or to determine if they feel well-suited to particular jobs before they enter the workforce as well as making them more employable post-graduation (Shoenfelt, Stone, & Kottke, 2013; Vairis et al., 2013). Researchers have shown that employers benefitted from internship programs because student interns offered fresh, unique perspectives and were likely to be familiar with the latest technology (Galloway et al., 2014). Academic institutions that offer internship opportunities are well-positioned to offer a curriculum that meets the needs of the IT industry (Ralevich & Martinovic, 2010).

Method

We conducted employer interviews in three phases. Phase 1 interviews were conducted in August and September 2014. An online pre-interview survey was used to collect basic demographic information about the interviewee as well as to create a basic profile of their business. To ensure understandability and precision, the interview questions (as seen in Appendix A) were pretested with the Co-PIs and subsequently reviewed and revised prior to their submission to the IRB and use in this study.

Phase 2 included 10 interviews that were completed in November and December 2014. The participants were drawn from employers who were surveyed at an FSU campus IT career fair and who agreed to participate in follow-up telephone interviews. The Phase 2 pre-interview data (basic profile and descriptive statistics) were collected via a face-to-face survey at the job fair. This protocol change was submitted to the FSU Human Subjects Committee and approved prior to conducting the survey at the IT career fair.

While in Phases 1 and Phase 2, researchers successfully solicited employers, 14 of the 16 interviewees were based in metropolitan areas. As such, a third phase of interviewing was conducted in an effort to gain more nonmetropolitan IT employers. Phase 3 interviews included two nonmetropolitan employers that were interviewed in December 2015. The interviews were

conducted entirely by phone including the collection of basic demographic information and a profile of their businesses.

After the consent document and questionnaire were completed, the research team conducted one-on-one semi-structured phone interviews with the employers (see Appendix A for interview questions). The interviews were recorded and transcribed. The transcripts were manually coded by two members of the research team using a codebook derived from the *Competencies Model for IT Program Management* (OPM, 2011) and *Career and Technical Education IT Frameworks* (FL DOE, 2013). To ensure reliability and validity of the findings, the two coders continually compared their coding and discussed discrepancies and made adjustments until a consensus was met. The combined codebook (included in Appendix B) includes 13 general competencies, such as soft skills like communication and self-management, and 14 technical competencies, including knowledge of operating systems, coding, and other related technical skills. Additional codes were added to the codebook after initial coding began. These codes, called emergent codes (see Appendix C), cover topics that employers frequently mentioned but were not encompassed by the existing codebook. Examples of emergent codes include experiential learning, coding and programming, and industry partnerships.

Limitations

Given the qualitative nature of the interviews used for this report, the findings reported below are not generalizable. However, they are likely indicative of the beliefs and opinions of employers in similar contexts. Additionally, as mentioned above, it was difficult to recruit rural IT employers to participate in the study.

Findings

Demographics

Of the 18 employers, four are located in nonmetropolitan areas. The remaining 14 employers are located in metropolitan areas. The types of organizations represented by the employers include government agencies (4), IT/software consultants (4), healthcare providers (2), banks (2), engineering consultants (1), marketing firms, IT employment agencies (1), broadband wholesale and retail sales companies (1), university IT support (1), manufacturing/services (1), and a major network operations/management companies (1). Organizations ranged in size from small locally based businesses with staff sizes below 10 employees to large multinational companies employing over 5,000 employees worldwide.

Hiring Process

A majority of the employers (n=12) use online ads for all or some of their recruiting for IT positions. Four of the employers said that their Human Resources department takes care of all of the hiring. Other employers use career fairs (n=3) and recruiters (n=3), sometimes in conjunction with online ads.

General Competencies

General competencies, derived from the Office of Personnel Management's *Competencies Model for IT Program Management* (OPM, 2011), were mentioned 296 times across the 18 interviews.

The top three desired general skills were Interpersonal Skills, Self-Management, and Learning. Flexibility, Compliance, and Teaching Others were mentioned the least.

Table 1. General Competencies

General Competencies	Number of Times Coded	Percentage of Coding
Interpersonal Skills (G-IS)	57	19.26%
Self-Management (G-SM)	55	18.58%
Learning (G-LE)	49	16.55%
Oral Communication (G-OC)	29	9.80%
Problem Solving (G-PS)	22	7.43%
Customer Service (G-CS)	21	7.09%
Writing (G-W)	18	6.08%
Reading Comprehension (G-RC)	16	5.41%
Accountability (G-A)	12	4.05%
Teamwork Collaboration (G-TC)	11	3.72%
Flexibility (G-F)	4	1.35%
Compliance (G-C)	2	0.68%
Teaching Others (G-TO)	0	0.00%
Total	**296**	**100%**

There were 63 more mentions of general skills (n= 296) compared to technical competencies (n=233). Employers are looking for well-rounded people who understand the technical side of the job as well as the personal:

- "People skills is a must. They have to be able to present themselves in a clean, respectable manner and be patient."
- "They have to have good people skills."
- "I mean, given enough time you can teach anybody anything, but people skills, I think that starts from early on and that's what we kind of look for in our recruiting and our hiring process."
- "Interpersonal skills are crucial because our employees need to speak well to their customers and also the industry as a whole"
- "Communication skills, writing skills, those are all very much important."

Employers believed that general competencies are important for their IT employees.

Technical Competencies

Technical competencies were mentioned 233 times across the 18 interviews. Of the technical competencies (as described in Appendix B), Infrastructure Design (19.37%), Information Technology Architecture (18.18%), Operations Support (15.02%), Configuration Management (13.04%) and Data Management (10.28%) were the most frequently mentioned skill sets. Notably, the remaining technical competencies were less emphasized, accounting for 7% or less of the coding.

Table 2. Technical Competencies

Technical Competencies	Number of Times Coded	Percentage of Coding
Infrastructure Design (T-ID)	49	19.37%
Information Technology Architecture (T-ITA)	46	18.18%
Operations Support (T-OS)	38	15.02%
Configuration Management (T-COM)	33	13.04%
Data Management (T-DM)	26	10.28%
Technology Awareness (T-TA)	17	6.72%
Information Systems Network Security (T-ISNS)	16	6.32%
Project Management (T-PM)	10	3.95%
Compliance (T-C)	7	2.77%
Information Management (T-IM)	5	1.98%
Information Technology Performance Assessment (T-ITPA)	2	0.79%
Product Evaluation (T-PE)	2	0.79%
Systems Testing and Evaluation (T-STE)	2	0.79%
Total	**233**	**100%**

While all 18 of the employers interviewed mentioned technical competencies, as seen above, certain technical skills sets were mentioned more than others. In describing the types of technical competencies and their importance, multiple technical competencies and related skills sets were often mentioned together, demonstrating the breadth and depth of knowledge expected of IT professionals by their employers. For example, in describing the sorts of skills needed for Infrastructure Design and Information Technology Architecture, employers emphasized the following skills, ranging from basic to more advanced knowledge, for their employees:

- "As far as network skills, just basics. Um what we require them to do is just be able to open a port, close a port, on our network switch."
- "We do have a networking group that does require those skills because we do sell not only the mainframes and the peripherals, but we also sell solutions that would involve- they could involve- redoing the WiFi capability of a business or, you know, setting up a high speed internet connection to be redundant or a disaster recovery site."
- "[T]he role is primarily in setting up networks, software applications, um, uh, servers, um, assisting faculty, and uh with new equipment, uh connecting new equipment to networks, providing technical support, uh when something goes wrong uh on a network or on an individual uh pc, uh whether it be a notebook, um or a smartphone."
- "…think it's very important very important for a graduate to have some idea of what an ISDM is. An ISDM is an information system development methodology. The ISDM is different with every organization but it still relates back to the same it's how you build something in IT."

As seen above, designing and managing networks and providing technical support for a variety

of technologies and devices are all interconnected parts of the overall services and knowledge expected of IT professionals.

Certifications

The majority of employers (10) mentioned that certifications were a plus, but not required for IT jobs at their companies. One of the statements from an employer in the majority captured the overall theme reflected by the 9 other employers:

- "Um, credentials are always a bonus, experience though also to me tells me you've been there, done that. And it depends on how much experience you have. See you have to weight experience versus credentials. You know somebody can come out of college with 50 certifications but give me some real life when you've acquired that, that knowledge."

While they were not required for employees, one IT employer mentioned that certifications can "open doors if a person lacks experience." Another employer who did not require certifications thought that, aside from the technical knowledge, certifications showed commitment. Each industry certification mentioned as preferred or required in an interview was added as a code and listed in the table below.

Table 3. Certifications

Certifications	**Number of Times Coded**	**Percentage of Coding**
Microsoft	13	20.97%
A+	10	16.13%
Security+	6	9.68%
Cisco; CCNA	5	8.06%
.NET	4	6.45%
Microsoft Certified Professional	3	4.84%
Network+	3	4.84%
Oracle	3	4.84%
Project Management Professional (PMP)	3	4.84%
Prograph	2	3.23%
Taradata	2	3.23%
C++	1	1.61%
CISSP	1	1.61%
Comp PS Skill MCSA	1	1.61%
Java	1	1.61%
Microsoft SharePoint	1	1.61%
Microsoft SQL Server Database	1	1.61%
Visual Basic	1	1.61%
V-Shark	1	1.61%
Total	**62**	**100%**

Of the many certifications mentioned by employers, Microsoft and A+ certifications were the most frequent. Two employers said that certifications were mandatory for their IT employees.

However, only one of these employers believed that schools should focus more on helping students earn their certifications.

Emergent Codes

The emergent codes arose from topics, like internships and industry partnerships, which employers frequently mentioned but were not encompassed by the codebook (see Appendix C). Experiential learning encompassed five sub-codes, on the job training, internships, work experience, service experience, and other. The other sub-code was used when employers mentioned experience more broadly and did not specify what kind of experience they were looking for.

Coding/Programming was added as an emergent code because the FLDOE Frameworks did not fully cover this aspect of IT. Similarly, the OPM competencies did not cover aspects of business fundamentals, so that was also added as a code. Both Coding/Programming and Business Fundamentals were derived from the Association of Computing Machinery and the Institute of Electrical and Electronics Engineers 2008 IT Curriculum Framework.

Table 4. Emergent Codes

Emergent Codes	**Number of Times Coded**	**Percentage of Coding**
Industry Partnerships (IP)	48	21.82%
Other Experiential Learning (OT)	43	19.55%
Experiential Learning- On the job training (OJT)	37	16.82%
Experiential Learning- Internships (IN)	34	15.45%
Coding/Programming (CP)	22	10.00%
Business Fundamentals (BF)	21	9.55%
Experiential Learning- Work experience (WE)	14	6.36%
Experiential Learning- Service experience (SE)	1	0.45%
Total	**220**	**100%**

Experiential Learning

Employers viewed experience as an important factor when looking at potential IT employees:

- "Students should work in their related field and get some hands-on knowledge. It would be beneficial for them down the road."
- "It'd be nice if they had a little more hands-on skills, like with technology that's actually being used."
- "It goes beyond academics. It's got to be real world application."

Four employers mentioned that experience was interchangeable with a degree if an applicant did not have a degree. For emergent codes, experiential learning as a whole was mentioned 129 times. Of those mentions general experience was mentioned most frequently (n=43), followed by

on the job training (n=37), internships (n=34), and work experience (n=14). Service experience received only one mention.

The employers explained how internships are valuable for recent graduates:

- "Internships are key. If you want a technology job right out of college, you already have the education leg of the stool, in school you can get a certification leg of the stool, so really the third leg that you're missing is experience and I think that that there's nothing more valuable than a good internship or any internship after you graduate or even during school in order to land a job."
- "What I strongly recommend—and don't wait until your last term in school to do this—is an internship."
- "It just ought to be mandatory to get some type of internship."
- "…if they could push harder on internships to get more experience for jobs"

Employers see internships as a way for IT students to gain valuable experience.

Industry Partnerships

Ten employers believed that IT programs in community colleges lacked the practical skills students need for jobs in the industry. Nine employers specifically mentioned seeing a disparity between what schools are teaching and what employers are looking for in terms of content. They believed that the curriculum is "outdated" and out of touch with the industry. As one employer summarized:

- "So, essentially, what you teach in college is right, but sometimes, I wish colleges were more on the leading edge instead of industry—you kind of lag [behind] what we do."

However, one employer acknowledged that is difficult for curricula and educators to stay up-to-date with current technological trends. When asked if they expected new graduates to be proficient in all of the latest technologies, an employer simply stated: "No they can't be. No I don't think they could be. I think the technologies move faster than the curriculum can change."

Two of the employers mentioned that they often see graduates as having more generalized skillsets rather than more specialized knowledge and experience. For example:

- "We haven't hired anybody new that didn't have, you know, a lot of years of experience because we're looking for specialized skill sets that you don't typically get in college. I hate to say it like that, but that's what we've seen."
- "Far as IT goes, we get generalists. We get people that have, you know, maybe they came from Computer Science, and they'll have more of a programming background and less about how to create webpages, let's just say for example. But from the employer standpoint, they're still a generalist. They've got, you know, book learning about real-world stuff I'm not saying every class ignores the outside. That's not true; we know that. But what we need is we need a spec- we don't need a generalist; we need a specialist in a particular product. So that's kind of the rub there, right? I mean, in academia, you really don't want, at least in my mind, I wouldn't want to just teach to a certain product because

> I'm pretty much a shill for the company creating the product, right? I'm just part of the corporation. In my opinion, the educator should be surveying the most popular products, and- software products and applications that people use when they get- when they graduate and making sure that that's part of the curriculum."

As seen above, some employers would prefer to see new professionals and graduates with more specialized skill sets. However, many (n=11) employers mentioned a desire to see an increase in industry partnerships with universities and community colleges that could offer internships or have speakers from people currently working in the IT field talk about the practical sides of various jobs:

- "I think that more of these advisory councils should be at every university, every college."
- "I think that if there was a way for us to work more with the universities, so that they understand what activities the candidate is going to be engaged in, then that would produce a better person for us."
- "We need more guest speakers at the community colleges and universities where experienced people both young and old come in and uh talk to the students."

Employers believe that industry partnerships with IT programs will benefit the industry as well as the students and academic programs.

Nonmetropolitan Challenges

Four of the employers work in nonmetropolitan areas. They mentioned additional struggles they face when hiring IT workers like being unable to offer competitive wages, lack of broadband, and lack of qualified applicants:

- "We taught him all his technical skills, and he was able to get a job in [the city] making about 10 dollars more an hour than he was here because of the new skillsets he had. And, it was just something that we couldn't offer because we couldn't match it at all…sometimes I guess we're kind of like a stepping stone."
- "I could very easily construct a very nice office and a warehouse on my property and work and make this this could be my hub but because of the lack of technology, I can't. I'm limited in my growth because of that."
- "There is a rural program out there that does subsidize internet access, but it does not give you the same access that the person that's paying a premium for it gets. The service is very slow. It's half faster than a dial-up connection."
- "Unfortunately IT is a big demand right now, so they figure they can ask for these outrageous prices and we can't compete on a national level like that."

Nonmetropolitan employers face additional challenges when hiring IT employees.

Preliminary Conclusions

In this study, we interviewed 18 employers in the Northwest Florida region. The interviews were aimed at understanding the perceptions of IT employers on the skills they look for when hiring

recent graduates from two-year community college IT programs. The interview data were analyzed using the OPM & FL DOE Combined Codebook (Appendix B), but also utilized open coding to allow for emergent themes to arise from the data. Overall, employers had mixed opinions on the readiness of recent graduates, but often mentioned the importance of soft skills and the helpfulness of experiential learning opportunities, such as internships, to help students and graduates to more fully develop their knowledge and skills before entering the job market.

Preliminary answers to the aforementioned research questions are discussed below:

> *RQ 1 How do the IT/broadband skills graduates gain through two-year community college programs compare to the needs expressed by employers in nonmetro/metropolitan areas?*

The results indicate that just over half of employers mentioned that recent graduates were lacking needed technical and general or soft skills. Experiential learning opportunities, such as internships, were often identified as effective ways for students to gain much needed hand-on experience and exposure to cutting edge technologies used in the industry that may not be reflected in the curricula of IT programs.

These results confirm previous findings that internships give students the chance to develop a wide range of soft skills in a workplace environment (Galloway et al., 2014, Ralevich & Martinovic, 2010, Venables & Tan, 2009) and allow students to increase their employability by gaining hands-on experience with the technical skills (Vairis, Loulakakis, & Petousis, 2013). Unlike Galloway et al. (2014), who found that interns often offer new perspectives and are more likely to be familiar with the latest technology, we found that internships themselves served as exposure to the newest technologies rather than the IT programs they graduated from. (Galloway et al., 2014). However, based on the feedback from employers, our results support Ralevich and Matrinovic's (2010) findings that academic institutions that offer internship opportunities are well-positioned to offer curricula that meet the needs of the IT employers.

While employers emphasized soft skills and the value of experiential learning opportunities, some employers wanted to hire more specialized IT professionals. Employers stated that much of this specialized knowledge can be gained through internships or on the job training, but suggested it would be beneficial to them if recent graduates had more options to specialize their skillset during their education.

Interestingly, while employers stressed the importance of soft skills, these skills were not directly linked with internship or experiential learning experiences. Employers primarily placed value on internships because they can provide hands-on experience and exposure to technologies currently used in the industry. As such, recent graduates with internship experience may require less training after they are hired to get up to speed with the specialized systems and technologies, especially if they are hired by the company where they interned. These findings suggest that internships and other experiential learning opportunities are a crucial part of the student to career pathways for new IT professionals. However, the potential for experiential learning opportunities to develop and promote soft skills should be further explored.

RQ 3 What, if any, gaps exist between the skill nonmetro/metropolitan employers report their IT/broadband employees need and the skill sets new professionals report they need to be successful as IT/broadband employees?

The findings presented in this report support the findings from *Preliminary Report of New Professional Interviews*[2] that both technical and soft skills and hands-on work experience gained through internships are highly valuable to new professionals and sought after by IT employers.

Like the interviewees in the *Preliminary Report of New Professional Interviews*, soft or general skills were more often identified as important and desired skills by employers. Of particular note, employers and new professionals both stressed the importance of Interpersonal Skills and Self-Management. These findings also align with the results from the final report[3] of our *Florida IT Career (FITC) Alliance Pathways Assessment* grant project. Employers interviewed in that report stated they expected IT graduates to be prepared and ready to be "plugged into" existing teams in their businesses and that new hires and graduates needed to have interpersonal and communication skills in order to do so.

Employers also emphasized the importance of learning, often in relation to both soft skills and current technology skills on the job, more so than new professionals. While the new professionals valued their education and especially relished the experience and skills gained through internships, these findings suggest that new professionals might not consider the importance of learning and/or continuing education as they enter the workforce and develop their careers. As employers expect new hires to spend a great deal of time learning the responsibilities and skills needed for their position and to fit into the workplace, seeking potential employees that also value learning is a sound hiring strategy.

In regards to technical competencies, employers sought more specific skills sets, such as Infrastructure Design and Information Technology Architecture. As seen above, employers often wished graduates had more specific skillsets coming into new positions. This may also explain why employers seek new hires with the ability to learn new skills. Both new professionals and employers emphasized the importance of basic computer knowledge, such as Operations Support and Configuration Management. New professionals identified problem solving and troubleshooting skills, the latter referring to more practical abilities to fix specific technical issues, more so than employers. However, given the nature of problem solving and troubleshooting, what new professionals referred to as problem solving and troubleshooting could, in part, be what employers are suggesting when they mentioned learning.

RQ 4 What, if any, differences are there between the skills needed for IT/broadband

[2] This and related reports from this project can be found on our website at: http://ii.fsu.edu/Research/Projects/Assessing-Information-Technology-Educational-Pathways-that-Promote-Deployment-and-Use-of-Rural-Broadband-NSF

[3] The FITC Assessment Final Report can be found on our website here: http://ii.fsu.edu/Research/Projects/IMLS-LB21-2014-Project-Summary

employees in nonmetro and metropolitan areas?

Of particular note are the challenges noted by rural IT employers. Smaller, rural companies often do not have the funding or technological infrastructure to attract IT professionals to live and work in rural areas. While rural or nonmetro IT employers did not seem to suggest that rural IT professionals required a different skill set than metro-area IT professionals, they did mention it was difficult to attract and retain IT professionals that were well-qualified. As such, these findings identify issues to be explored in order to fulfill the needs of rural IT employers.

Findings from other Information Institute grant projects on rural broadband deployment and adoption help to explain why rural IT employers are facing these and related challenges. In the fourth and final report of the *Florida Rural Broadband Alliance Broadband Needs Assessment and Benchmarking of Anchor Institutions* grant project,[4] the research team found four barriers and enablers to broadband adoption in rural Florida: awareness levels of broadband and its importance among stakeholders (including anchor institution staff, funding agencies, administrators, and the end users); technical expertise of staff, IT or otherwise; lack of funding and related resources; and attitudes towards and acceptance levels of technology. Our Institute of Museum and Library Services Laura Bush 21st Century Librarian grant project, *Creating Rural Economic Development Opportunities through Broadband Adoption*,[5] found that while many stakeholders understand the economic and educational benefits of broadband, increased funding opportunities and resources as well as substantial and successful politicking are needed to make broadband and related technologies a reality in rural communities. Without support from key stakeholders in rural communities, in terms of awareness, funding, and acceptance, and/or existing infrastructure, rural communities may not seem like attractive places to live and work for highly qualified IT workers. These barriers may, in turn, lead to less skilled or specialized IT professionals filling rural IT positions.

RQ 5 How can two-year community college IT/broadband program curricula be modified to best meet the specific needs of employers and IT/broadband employees in nonmetro/metropolitan areas?

As reported above, rural employers explained difficulties in attracted and retaining well-qualified IT professionals. This echoes the findings from *Preliminary Report of New Professional Interviews*, where many new IT professionals were reluctant to or not interested in pursuing careers in rural areas. However, these results suggest some new opportunities for exploring ways to embed soft skills and experiential learning into the IT curricula. Implications for practice are discussed below.

As IT employers seek increasingly specialized new IT professionals and prefer applicants with soft skills and internship experience when making hiring decisions, IT curricula should be adjusted to incorporate more experiential learning opportunities into the requirements of their

[4] This and related reports for the Florida Rural Broadband Alliance (FRBA) grant project can be found at: http://ii.fsu.edu/content/view/full/45135

[5] The IMLS Laura Bush 21st Century Librarian grant project's summary and final report can be found at: http://ii.fsu.edu/Research/Projects/IMLS-LB21-2014-Project-Summary

respective programs. As such, community college IT/broadband programs should strengthen existing partnerships with employers and continue to build new relationships with other employers in order to provide experiential learning opportunities, such as internships, service learning, volunteering, apprenticeships, etc. Additionally, IT curricula should more directly address and provide opportunities to learn and apply soft skills, as reported in our *Second Curriculum Analysis Report.*[6]

Given the need for highly-skilled IT professionals in rural communities, building partnerships with rural employers could be especially beneficial for all stakeholders involved. Experiential learning opportunities in rural areas would allow students to gain needed skills and experience as well as provide opportunities for rural communities and employers to demonstrate and fulfill their IT and broadband needs as well as chance to extoll the benefits of living and working in nonmetro areas. New IT professionals that have internships in rural areas might be more likely to stay and work in the area, assuming some of the other challenges mentioned above are addressed.

Directions for Further Research

This report concludes the data collection phase of our NSF ATE grant project. The next steps include an in-depth, comprehensive and comparative analysis of the primary findings and themes from each of the project's data points. The analysis will help to identify gaps in IT education, such as the lack of soft skills, and understand critical student to career pathways, allowing us inform IT curricula and build and strengthen partnerships between two- and four-year colleges, employers, and communities, particularly in rural areas.

Areas of future research could include:

1. What are the best practices for building partnerships between educational institutions and industries, particularly in rural areas, to provide experiential learning opportunities for IT students and new professionals?
2. How can rural communities and companies attract and retain well-qualified IT professionals?
3. To what extent do IT programs in two- and four- year institutions offer specializations or certificates beyond a general IT degree or major?
4. How can soft skills be effectively integrated into the IT curriculum?
5. How can experiential learning experiences be leveraged to develop and promote soft skills?
6. Are there specific IT skill and knowledge sets that should be stressed for prospective employees in a rural setting as opposed to other settings?

The study team will be considering the degree to which these areas for future research might be addressed during the remainder of the project.

[6] The Second Curriculum Analysis Report can be found on our website here: http://ii.fsu.edu/Research/Projects/Assessing-Information-Technology-Educational-Pathways-that-Promote-Deployment-and-Use-of-Rural-Broadband-NSF

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APPENDIX A—INTERVIEW QUESTIONS

INTERVIEW GUIDE FOR EMPLOYERS

1. Personal Background

Can you tell me a little about yourself?

1.1 What is your job position?
1.2 What is the tenure with your current employer?
1.3 What is your work experience and educational background?
1.4 Are you a member of any professional associations related to information technology (IT) and/or human resources (HR)?

2. *Organization Profile*

Can you tell me a little about your organization?

2.1 Products and services your organization offers?
2.2 Organization size (# of employees, revenue range)
2.3 # of locations
2.4 Public/private status (Public, Private, Non-profit, hybrid, Government)
2.5 Position types within the organization (industry-specific)
2.6 How is IT obtained? (internal/external). If external, please describe.
2.7 Is broadband available at your organization?
2.8 How many, if any, IT/broadband positions have been posted and filled over the past year?

3. IT Operations

Can you tell me about the role of IT in your organization?

3.1 What is the role of IT in the organization (Organization of IT network and computer support functions)?
3.2 What are the roles of entry-level IT computer support and network technicians?
3.3 How necessary is it for positions to have broadband network skills to fix or design broadband-based networks?
3.4 What is the role of IT education/training in the promotion process?
3.5 What is the typical career path for an IT employee in your organization?
3.6 What kind of professional development is required by the IT employee?

- On the job training and development
- Certifications and updates
- Leadership & supervisory
- Other _____

3.7 How do you think IT technicians learn skills they need, if not during their formal education?
3.8 How has widespread broadband deployment (high-speed Internet connectivity) affected the skills that your IT technician staff need?

4. Hiring Process

Please describe the recruiting, selection and hiring process of your organization.

4.1 What methods and sources do you use to recruit entry-level IT technicians? Which do you find to be the most successful? (Particular schools, temporary placement agencies, postings, networking)
4.2 What process do you use for preparing recruitment materials, especially job position description announcements/job competency descriptions for the positions?
4.3 When recruiting for entry-level IT technicians, what qualifications or competencies do you seek? Do you require a skill proficiency test during a job interview? If so, please describe.
4.4 Is there a minimum level of education you prefer or require? (High school, Some college, Associate degree, Bachelor degree)
4.5 To what extent do you use industry certifications in hiring and promotions?
4.6 To what extent does your employment policy and rules influence the hiring process?

5. Relationship with Local Educators

Can you tell me a little bit about the schools in your area?

5.1 When you think of community colleges, in general, what are your impressions?
5.2 What do you know about local community college? Their programs in IT?
5.3 What experiences have you had with local community colleges?

- Posting jobs/recruiting students
- Internship programs
- Apprenticeship programs
- Volunteering, i.e. advisory board, mentoring students
- Connection with faculty or administrators or career center
- Personal experience

5.4 How would you describe the interaction that the local college has with your organization? Your community?

6. Perceptions of Job Readiness

Describe your view of the available pool of job applicants.

6.1 How well are your local schools preparing students for the IT/broadband technician position in your organization?
6.2 How valuable do you perceive the credentials received from your local college is for the IT technicians of your organization? Please describe why this is.
6.3 What suggestions, if any, do you have to improve the education and training that your local colleges provide to your community?

THANK YOU FOR TAKING THE TIME TO SPEAK WITH ME TODAY. IF YOU HAVE A FEW MINUTES, I ASK THAT YOU GO TO THE WEBSITE I AM EMAILING TO YOU NOW AND TAKE A FEW MINUTES TO RANK JOB SKILLS THAT WE HAVE FOUND TO BE PREVALENT IN OUR JOB POSTING ANALYSIS. THANKS VERY MUCH. THE LINK IS ON ITS WAY TO YOU NOW.

APPENDIX B – OPM & FL DOE COMBINED CODEBOOK

Technical Competencies	Abbr.	Conceptual Definition	Operational Definition/Examples
Operations Support	T-OS	Knowledge of procedures to ensure production or delivery of products and services, including tools and mechanisms for distributing new or enhanced software.	Ability to stay within the guidelines of Operations & Maintenance releases; Experience in implementing, day to day operations, architecture, troubleshooting, maintaining/ upgrading SW with Networking products LAN/ WAN, MPLS Support;
Technology Awareness	T-TA	Knowledge of developments and new applications of information technology (hardware, software, telecommunications), emerging technologies and their applications to business processes, and applications and implementation of information systems to meet organizational requirements.	Knowledge of current and emerging Network and Open Systems environments; Create whitepapers and briefings to highlight emerging computer security trends to U.S. Army leadership and technical personnel; Familiarity with emerging WAN protocols; Ability to stay abreast of, current security related laws, trends, and emerging technologies; Mobile technology (software, hardware, etc.); Cloud computing;
Configuration Management	T-COM	Knowledge of the principles and methods for planning or managing the implementation, update, or integration of information systems components	Experience with client/server software integrations in the image centric healthcare information; Experienced in the installation, integration and testing of HDX family of CODECs; Cloud computing;
Infrastructure Design	T-ID	Knowledge of the architecture and typology of software, hardware, and networks, including LANS, WANS, and telecommunications systems, their components and associated protocols and standards, and how they operate and integrate with one another and with associated controlling software.	Understanding of virtual infrastructure environments; Experience in network systems administration, network architecture, TCP/IP,LAN/WAN, routers and switches, Windows and Linux based server and client environments;
Information Management	T-IM	Identifies a need for and knows where or how to gather information; organizes and maintains information or information management systems.	Ability to drive requirements gathering using effective elicitation and documentation techniques; Ability to set up and maintain computer hardware, networks and systems; Ability to accurately maintain records, logs, reports, work orders, etc.;

Compliance	T-C	Knowledge of procedures for assessing, evaluating, and monitoring programs or projects for compliance with Federal laws, regulations, and guidance.	Experience supporting DHS, Federal Civil, Intelligence and/or DoD Customers;
Systems Testing and Evaluation	T-STE	Knowledge of principles, methods, and tools for analyzing and developing systems testing and evaluation procedures and technical characteristics of IT systems, including identifying critical operational issues.	Ability to use scripting languages to automate testing tasks (Visual Basic or VBA preferred); Familiarity with agile software development and exploratory testing; Experience with automated testing tools such as TestPartner, SilkTest, or Quick Test Pro, demonstrated experience independently creating test;
Data Management	T-DM	Knowledge of the principles, procedures, and tools of data management, such as modeling techniques, data backup, data recovery, data dictionaries, data warehousing, data mining, data disposal, and data standardization processes.	Experience administering SQL or Oracle 11G or Sybase databases; Knowledge of Windows Server/Exchange, Storage Area Networks, Backup utilities; Experience in computer evidence seizure, computer forensic analysis, and data recovery;
Information Technology Architecture	T-ITA	Knowledge of architectural methodologies used in the design and development of information systems, including the physical structure of a system's internal operations and interactions with other systems.	Experience in MEDITECH hardware infrastructure experience; Understanding of virtual infrastructure environments; Experience in network systems administration, network architecture, TCP/IP,LAN/WAN, routers and switches, Windows and Linux based server and client environments; Mobile technology (software, hardware, etc.)
Information Technology Performance Assessment	T-ITPA	Knowledge of the principles, methods, and tools (for example, surveys, system performance measures) to assess the effectiveness and practicality of information technology systems.	Understanding of basic debugging techniques such as analysis of dump files, tracing, performance tuning, and monitoring;
Information Systems/Network Security	T-ISNS	Knowledge of methods, tools, and procedures, including development of information security plans, to prevent information systems vulnerabilities, and provide or restore security of information systems and network services.	Experience with network intrusion detection and response operations (Protect, Defend, Respond and Sustain methodology); Knowledge of and skills relevant to information & network security, access and authentication, physical location security, data integrity, and business recovery;

Product Evaluation	T-PE	Knowledge of methods for researching and analyzing external products to determine their potential for meeting organizational standards and business needs.	Perform advanced level evaluation, installation, maintenance and repair functions for department multi-function automated computer and computer related hardware; Provide technical leadership including evaluation of technology to determine infrastructure direction, project planning and coordination, and technical assistance to other staff;
Project Management	T-PM	Knowledge of the principles, methods, or tools for developing, scheduling, coordinating, and managing projects and resources, including monitoring and inspecting costs, work, and contractor performance.	Knowledge of project management practices and will be required; Experience in administration, technology and/or project management is required; Experience in project management and managing with multiple projects.(PMP preferred);
Coding/Programming	C/P	Programming Fundamentals Programming is a foundational skill for all computing disciplines. This knowledge area develops skills and concepts that are essential to good programming practice and problem solving. It covers fundamental programming concepts, event-driven programming, object-oriented programming, basic data structures, and algorithmic processes. a. Fundamental Data Structures b. Fundamental Programming Constructs c. Object-Oriented Programming d. Algorithms and Problem-Solving e. Event-Driven Programming Integrative Programming and Technologies Organizations typically use many disparate technologies that need to communicate and work with each other. A key component to the discipline of Information Technology is the integration of applications and systems. This knowledge area examines the various types of programming languages and their appropriate use. It also addresses the use of scripting languages, architectures, application programming interfaces and programming practices to facilitate the management, integration and security of the systems that support an organization.	1a. Write programs that use each of the following data structures: arrays, records, strings, linked lists, stacks, and queues 2a. Choose the appropriate data structure for modeling a given problem 3a. Utilize primitive data types and built-in data structures. 4a. Describe common applications for each data structure in the topic list. 5a. Describe a simple hash function. 6b. Modify and expand short programs that use standard conditional and iterative control structures and functions 7b. Apply the techniques of structured (functional) decomposition to break a program into smaller pieces 8b. Analyze and explain the behavior of simple programs involving the fundamental programming constructs covered by this unit. 9b. Design, implement, test, and debug a program that uses each of the following fundamental programming constructs: basic computation, simple I/O, standard conditional and iterative structures, and the definition of functions. 10b. Choose appropriate conditional and iteration constructs for a given programming task.

		f. Intersystems communications g. Data mapping and Exchange h. Integrative Coding i. Scripting Technologies j. Software Security Practices k. Miscellaneous Issues l. Overview of Programming Languages	11b. Describe the mechanics of parameter passing and the issues associated with scoping. 12b. Describe the concept of recursion and give examples of its use. 13b. Implement and trace the execution stack of a simple recursive function. 1c. Discuss and identify the concepts of encapsulation, abstraction, inheritance, and polymorphism 2c. Describe the relationship between an object and its corresponding class 3c. Compare and contrast the notions of overloading and overriding methods in an object-oriented language 4c. Design, implement, test, and debug simple programs in an object-oriented programming language. 5c. Describe how the class mechanism supports encapsulation and information hiding. 6c. Design, implement, and test the implementation of "is-a" relationships among objects using a class hierarchy and inheritance. 7c. Utilize iterators to access the elements of a container. 8c. Describe how constructors and destructors relate to the life of an object. 9c. Describe the relationship between an object and its corresponding class. 1d. Use a programming language to implement, test, and debug algorithms for solving simple problems 2d. Discuss the importance of algorithms in the problem-solving process 3d. Create algorithms for solving simple problems 4d. Identify the necessary properties of good algorithms. 5d. Apply effective debugging strategies.
General Competencies	**Abbr.**	**Conceptual Definition**	**Operational Definition/Examples**

Writing	G-W	Recognizes or uses correct English grammar, punctuation, and spelling; communicates information (for example, facts, ideas, or messages) in a succinct and organized manner; produces written information, which may include technical material, that is appropriate for the intended audience; Ability to document procedures, policies and infrastructure in a detailed manner;	Excellent written communication skills; Ability to use basic grammar and sentence structure in English; Ability to write legibly and understand the English language; Ability to document procedures, policies and infrastructure in a detailed manner; Ability to type 30 to 40 words per minute;
Customer Service	G-CS	Works with clients and customers (that is, any individuals who use or receive the services or products that your work unit produces, including the general public, individuals who work in the agency, other agencies, or organizations outside the Government) to assess their needs, provide information or assistance, resolve their problems, or satisfy their expectations; knows about available products and services; is committed to providing quality products and services	Ability to achieve successful outcomes in handling difficult situations and customers; Ability to demonstrate excellent customer service skills; Customer interaction skills; Experience in a customer service environment; General hospitality;
Oral Communication	G-OC	Expresses information (for example, ideas or facts) to individuals or groups effectively, taking into account the audience and nature of the information (for example, technical, sensitive, controversial); makes clear and convincing oral presentations; listens to others, attends to nonverbal cues, and responds appropriately	Ability to clearly and concisely communicate technical information to non-technical users at all organizational levels; Group presentation skills; Effective listening skills; Ability to speak legibly and understand the English language;
Interpersonal Skills	G-IS	Shows understanding, friendliness, courtesy, tact, empathy, concern, and politeness to others; may include effectively dealing with individuals who are difficult, hostile, or distressed; relates well to people from varied backgrounds and different situations; is sensitive to cultural diversity, race, gender, disabilities, and other individual differences	Strong interpersonal skills; Personal Skills; People Skills; Ability to build and maintain relationships with clients, colleagues, and co-workers; Ability to interact professionally with a diverse group;
Reading Comprehension	G-RC	Understands and interprets written material, including technical material, rules, regulations, instructions, reports, charts, graphs, or tables; applies what is learned from written material to specific situations	Ability to read and interpret documents such as safety rules, operating and maintenance instructions, and procedure manuals;

Problem Solving	G-PS	Identifies problems; assess accuracy and relevance of information; uses sound judgment to generate and evaluate alternatives, and to make recommendations	Ability to identify and resolve complex network problems; Ability to problem solve and resolve problems creatively; The ability to respond to crises objectively;
Self-Management	G-SM	Sets well-defined and realistic personal goals for themselves; displays a high level of initiative, effort, and commitment towards completing assignments in a timely manner; works with minimal supervision; is motivated to achieve; demonstrates responsible behavior; Multi-tasking; Time-management; Stress management; Remain positive, proactive; professionalism	Ability to work independently with minimum supervision; Ability to work efficiently and effectively in a fast-paced environment, under stress and within time constraints; Stay focused; Ability to manage time and work responsibly without supervision; Ability to manage multiple job tasks at one time; Ability to work independently, self–starter with good time management skills; Ability to work efficiently and effectively in a fast-paced environment, under stress and within time constraints;
Accountability	G-A	Holds self and others answerable for measurable high-quality, timely, and cost-effective results. Determines objectives, sets priorities, and delegates work. Accepts responsibility for mistakes; Professional ethical issues and responsibility	Ability to work unsupervised, responsively, and or independently;
Teaching Others	G-TO	Helps others learn through formal or informal methods; identifies training needs; provides constructive feedback; coaches others on how to perform tasks;	Ability to train and instruct effectively;
Flexibility	G-F	Is open to change and new information; adapts behavior or work methods in response to new information, changing conditions, or unexpected obstacles; effectively deals with ambiguity	Ability to be flexible and resourceful; Ability to work a flexible schedule; Ability to work scheduled and/or unscheduled overtime and callouts; Ability to take on-call duties; be patient to ambiguity (e.g., process and tasks, etc.)
Teamwork/Collaboration	G-TC	Encourages and facilitates cooperation, pride, trust, and group identity; fosters commitment and team spirit; works with others to achieve goals	Ability to demonstrate team building and collaboration; Team building experience; Ability to work in a team environment; Experience managing teams;

Compliance	G-C	Knowledge of procedures for assessing, evaluating, and monitoring programs or projects for compliance (e.g. ability to read and comply with Federal or state laws) regulations, and guidance	Ability to follow precise direction; Ability to follow written and oral instructions; Ability to read, understand, and comply with the department's policies, procedures, methods, and practices; Ability to read and apply Florida Statute; Maintain confidentiality; Intellectual property (e.g., copy rights, patents, and trade secrets); Legal issues in Computing, E.U. Data protection act, HIPPA, FERPA acts, Gramm-Leach-Bailey Act and privacy related acts and issues;
Learning	G-LE	Ability to research, acquire, update, and apply new and relevant knowledge and skills quickly; uses training, feedback, or other opportunities for self-learning and development;	Ability to quickly master new subjects and new technical concepts quickly; Ability to research information; Ability to learn and retain knowledge; Technical research and study skills;

APPENDIX C—EMERGENT CODES

Competencies	Codes	Sub-codes	Definitions	Examples
Experiential Learning	Experiential learning	Internships	Characteristics of experiential learning include active learning, student-based perspectives, subjective experiences, personal growth, participative learning that includes evaluation and reflection (Kolb, 1983). The U.S. DOE defines experiential learning as "all programs that are designed to expand the setting of learning experiences beyond the traditional school environment to occupational and community settings and these programs use planned experiences...to promote cooperation between traditional educational institutions and business, industry, labor, government, and community groups to support learning (Miller, 1982, p. 3).	A temporary opportunity for a person, usually a student, to gain skills through a guided/supervised work experience.
	Experiential learning	On the job training		Training provided by a company/organization to further employees' skills.
	Experiential learning	Work experience		Gaining experience/skills by working in a job.
	Experiential learning	Service experience		Gaining experience/skills by providing service to a community.
	Experiential learning	Other		General mentions of experience; hands-on (practical) instruction in the class;
Business Fundamentals	BF		a. Social Context of Computing d. Organizational Context e. History of Computing	a. Describe positive and negative ways in which information technology alters the modes of interaction between people Identify underlying gender, cultural and diversity related issues in information technology Interpret the social context of a particular information technology implementation. Evaluate a particular implementation through the use of empirical data. Explain why computing and networking access is restricted in some countries. Explain the concept of "digital divide", identify some causes and discuss possible solutions. Identify how information technology changes and affects culture as a whole. Identify how the internet has changed the face of computing and how it has affected society. Compare and contrast the computing and networking access in at least two different countries. Identify some causes of the "digital divide" and discuss possible solutions. d. Identify how an IT professional maintains their professional behavior Explain how an organizational culture can affect IT Outline the basic parts of a typical IT environment. Explain how IT must support business processes. f. Identify and describe emerging technologies in the context of the history of

				computing technologies Identify significant trends in the information technology profession Identify how life-long learning impacts the information technology professional.

Coding/Programming	C/P		Programming Fundamentals Programming is a foundational skill for all computing disciplines. This knowledge area develops skills and concepts that are essential to good programming practice and problem solving. It covers fundamental programming concepts, event-driven programming, object-oriented programming, basic data structures, and algorithmic processes. a. Fundamental Data Structures b. Fundamental Programming Constructs c. Object-Oriented Programming d. Algorithms and Problem-Solving e. Event-Driven Programming Integrative Programming and Technologies Organizations typically use many disparate technologies that need to communicate and work with each other. A key component to the discipline of Information Technology is the integration of applications and systems. This knowledge area examines the various types of programming languages and their appropriate use. It also addresses the use of scripting languages, architectures, application programming interfaces and programming practices to facilitate the management, integration and security of the systems that support an organization. f. Intersystems communications g. Data mapping and Exchange h. Integrative Coding i. Scripting Technologies j. Software Security Practices k. Miscellaneous Issues l. Overview of Programming Languages	1a. Write programs that use each of the following data structures: arrays, records, strings, linked lists, stacks, and queues 2a. Choose the appropriate data structure for modeling a given problem 3a. Utilize primitive data types and built-in data structures. 4a. Describe common applications for each data structure in the topic list. 5a. Describe a simple hash function. 6b. Modify and expand short programs that use standard conditional and iterative control structures and functions 7b. Apply the techniques of structured (functional) decomposition to break a program into smaller pieces 8b. Analyze and explain the behavior of simple programs involving the fundamental programming constructs covered by this unit. 9b. Design, implement, test, and debug a program that uses each of the following fundamental programming constructs: basic computation, simple I/O, standard conditional and iterative structures, and the definition of functions. 10b. Choose appropriate conditional and iteration constructs for a given programming task. 11b. Describe the mechanics of parameter passing and the issues associated with scoping. 12b. Describe the concept of recursion and give examples of its use. 13b. Implement and trace the execution stack of a simple recursive function. 1c. Discuss and identify the concepts of encapsulation, abstraction, inheritance, and polymorphism 2c. Describe the relationship between an object and its corresponding class 3c. Compare and contrast the notions of overloading and overriding methods in an object-oriented language 4c. Design, implement, test, and debug simple programs in an object-oriented programming language. 5c. Describe how the class mechanism supports encapsulation and information hiding. 6c. Design, implement, and test the implementation of "is-a" relationships among objects using a class hierarchy and inheritance. 7c. Utilize iterators to access the elements of a container. 8c. Describe how constructors and destructors relate to the life of an object. 9c. Describe the relationship between an object and its corresponding class. 1d. Use a programming language to implement, test, and debug algorithms for solving simple problems 2d. Discuss the importance of algorithms in the problem-solving process

				3d. Create algorithms for solving simple problems 4d. Identify the necessary properties of good algorithms. 5d. Apply effective debugging strategies. 1e. Explain the difference between event-driven programming and command-line programming 2e. Develop code that responds to exception conditions raised during execution 3e. Design, code, test, and debug simple event-driven programs that respond to user events 1f. Describe and contrast the different types of architectures for integrating systems 2f. Define the role of DCOM, CORBA, and RMI in distributed processing 3f. Describe the role of socket programming in communicating between systems and contrast the protocols and uses of TCP/IP sockets and Datagram sockets 4f. Describe how web services are used to integrate disparate applications in an organization: for example, describe the role of the WSDL, SOAP, and UDDI architectures in creating and using web services. 5f. Describe the purpose of message and queuing services and how they work and list the protocol used by one messaging service (e.g. JMS). 6f. List commonly used low level data communications protocols (e.g., RS232), state conditions for when each protocol should be used, and outline the protocol for one low level communications protocol. 7f. Create valid WSDL, SOAP and UDDI XML documents to define a web service. Write, debug, and test a web service. Deploy the web service to middleware and invoke the web service from an application across the network. 8f. Design, develop and test a socket program that communicates between two different services using both TCP/IP sockets and Datagram sockets. 9f. Design, develop and test a program that uses a messaging service to send asynchronous messages to another application across the network. 10f. Design, develop and test a program that uses the RS232 protocol to communicate with a hardware device. 1g. Tell how XML and the document object model are being used to integrate and exchange data between systems 2g. Use DTD to create a document definition for a data structure 3g. Define the term metadata. 4g. Describe the characteristics of each of the following data encoding schemes, and recommend under what conditions each should be used: ASCII, EBCDIC, and Unicode. 5g. Describe how XSL, XSLT and XPath are used to transform data streams. 6g. Design, develop and test a program that converts a data stream using one encoding scheme to a different encoding scheme. (EBCDIC and ASCII) 7g. Design, develop and test a program that uses SAX or DOM to parse an

				XML document. 8g. Design, develop and test a program that uses XSL and XSLT to transform a data stream from one format to another. 1h. Define the concept of inheritance and describe how it can be applied to encourage code reuse 2h. Describe what a programming interface is and why it is important to programming 3h. Define the importance of using design patterns and list the motivation for using each of the following design patterns: MVC, singleton, factory method, façade, proxy, decorator, and observer. 4h. Describe what a programming interface is and why it is important to programming and give an example of where the use of a programming interface simplified the development of a system. 5h. Design an abstract class and use inheritance to create a class that extends the abstract class. 6h. Design, develop and test an application that uses the abstract class. 7h. Draw the UML class diagrams for each of the following design patterns: singleton, factory method, façade, proxy, decorator, and observer. 8h. Design, develop and test a program that appropriately applies two or more design patterns to solve a problem. 9h. Design and develop a programming interface. Implement the interface for at least two different realizations using the factory method pattern. Design, develop and test an application that uses the factory method pattern to instantiate objects for each realization and uses the common interface to access the functionality of each instance. 1i. Program and deploy simple scripts in PHP 2i. Identify key scripting languages used for web scripting, server-side scripting and operating system scripting 3i. Write, debug and test a script that includes selection, repetition and parameter passing. 4i. Write, debug and test a web page that uses scripting to validate the input values in a form. 5i. Write, debug and test an interactive web based application that uses server-side script to process input from a web page. 6i. Write, debug and test a script using an operating scripting language to facilitate the management of an operating system 1j. Define the goals of secure coding 2j. Contrast evidence-based security and code access security 3j. Give guidelines for authenticating and defining permissions to systems services and resources 4j. For each of the following “best secure coding” practices, give an example of a problem that can occur when the practice is not followed and then describe how to overcome the problem: Preventing buffer overflow, Securing state data, Securing method access,

				Wrapper code, Unmanaged code, Validation of user input, Remote considerations, Protected objects, Serialization, Robust error handling 5j. Develop and test an application that uses systems services to encrypt a data stream, send it to a different system and decrypt the data stream. 6j. Perform a security audit of the code of an existing system, identify problems that violate best security coding practices and make recommendations to fix each problem. 1k. List issues that should be considered when deciding whether to create new software or adapt existing software to solve a problem 2k. Tell why it is important to version software and describe one mechanism that can be used to control the versioning of software. 3k. Use a version control system to create a new version of a software application, check out a module, make modifications to the module, check the module back in, and then rebuild, deploy and test the new version. 4k. Install and set up a version control system for a new project. 1l. Contrast the differences between the structured and object-oriented programming paradigms 2l. Describe the benefits and weaknesses associated with using a virtual machine 3l. Diagram and label models for both a compiled program and an interpretative program. 4l. Give an example where an application language and a scripting language would be more appropriate and give a valid reason to support your selection.

Industry Partnerships	IP		Collaborative effort between industry representatives and program developers to make curriculum better, produce more internships and etc.	Sometimes this is relevant to internship programs. Other times, organizations/companies have input on academic programs e.g. advisory boards/councils.

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