



FITC Institute Final Report Appendix O

Industry Certification Analysis Preliminary Findings Report

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Chandrasaha Ambavarapu, Graduate Research Assistant
Jinxuan Ma, Ph.D., Post-Doctoral Researcher
Heather Kelleher, Graduate Research Assistant
Laura I. Spears, Research Coordinator
Charles R. McClure, Ph.D., Director, Information Institute
Marcia A. Mardis, Ed.D. Associate Professor
Susan C. Thomas, Program Coordinator

1. Introduction

The Florida IT Career Alliance (FITC) Assessment project investigates the educational and career pathways of individuals pursuing computing technology education in the north Florida region. The project employs multiple assessment activities including curriculum analysis among selected information technology (IT), computer science (CS), information systems (IS), and computer engineering (CE) undergraduate programs, regional job postings, IT certifications, and regional technology employer needs. This certification analysis compares learning objectives of selected IT certifications and course learning outcomes in Bachelor of Science in information technology (BS/IT) curricula at FSU and FAMU. The research findings answer one research question: To what extent are the learning objectives specified in selected IT certifications similar to the course learning outcomes in the FSU and FAMU BS/IT curricula?

1.1 Motivation for Certification

IT certifications are often designed to reflect developments in the constantly changing IT industry (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 et al., 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; Wierschem et al.,

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2010). Additionally, certifications often act 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 (Dixon & McGill, 2005; Hunsinger & Smith, 2008).

1.2 Types of Certifications

IT certifications can be either vendor-specific or vendor-neutral. Companies such as Cisco offer certifications specifically related to their products in response to the need for qualified and knowledgeable employees who know their products. Trade organizations such as CompTIA provide certifications that are not tied to a particular product but provide fundamental knowledge of a particular area of computing such as foundations of computer hardware, software, and basic networking (Ejiaku et al., 2010). Vendors such as Oracle and Microsoft offer training courses for their certifications, and some community colleges design their program to concentrate on a specific field (Zeng, 2004).

1.3 Certification and Existing IT Curricula

While two-year colleges have featured certification preparation, fewer universities have integrated certifications into their IT programs because these typically focus on skills delivery which conflicts with a university's traditional mission of theoretical course content (Marshall et al., 2007; Rob & Roy, 2013). Hua (2013) notes that the opportunity for a student to become certified "can increase an academic program's visibility to potential students" (p.56). Rob and Roy (2013) reported increased enrollment in a university Management Information Systems (MIS) program by integrating Microsoft, Cisco, and Oracle certification contents into some MIS curricula including programming, web development, and networking and database courses.

1.4 Potential Drawbacks to Certification

Existing studies report that IT certification may not play as large a role in hiring processes as students think; few job posts mention any required certifications, and employers may still prefer experience combined with formal education (Anderson et al., 2005; Benham, 2006; Rob & Roy, 2013; Spears, Lee, Ambavarapu, Mardis, Alemanne & McClure, 2015). Two other studies (Cegielski & Hall, 2009; Hunsinger & Smith, 2009) find that Human Resources (HR) professionals value IT certifications more than IT professionals in charge of hiring, as IT professionals do not necessarily find that certification attainment directly relates to specific job competencies. Additionally, the rapidly-changing nature of the IT field that would serve as motivation for certifications' inclusion into existing curricula could potentially render

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certifications obsolete (Dixon & McGill, 2005). Hua (2013) also argues that incorporating vendor materials in curricula can result in a loss of “academic freedom” for faculty if the learning outcomes of the course do not correspond with the certification outcomes (p. 54).

The synthesis of certification outcomes and course learning outcomes has been a focus for academic institutions seeking to integrate IT certifications into their existing computing curricula, particularly at the university level. Previous work has been done to map certification learning objectives and exam contents to IT course topics and learning objectives in order to determine into which course the IT certification would best fit (Al-Rawi et al., 2005; Al-Rawi et al., 2006; Poteat, 2006; Nelson & Rice, 2001).

2. Method

2.1 Data Collection

This certification analysis study comprises 15 key certifications (shown as Table 1) that best reflect the abilities and knowledge for students seeking entry-level employment selected from a list of identified 27 (N=27) IT certifications. The remaining certifications were excluded due to their requirements or content that are inappropriate to the study’s purpose.

Table 1: A List of the 15 Key Certifications and Vendors/Associations

	Vendors/Associations	Certifications
1	Project Management Institute, Inc.	Project Management Institute’s Certified Associate in Project Management (CAPM)
2	CompTIA	Computing Technology Industry Association Basic A+
3	CompTIA	Computing Technology Industry Association Network+
4	CompTIA	Computing Technology Industry Association Security+
5	CompTIA	Computing Technology Industry Association Linux+
6	W3S	W3Schools Certification: HTML & HTML5
7	W3S	W3Schools Certification: CSS
8	Oracle	Oracle MySQL Database Developer
9	Oracle	Oracle MySQL Database Administration
10	Information System Security Certification Consortium, Inc., (ISC) ² ®	Information Systems Security Professional (CISSP)
11	VMware	VMware Certified Associate – Data Center Virtualization
12	Cisco	Cisco Certified Network Associate (CCNA)
13	Cisco	Cisco Certified Network Professional (CCNP)
14	W3S	W3Schools Certification: PHP: Hypertext Preprocessor
15	W3S	W3Schools Certification: XML: Extensible Markup

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	Language
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For each of these certifications, their respective professional organization websites were reviewed and certification objectives collected. Certification objectives are sometimes referred to as exam outlines, exam contents, or certification domains, and these terms are often used interchangeably to describe the certification topics. Each certificate has specific objectives which include a list of concepts/contents that represent a student's desired competencies. Objectives state content students should know and be able to demonstrate before taking the certification exam. The format of certification objectives vary from vendor to vendor. For example, some vendors list learning objectives using Bloom's taxonomy of terms for detailing course objectives.

2.2 Data Analysis

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 the ACM/IEEE 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" (ACM/IEEE, 2008, p. 48). Similar to previous research conducted by Al-Rawi 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.

For example, the analysis demonstrated how the Information Systems Security Professional (CISSP) certification integrates into *Information Security (LIS 4774)* and *Advanced Information Security (LIS 4777)*¹ courses; also examined was the Oracle MySQL Database Developer certification integration into the *Advanced Database Management (LIS 3781)* course. The goal of this analysis is to identify potential topics/contents from the various specified certifications that may be beneficial to add to required courses.

Once certification objectives were identified, 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.

¹ Networking & Security pool courses from BS in IT program, FSU

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3. Findings

Based on the comparison between FSU and FAMU undergraduate IT course learning outcomes and the certification learning objectives and exam contents, 15 certifications were determined to be a content match, meaning that the certification objectives were comparable to the existing courses.²

3.1 Project Management Institute's Certified Associate in Project Management (CAPM)

PMI's Certified Associate in Project Management (CAPM) is an entry-level certification for project practitioners which is designed for those with little or no project experience. The CAPM requires an understanding of the fundamental knowledge, terminology and processes of effective project management. Table 1 indicates how the CAPM exam is divided. Each domain is assigned a certain percentage relating to the overall percentage of exam contents associated with that domain.

Table 1: Percentage CAPM exam content³ by domain

Domain	Percentage of Examination
Project Management and Processes in Context	15%
Project Integration Management	12%
Project Scope Management	11%
Project Time Management	12%
Project Cost Management	7%
Project Quality Management	6%
Project Human Resource Management	8%
Project Communication Management	6%
Project Risk Management	9%
Project Procurement Management	7%
Project Stakeholder Management	7%
Total	100%

3.1.1 FSU BS/IT: The CAPM certification objectives can be integrated into the *LIS 4910 Information Technology Project* and *LIS 4708 Perspectives on Information Technology* courses. CAPM exam contents were compared with these two course syllabi to identify the contents missing in the syllabi. The exam contents missing from syllabi are project integration management, project human resource management, project procurement management, and project stakeholder management.

² Both the HTML and the HTML5 certifications were combined into one certification for analysis, resulting in 15 rather than 16 certifications that exhibited a content match.

³ <http://www.pmi.org/~media/PDF/Certifications/CAPM-Exam-Content-Outline.ashx>

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3.1.2 FAMU BS/IT: The CAPM certification objectives can be compared with the topics and learning objectives in *CIS 4945 IT Capstone Project*. This course covers exam contents in project management and processes in context, project integration management i.e., 27% of the exam contents are covered in the courses.

3.2 Computing Technology Industry Association Basic A+

In order to receive the CompTIA A+ certification, a student must pass two exams. *CompTIA A+ 220-801* covers the fundamentals of computer technology, installation and configuration of PCs, laptops and related hardware, and basic networking. *CompTIA A+ 220-802* covers the skills required to install and configure PC operating systems, as well as configuring common features (e.g. network connectivity and email) for mobile operating systems Android and Apple iOS.⁴ Tables 2 and 3 list the domains measured by this examination and the extent to which they are represented in the examination.

Table 2: Percentage of CompTIA A+ 220-801 exam content by domain

Domain	Percentage of Examination
PC Hardware	40%
Networking	27%
Laptops	11%
Printers	11%
Operational Procedures	11%
Total	100%

Table 3: Percentage of CompTIA A+ 220-802 exam content by domain

Domain	Percentage of Examination
Operating Systems	33%
Security	22%
Mobile Devices	9%
Troubleshooting	36%
Total	100%

3.2.1 FSU BS/IT: The objectives of *CompTIA A+ 220-801* certification are covered in two courses: *LIS 3353 Technologies for Information Services* and *LIS 4482 Managing Networks and Telecommunications*. The skills mentioned in laptops, printers and operational procedures domains were not covered in this program. *CompTIA A+ 220-802* certification objectives can be integrated into *LIS 4488 Network Administration*, *LIS 4777 Advanced Information Security*, and *LIS 4381 Mobile Application Development* courses.

⁴ <http://certification.comptia.org/getCertified/certifications/a.aspx>

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3.2.2 FAMU BS/IT: *CNT 2000 Computer Systems & Network Fundamentals* is one course where the certification domains PC hardware, networking and operating system and troubleshooting domains were covered. Again, the skills mentioned in laptops, printers and operational procedures domains were not covered in these courses. The courses *CNT 4504 Data Communication and Organizational Network*, and *CNT 4514 Introduction to Mobile Computing*, which is an elective course, were examined for security and mobile device domains respectively.

3.3 Computing Technology Industry Association Network +

The CompTIA Network+ certification is an internationally recognized validation of the technical knowledge required of foundation-level IT network practitioners. This exam will certify that the successful candidate has the knowledge and skills required to implement a defined network architecture with basic network security, troubleshoot, configure, and manage common network wireless and wired devices, establish basic network design and connectivity, understand and maintain network documentation, identify network limitations and weaknesses, and implement network security, standards, and protocols.⁵

3.3.1 FSU BS/IT: Two courses from this program that cover domains in Network+ certification are *LIS 4482 Managing Networks and Telecommunications* and *LIS 4488 Network Administration*.

3.3.2 FAMU BS/IT: Three courses in this program cover domains in Network+ certification. The courses are *CNT 4504 Data Communication and Organizational Network*, *CIS 4250 Computer Ethics and Professional Responsibility*, and *CNT 2000 Computer Systems & Network Fundamentals*.

3.4 Computing Technology Industry Association Security +

The CompTIA Security+ exam is an internationally recognized validation of foundation-level security skills and knowledge, and organizations and security professionals around the globe use it.⁶ The Security+ exam covers the most important foundational principles for securing a network and managing risk. Access control, identity management and cryptography are important topics on the exam, as well as selection of appropriate mitigation and deterrent techniques to address network attacks and vulnerabilities. Table 4 lists the domains measured by this examination and the extent to which they are represented in the examination.

Table 4: Percentage of CompTIA Security+ exam content by domain

Domain	Percentage of Examination
Network Security	20%
Compliance and Operational Security	18%
Threats and Vulnerabilities	20%
Application, Data, and Host Security	15%

⁵ http://certification.comptia.org/docs/default-source/exam-objectives/comptia_network_n10-005.pdf

⁶ http://certification.comptia.org/docs/default-source/exam-objectives/comptia_security_sy0-301.pdf

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Access Control and Identity Management	15%
Cryptography	12%
Total	100%

3.4.1 FSU BS/IT: The topics in Security+ certifications are covered in the *Networking & Security* track. The courses in this track were examined to identify if they were missing any Security + certification objectives. The Network Security domain includes topics such as network device configurations, network design elements, administration, network protocols and security issues related to wireless networking. The compliance and operational security domain includes concepts related to risk mitigation, practices, forensic procedures and some security related concepts. The courses *LIS 4482 Managing Networks and Telecommunications*, *LIS 4488 Network Administration*, *Information Security* and *LIS 4777 Advanced Information Security* cover certification objectives. The skills application, data and host security, access control and identity management, and cryptography domains, which constitute 42% of the certification contents, were not covered in these courses.

3.4.2 FAMU BS/IT: The certification topics were compared with the course topics and learning outcomes in the courses *CNT 4504 Data Communication and Organizational Network*, *CIS 4360 Introduction to Computer Security*, *CIS 4385C Digital Forensics*, and *CIS 4250 Computer Ethics and Professional Responsibility*. The skills from application, data and host security, access control and identity management are not covered in these courses.

3.5 Computing Technology Industry Association Linux +

The CompTIA Linux+ certification offers a framework for acquiring a working knowledge of Linux for IT professionals working as junior-level system administrators, as well as those working in Web and software development.⁷ Linux is an essential skill for working in a variety of job roles in Web, Systems and Network Administration. In order to receive a CompTIA Linux+ certification, a student must pass two certification exams. Tables 5 and 6 list the exam domains and the extent to which they are represented in the exam.

Table 5: Percentage of certification exam 1: LX0-101 by domain

Domain	Percentage of Examination
System Architecture	14%
Linux Installation and Package Management	18%
GNU and Unix Commands	43%
Devices, Linux File Systems, File System Hierarchy Standard	25%
Total	100%

Table 6: Percentage of certification exam 2: LX0-102 by domain

Domain	Percentage of Examination
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⁷ <http://certification.comptia.org/getCertified/certifications/linux.aspx>

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Shells, Scripting, and Data Management	17%
User Interfaces and Desktops	8%
Administrative Tasks	20%
Essential System Services	17%
Networking Fundamentals	23%
Security	15%
Total	100%

3.5.1 FSU BS/IT: Upon careful examination of BS/IT program, it has been observed that certification domains such as system architecture, linux file systems, administrative tasks, and essential system services were not covered in the course syllabi. Linux installation and package management, some skills from the shells, scripting and data management, networking fundamentals, and security domains were covered in courses like *LIS 3781 Advanced Database Management*, *LIS 4488 Network Administration*, and *LIS 4777 Advanced Information Security*.

3.5.2 FAMU BS/IT: *CIS 4385C Digital Forensics* is an elective course from the information assurance and security tract that covers certification domains like Linux installation and package management, devices, Linux file systems, and file system hierarchy standard. *CNT 2000 Computer Systems & Network Fundamentals* and *CNT 4504 Data Communication and Organizational Network* courses cover networking fundamentals and security domains.

3.6 W3Schools Certifications: HTML & HTML5

HTML Certification from w3schools, a W3S vendor, provides fundamental knowledge of web development using HTML. By mastering HTML, a person will be able to develop and maintain web pages unlimited to a particular software program's features.⁸ In order to take this certification, one should have a fundamental knowledge of the hypertext markup language - HTML 4.01. According to w3schools, the questions in the exam are based on the content of w3school's HTML tutorial. The concepts/topics in HTML tutorial were compared with FSU and FAMU IT program's courses to determine what, if any, topics could be included in existing courses.

3.6.1 FSU BS/IT: The main contents in w3schools HTML tutorial are- Introduction, HTML forms, HTML 5, HTML graphics, HTML media, HTML APIs, and HTML references. The topics from HTML tutorial can be compared with the learning outcomes and topics in the courses *LIS 3353 Technologies for Information Services*, *LIS 4369 Extensible Enterprise Solutions*, and *LIS 4368 Website Development with PHP*. On examining the syllabi of these courses, the concepts from HTML graphics like SVG and canvas elements, HTML APIs and some concepts like unicode's, encodings from HTML references were not covered in these courses.

There were several new elements offered in HTML5 for better document structure. On examining the related courses, it has been observed they do not cover these new elements in their courses, but referenced books are suggested in the course syllabi. *LIS 4368 Website Development*

⁸ http://www.w3schools.com/cert/cert_html.asp

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with PHP covers some introductory elements about HTML5 but not all the newly introduced elements in HTML5

3.6.2 FAMU BS/IT: The *COP 3828 Web Programming and Design* course was examined and the certification objectives were compared to the topics in this course. This course covers all the certification topics. Advanced concepts from HTML tutorial like HTML graphics, HTML APIs and HTML references were not covered in this course. HTML5 topics were not identified in the syllabus.

3.7 W3Schools Certifications: CSS

Cascading Styles Sheets (CSS) Certification from w3schools proves fundamental knowledge of web development using advanced CSS. CSS is used to control the style and layout of multiple web pages all at once. Before applying for the exam, a person should have a fundamental knowledge of cascading style sheets – CSS1 and CSS2. The certification questions in the exam are based on the content of w3school's CSS tutorial.

3.7.1 FSU BS/IT: The concepts/topics in CSS tutorial were compared with the courses *LIS 3353 Technologies for Information Services*, *LIS 4369 Extensible Enterprise Solutions* and *LIS 4368 Website Development with PHP*. These courses cover the CSS tutorial concepts.

3.7.2 FAMU BS/IT: *COP 3828 Web Programming and Design* covers CSS certification objectives.

3.8 Oracle MySQL Database Developer

The exam topics in this certification are:

- MySQL Architecture
- General MySQL Syntax
- Creation and Design of MySQL Schema Objects
- Querying for Data
- Modifying Data
- Joins, subqueries and UNION
- MySQL Application Development
- Basic Optimizations

3.8.1 FSU BS/IT: The exam topics were compared to *LIS 3781 Advanced Database Management* course. The course covers the certification objectives excluding subtopics: key characteristics, features and options for PHP, Java, and .NET development using MySQL standard drivers, usage of NoSQL and APIs, etc. from the MySQL application development domain.

3.8.2 FAMU BS/IT: *COP 3710 Database Management System* and *COP 4710 Advanced Database Management Systems* covered all certification objectives.

3.9 Oracle MySQL Database Administration

The exam topics in this certification are:

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- MySQL Architecture
- MySQL Server Installation, Configuration and Maintenance
- MySQL Security
- Diagnostic Data and Metadata Sources in MySQL
- Optimizing MySQL Performance
- Backups and Recovery in MySQL
- High Availability Techniques for MySQL

3.9.1 FSU BS/IT: The exam topics in this certification were compared with the *LIS 3781 Advanced Database Management* course. The topics from the certification are MySQL architecture, MySQL server installation, security, optimizing performance, backup and recovery in MySQL, and high availability techniques for MySQL. The course *Advanced Database Management* course covers various topics related to administration, security, stored procedures, triggers, transactions, and remote access to databases etc. Availability techniques for MySQL and diagnostic data and metadata sources in MySQL topics from certification were not covered in this course.

3.9.2 FAMU BS/IT: The *COP 3710 Database Management System* and *COP 4710 Advanced Database* courses in this program were compared to the certification objectives. Availability techniques for MySQL and diagnostic data and metadata sources in MySQL topics from certification were not covered in these courses.

3.10 Cisco Certified Information Systems Security Professional

The Cisco Certified Information Systems Security Professional (CISSP) exam tests one's competence in the 10 CISSP domains of the Information Security Certification (ISC)²® common body of knowledge (CBK®), which cover critical topics in security today, including risk management, cloud computing, mobile security, application development security and more. Candidates must have a minimum of five years of paid full-time work experience in two of the 10 domains because this certification was designed for experienced professionals (<https://www.isc2.org/cissp-sscp-domains-faq/default.aspx>). This vast breadth of knowledge and the experience it takes to pass the exam is what sets the CISSP apart.⁹

The CISSP exam is based on the following 10 domains:

- Access Control
- Telecommunications and Network Security
- Information Security Governance and Risk Management
- Software Development Security
- Cryptography
- Security Architecture and Design
- Operations Security
- Business Continuity and Disaster Recovery Planning

⁹ <https://www.isc2.org/cissp/default.aspx>

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- Legal, Regulations, Investigations, and Compliance
- Physical (Environmental) Security

3.10.1 FSU BS/IT: The domain contents were matched with the course objectives in *LIS 4482 Managing Networks and Telecommunications*, *LIS 3353 Technologies for Information Services*, *Information Security*, and *LIS 4777 Advanced Information Security*. Access control, business continuity and disaster recovery planning, and physical (Environmental) Security were the domains whose contents cannot be matched with the course's learning outcomes and objectives.

3.10.2 FAMU BS/IT: *CIS 4250 Computer Ethics and Professional Responsibility*, *CIS 4360 Introduction to Computer Security*, *CNT 2000 Computer Systems & Network Fundamentals*, and *CNT 4504 Data Communication and Organizational Network* were the courses from FAMU IT program that were analyzed. Two exam domains were not covered including Access Control and Physical (Environmental) Security

3.11 VMware Certified Associate – Data Center Virtualization

With the VCA – Data Center Virtualization certification, one can have greater credibility when discussing data center virtualization, the business challenges that vSphere is designed to address, and how virtualizing the data center with vSphere addresses those challenges. One can define data center virtualization and provide use case scenarios of how vSphere and data center virtualization can provide cost and operational benefits.¹⁰

The VCA-DCV exam covers the following objectives:

- Explain data center virtualization concepts and how they solve typical business challenges
- Identify, explain and differentiate vSphere technologies
- Correlate VMware data center virtualization solutions with specific business challenges

3.11.1 FSU BS in IT: There is only one learning outcome from the course *LIS 4488 Network Administration* that specified information about effective usage of VMware vSphere client to manage virtual machines.

3.11.2 FAMU BS in IT: No courses were identified in this program that cover certification exam objectives.

3.12 Cisco Certified Network Associate (CCNA)

The Cisco Certified Network Associate (CCNA) Routing and Switching (R&S) certification validates the ability to install, configure, operate, and troubleshoot medium-size routed and switched networks. CCNA certified professionals have the knowledge and skills to

¹⁰ https://mylearn.vmware.com/mgrReg/plan.cfm?plan=41162&ui=www_cert

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make connections to remote sites via a wide area network (WAN) and mitigate basic security threats.

3.12.1 FSU BS in IT: CCNA certification objectives can be compared with the topics in *LIS 4482 Managing Networks and Telecommunications* and *LIS 4488 Network Administration*. The topics IOS, IPv6, IPv4, OSPF, Cisco licensing, enhanced interior gateway routing protocol (EIGRP), serial line interfaces, frame relay interfaces, VLANs, Ethernet, VLSM, and basic traffic filtering were missing.

3.12.2 FAMU BS in IT: *CNT 2000 Computer Systems & Network Fundamentals* and *CNT 4504 Data Communication and Organizational Network* courses were analyzed. The topics IOS, IPv6, IPv4, OSPF, Cisco licensing, enhanced interior gateway routing protocol (EIGRP), serial line interfaces, frame relay interfaces, VLANs, Ethernet, VLSM, and basic traffic filtering were missing from the courses.

3.13 Cisco Certified Network Professional (CCNP)

CCNP equips students with the knowledge and skills needed to plan, implement, secure, maintain, and troubleshoot converged enterprise networks.

3.13.1 FSU BS in IT: The Networking related courses *LIS 4482 Managing Networks and Telecommunications* and *LIS 4488 Network Administration* were analyzed. The topics in CCNP curriculum such as implementation of complex enterprise local area network (LAN) and WAN routing solutions, IPv6, EIGRP, BGP, and OSPF are not covered in the courses analyzed.

3.13.2 FAMU BS in IT: The *CNT 4504 Data Communication and Organizational Network* course was analyzed. The topics in CCNP curriculum such as implementation of complex enterprise LAN and WAN routing solutions, IPv6, EIGRP, BGP, and OSPF are not covered in the courses analyzed.

3.14 W3Schools Certification: PHP

The PHP Developer Certificate proves fundamental knowledge of web development using PHP and SQL (MySQL). This certification proves the ability to develop and maintain dynamic and interactive web pages and also to retrieve and update data from a database over the internet. Before applying for the exam, one should have a fundamental knowledge of PHP and SQL (MySQL). The Certification questions in the exam are based on the content of w3school's PHP and SQL tutorial.¹¹

3.14.1 FSU BS/IT: The concepts/topics in PHP and SQL tutorial were compared with the courses *LIS 4368 Website development with PHP*, *LIS 3781 Advanced Database Management*, and *LIS 4369 Extensible Enterprise Solutions*. These three courses cover all the certification objectives.

¹¹ http://www.w3schools.com/cert/cert_php.asp

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3.14.2 FAMU BS/IT: *COP 3710 Database Management System, COP 4710 Advanced Database Management Systems, and COP 3828 Web Programming and Design* courses were analyzed, and it has been observed that all topics related to PHP scripting language were missing in the program.

3.15 W3Schools Certification: XML

The Extensible Markup Language (XML) Developer Certificate proves fundamental knowledge of web development using XML, XML DOM and XSLT. Before applying for an exam, one should have a fundamental knowledge of XML, XML DOM, and XSLT. All questions in the exam are based on the content of W3Schools' XML, XML DOM and XSLT tutorials.

3.15.1 FSU BS in IT: XML stands for Extensible Markup Language. It was designed to describe data and it is a software- and hardware-independent tool for carrying information. The concepts/topics in XML tutorial are covered in the course *LIS 4369 Extensible Enterprise Solutions*. XML DOM and XSLT tutorial concepts are not covered in this program.

3.15.2 FAMU BS in IT: Some concepts from the XML tutorial are covered in the course *COP 3366 C Sharp*. XML DOM and XSLT tutorial concepts are not covered in this program.

4. Discussion

4.1 Analysis

Consistent with the work of previous research conducted by Al-Rawi et al. (2005) and Poteat (2006), this analysis demonstrated that certain certifications fit more easily into existing IT and computing curricula than others. Often, certification learning objectives and exam contents will be conveyed in a sequence of courses as opposed to one course (Al-Rawi et al., 2005). 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 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* and *4708* and the FAMU course *CIS 4945*. In

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order to incorporate the CAPM certification topics fully, a course particularly related to software project management which 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.

Table 7: Possibilities for certification integration into FSU and FAMU IT courses

Certification to be Integrated	FSU Course(s)	FAMU Course(s)	Recommendations
CAPM	LIS 4910 and LIS 4708	CIS 4945	Schools may benefit from including a software project management course to cover all exam content related to this certification.
CompTIA A+ 220-902	LIS 4488, LIS 4777, and LIS 4381	CNT 4504 and CNT 4514	Certification objectives can be met with the inclusion of course content related to operating systems.
Network+	LIS 4482 and LIS 4488	CNT 4504, CIS 4250, and CNT 2000	Concepts such as performance tracking tools, monitoring tools could be incorporated into existing courses as well as information pertaining to Cloud technologies and virtualization.
CompTIA Security+	LIS 4482, LIS 4488, and LIS 4777	CNT 4504, CIS 4385C, and CIS 4250	Skills and concepts from the following certification domains could be included in existing IT coursework to meet certification objectives: Application, Data and Host Security, Access Control and Identity Management and Cryptography.
CSS	LIS 3353, LIS 4369, and LIS 4368		The latest version of CSS may be included in current courses related to the topic.

Table 7 lists certain certifications that may be potentially integrated into specified IT courses. These integrations might be helpful for program developers, faculty seeking to include certification content in their courses, and students as they choose a course or sequence of courses that will prepare them for certification attainment.

4.2 Limitations

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In this analysis, certification outcomes or domains were only compared to learning outcomes listed in course syllabi. Although they are an important aspect of the curriculum, course syllabi cannot fully convey all course content. Some certification objectives not matched with learning outcomes in course syllabi may be conveyed in other areas of course instruction such as textbooks, assignments, lecture, etc.

5. Conclusion

This IT certification assessment analysis examines IT course learning outcomes at two universities preparing students to pursue selected IT certifications. Student technical competencies gained in the IT academic programs could be potentially matched to the requirements of certain IT certifications. It is unclear how students benefit from certifications in terms of the high cost of certification testing, the extra curriculum requirements the benefits academic program IT courses may gain by integrating IT certification learning objectives or topics.

Findings from other phases of the FITC assessment project such as technology employer job postings and employer surveys and interviews will further address the employer perceptions of the value of industry certifications and the potential benefits of incorporating certification topics to existing curricula in IT academic programs.

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Appendix A: Chart Detailing the Comparison between Specified Certifications and FSU/FAMU IT Courses as well as a Listing of Certification Concepts Missing from Courses

Certification	FSU BS in IT Courses Analyzed	FAMU BS in IT Courses Analyzed	Concepts from Certifications Not Covered in Courses
Project Management Institute's Certified Associate in Project Management (CAPM)	<ol style="list-style-type: none"> 1. LIS 4910 Information Technology Project 2. LIS 4708 Perspectives on Information Technology 	<ol style="list-style-type: none"> 1. CIS 4945 IT Capstone Project 	<p>FSU :</p> <ol style="list-style-type: none"> 1. Project Integration management 2. Project Human Resource management 3. Project Procurement Management 4. Project Stakeholder Management <p>FAMU :</p> <ol style="list-style-type: none"> 1. Project Cost Management 2. Project Quality Management 3. Project Human Resource Management 4. Project Communication Management 5. Project Risk Management 6. Project Procurement Management 7. Project Stakeholder Management
CompTIA Basic A+	<ol style="list-style-type: none"> 1. LIS 3353 Technologies for Information Services 2. LIS 4482 Managing Networks and Telecommunications 3. LIS 4488 Network Administration 4. LIS 4777 Advanced Information Security 5. LIS 4381 Mobile App Development & Management 	<ol style="list-style-type: none"> 1. CNT 2000 Computer Systems & Network Fundamentals 2. CNT 4504 Data Communication and Organizational Network 3. CNT 4581 Introduction to Mobile computing 	<p>FSU:</p> <ol style="list-style-type: none"> 1. Laptops 2. Printers 3. operational procedures <p>FAMU:</p> <ol style="list-style-type: none"> 1. Laptops 2. Printers 3. operational procedures
CompTIA Network+	<ol style="list-style-type: none"> 1. LIS 4482 Managing Networks and Telecommunications 2. LIS 4488 Network Administration 	<ol style="list-style-type: none"> 1. CNT 4504 Data Communication and Organizational Network 2. CIS 4250 Computer Ethics and Professional Responsibility 3. CNT 2000 Computer Systems & Network Fundamentals. 	<p>FSU:</p> <ol style="list-style-type: none"> 1. performance tracking tools and Monitoring tools 2. Network Architecture <p>FAMU:</p> <ol style="list-style-type: none"> 1. Network Installation and Configuration(wireless communication Concepts) 2. performance tracking tools and Monitoring tools 3. Network Architecture
CompTIA Security+	<ol style="list-style-type: none"> 1. LIS 4482 Managing Networks and Telecommunications 2. LIS 4488 Network Administration 3. LIS 4774 Information Security 4. LIS 4777 Advanced Information Security 	<ol style="list-style-type: none"> 1. CNT 4504 Data Communication and Organizational Network 2. CIS 4360 Introduction to Computer Security 3. CIS 4385C Digital Forensics 4. CIS 4250 Computer Ethics and Professional Responsibility 	<p>FSU:</p> <ol style="list-style-type: none"> 1. Application, Data and Host Security 2. Access Control and Identity Management 3. Cryptography <p>FAMU:</p> <ol style="list-style-type: none"> 1. Application, Data and Host Security 2. Access Control and Identity Management
CompTIA Linux+	<ol style="list-style-type: none"> 1. LIS 3781 Advanced Database Management 2. LIS 4488 Network Administration 3. LIS 4777 Advanced Information Security 	<ol style="list-style-type: none"> 1. CIS 4385C Digital Forensics 2. CNT 2000 Computer Systems & Network Fundamentals 3. CNT 4504 Data Communication and Organizational Network courses 	<p>FSU :</p> <ol style="list-style-type: none"> 1. System Architecture 2. GNU and Unix Commands 3. Devices, Linux File systems, File system Hierarchy Standard 4. Shells, Scripting and Data Management 5. User Interfaces and Desktops 6. Administrative Tasks

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			<p>7. Essential System Services FAMU</p> <ol style="list-style-type: none"> 1. System Architecture 2. GNU and Unix Commands 3. Shells, Scripting and Data Management 4. User Interfaces and Desktops 5. Administrative Tasks 6. Essential System Services
W3Schools HTML/HTML5	<ol style="list-style-type: none"> 1. LIS 3353 Technologies for Information Services 2. LIS 4369 Extensible Enterprise Solutions 3. LIS 4368 Website development with PHP 	<ol style="list-style-type: none"> 1. COP 3828 Web Programming and Design 	<p>FSU:</p> <ol style="list-style-type: none"> 1. HTML Graphics 2. HTML APIs 3. unicodes, encodings from HTML References <p>FAMU:</p> <ol style="list-style-type: none"> 1. HTML Graphics 2. HTML APIs 3. unicodes, encodings from HTML References
W3Schools CSS	<ol style="list-style-type: none"> 1. LIS 3353 Technologies for Information Services 2. LIS 4369 Extensible Enterprise Solutions 3. LIS 4368 Website development with PHP 	<ol style="list-style-type: none"> 1. COP 3828 Web Programming and Design 	<p>FSU: All Covered</p> <p>FAMU: All Covered</p>
Oracle MySQL Database Developer	<ol style="list-style-type: none"> 1. LIS 3781 Advanced Database Management course 	<ol style="list-style-type: none"> 1. COP 3710 Database Management System 2. COP 4710 Advanced Database Management Systems 	<p>FSU: All Covered</p> <p>FAMU: All Covered</p>
Oracle MySQL Database Administration	<ol style="list-style-type: none"> 1. LIS 3781 Advanced Database Management course 	<ol style="list-style-type: none"> 1. COP 3710 Database Management System 2. COP 4710 Advanced Database Management Systems 	<p>FSU:</p> <ol style="list-style-type: none"> 1. Availability techniques for MySQL 2. Diagnostic Data and Metadata Sources in MySQL <p>FAMU :</p> <ol style="list-style-type: none"> 1. Availability techniques for MySQL 2. Diagnostic Data and Metadata Sources in MySQL
Information Systems Security Professional (CISSP)	<ol style="list-style-type: none"> 1. LIS 4482 Managing Networks and Telecommunications 2. LIS 3353 Technologies for Information Services 3. LIS 4774 Information Security 4. LIS 4777 Advanced Information Security 	<ol style="list-style-type: none"> 1. CIS 4250 Computer Ethics and Professional Responsibility 2. CIS 4360 Introduction to Computer Security 3. CNT 2000 Computer Systems & Network Fundamentals 4. CNT 4504 Data Communication and Organizational Network 	<p>FSU:</p> <ol style="list-style-type: none"> 1. Access control 2. Business Continuity and Disaster Recovery Planning 3. Physical (Environmental) Security <p>FAMU:</p> <ol style="list-style-type: none"> 1. Access control 2. Physical (Environmental) Security
VMWare Certified Associate—Data Center Visualization	<ol style="list-style-type: none"> 1. LIS 4488 Network Administration 	<p>No courses were identified in this program that cover certification exam objectives</p>	<p>FSU:</p> <ol style="list-style-type: none"> 1. Explain Data Center Virtualization Concepts and How They Solve Typical Business Challenges 2. Correlate VMware Data Center Virtualization Solutions with Specific Business Challenges

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Cisco Certified Network Associate (CCNA)	<ol style="list-style-type: none"> 1. LIS 4482 Managing Networks and Telecommunications 2. LIS 4488 Network Administration 	<ol style="list-style-type: none"> 1. CNT 2000 Computer Systems & Network Fundamentals 2. CNT 4504 Data Communication & Organizational Network 	<p>FSU:</p> <ol style="list-style-type: none"> 1. IOS 2. IPv6 3. IPv4 4. OSPF 5. Cisco Licensing 6. Enhanced Interior Gateway Routing Protocol (EIGRP) 7. Serial Line Interfaces 8. Frame Relay Interfaces 9. VLANs 10. Ethernet 11. VLSM 12. Basic Traffic Filtering <p>FAMU:</p> <ol style="list-style-type: none"> 1. IOS 2. IPv6 3. IPv4 4. OSPF 5. Cisco licensing 6. Enhanced Interior Gateway Routing Protocol (EIGRP) 7. Serial Line Interfaces 8. Frame Relay Interfaces VLANs 9. Ethernet 10. VLSM 11. Basic Traffic Filtering
Cisco Certified Network Professional (CCNP)	<ol style="list-style-type: none"> 1. LIS 4482 Managing Networks and Telecommunications 2. LIS 4488 Network Administration 	<ol style="list-style-type: none"> 1. CNT 4505 Data Communication and Organizational Network 	<p>FSU:</p> <ol style="list-style-type: none"> 1. Implementation of complex enterprise LAN and WAN routing solutions 2. IPv6 3. EIGRP 4. BGP 5. OSPF <p>FAMU:</p> <ol style="list-style-type: none"> 1. Implementation of complex enterprise LAN and WAN routing solutions 2. IPv6 3. EIGRP 4. BGP 5. OSPF
W3Schools Certification: PHP	<ol style="list-style-type: none"> 1. LIS 4368 Website Development with PHP 2. LIS 3781 Advanced Database Management 3. LIS 4369 Extensible Enterprise Solutions 	<ol style="list-style-type: none"> 1. COP 3710 Database Management System 2. COP 4710 Advanced Database Management Systems 3. COP 3828 Web Programming and Design 	<p>FSU:</p> <p>All covered</p> <p>FAMU:</p> <ol style="list-style-type: none"> 1. All topics related to PHP scripting language
W3Schools Certification: XML	<ol style="list-style-type: none"> 1. LIS 4369 Extensible Enterprise Solutions 	<ol style="list-style-type: none"> 1. COP 3366 C Sharp 	<p>FSU:</p> <ol style="list-style-type: none"> 1. XML DOM and XSLT tutorial concepts <p>FAMU:</p> <ol style="list-style-type: none"> 1. XML DOM and XSLT tutorial concepts