
Costs and Benefits of Vendor Sponsored Learning Materials in Information Technology Education

David M. Hua
dhua@bsu.edu
Department of Technology
Ball State University
Muncie, IN 47306, USA

Abstract

The demand for qualified information technology professionals remains high despite the lackluster economy. It is imperative to provide students with a curriculum that provides a broad foundation in information technology knowledge, skills, and abilities. However, students also need access to specialized technologies and learning materials to develop the skills that will be needed to drive growth in companies across all sectors of the economy. The dilemma faced by administrators of information technology degree programs is the lack of resources needed to provide students with these specialized learning opportunities. Cisco, VMWare, NetApp, and other information technology vendors offer learning materials that can be used by higher education programs. The potential costs and benefits of using these resources and how they have been incorporated into the undergraduate Computer Technology program at Ball State University will be discussed.

Keywords: information technology, education, vendor sponsored curriculum

1. INFORMATION TECHNOLOGY EDUCATION

Information has long been recognized as a facilitator of economic growth (Stiroh, 2002, World Economic Forum, 2012). The U.S. Bureau of Labor Statistics (2012) projected that the demand for information technology professionals will increase by 28% over the period of 2010 – 2020. It is imperative that information technology education provide students with the knowledge and skills to take advantage of these job opportunities.

Curriculum designers in information technology are faced with a constant set of challenges. The goal is always to provide students with the resources they need to attain the learning objectives of their academic program. To meet these challenges, information technology vendors offer degree granting programs in higher education with learning materials at little to no cost (Cisco, 2012; NetApp, 2012; Microsoft, 2012; Oracle Academy, 2012).

Some of the challenges in providing information technology students with resources relevant to market needs will be presented. To address these challenges, the potential costs and benefits of using vendor sponsored learning materials, and the way they have been incorporated into the undergraduate Computer Technology program at Ball State University will be discussed.

Challenges

Hardware/Software Resources

One of the most formidable challenges for information technology programs is providing students with the hardware and software resources they need to learn the applied skills required to successfully enter into the information technology workforce. The equipment may include hardware like computers, servers, switches or routers. Or it may be software like operating systems, server applications, or end-user applications.

The need for hardware and software resources places a significant strain on educational budgets for information technology programs. Whether it is providing enough resources to serve a large student population or purchasing the enterprise level resources required for specialized classes, curriculum designers are faced with balancing experiential learning and conceptual learning opportunities.

Moving Target

Keeping curriculum up-to-date with the ever-changing face of information technology is a constant challenge. In many disciplines, the core materials for a class remain relatively static. The general design and content of these courses do not need major revisions. That cannot be said for information technology courses.

Information technology programs also have a foundation of fundamental concepts and theories that remain constant. Students should understand protocols like TCP/IP, DHCP, and DNS. They need to be aware of how these theories govern data communications. A thorough understanding of the core concepts and theories that underlie information technology provides students with a foundation upon which to build.

Information technology courses depart from the static nature of many disciplines when going from theory to practice. With every new technology, new version of an operating system, or new version of an application comes a major curriculum revision. In order to provide students with the skills that they will need to be employable in the information technology workforce, courses have to be constantly updated.

2. VENDOR SPONSORED LEARNING MATERIALS

All information technology manufacturers have learning materials about their products. Both hardware and software vendors will need these materials to train their employees on the proper installation, configuration, and maintenance of their product. The challenge faced by vendors is that there are not enough qualified information technology professionals to implement the technology for their customer base. In the healthcare industry, it is being forecast that the information technology staffing shortage will hinder the ability of hospitals and other healthcare facilities to roll out new medical

technologies (Bahensky, Ward, Nyarko, & Li, 2009; Zwylak, 2011).

To address the staffing needs of their customer base, vendors began by offering product specific certifications. These certifications provided information technology professionals with a set of credentials indicating that they have attained a certain level of knowledge or expertise with a product (Al-Rawi, Bouslama, & Lansari, 2006; Randall & Zirkle, 2005).

In 1989, Novell became the first information technology company to offer a vendor-specific certification (Ziob, 2000). Since then, vendors from all aspects of the information technology industry have been developing their own product certifications (Al-Rawi, Bouslama, & Lansari, 2006; Randall & Zirkle, 2005). Apple Computers, Hewlett-Packard, Dell and other hardware vendors require technicians to earn their certification in order to do warranty repairs on their products. Cisco, Microsoft, NetApp, and other vendors have a progressive series of certifications that represent increasing levels of expertise in technical support, installation, configuration, and system design.

For the vendors, the primary purpose of these materials was to encourage information technology professionals to specialize in their products. However, the training materials for these certifications have also been used in information technology programs in higher education (Al-Rawi, Bouslama, & Lansari, 2006; Randall & Zirkle, 2005).

The certification preparation materials were originally intended for practicing information technology professionals. It was up to these practitioners to seek out the certification training materials and to take the certification exam. If higher education adopted these materials into their curriculum, it was simply a bonus for the vendor. However, some vendors were able to recognize the value of using an educational model to organize and offer their materials to not only practicing professionals, but to educational institutions as well.

Cisco, Microsoft, Oracle and other vendors have developed comprehensive systems that provide a turnkey training solution to educational institutions (Sands, 2003). These systems were designed specifically for educational institutions. Each of these vendors has marketed its respective information technology academies to

high schools, undergraduate programs, and graduate programs.

3. COSTS

Considering the use of a vendor sponsored curriculum should not be done without also considering the potential associated costs. Regardless of the vendor, each has a purpose for offering its learning materials. In pursuit of this purpose, vendors will have certain expectations of the faculty or institutions that are using their learning materials. It is incumbent upon the faculty to be aware of these expectations, or costs, before entering into any agreement with the vendor.

Financial Costs

There is almost always a financial cost associated with vendor sponsored learning materials. The amount of the cost depends on the vendor. The financial costs can be broken down into four categories: subscription fee, instructor preparation, equipment, and software.

Subscription Fee

The subscription fee is the price the vendor charges in order to gain access to their curriculum. Payment of the subscription fee typically gives the institution access to a prepared curriculum, lesson plans, course presentation slides, and course progress testing materials.

Some vendors, such as Microsoft, charge a flat, annual rate. Whether it is a high school vocational program, an associate or certificate program at a community college, or a bachelor degree program in information technology, the amount charged for the subscription is the same. Also, the subscription fee provides access to a variety of courses offered by the vendor.

Other vendors, like Oracle, will have a variable subscription fee based on the product lines the educational institutions want to utilize. Oracle offers a free introductory course to computer science that it markets to high schools. After that, there is a nominal annual fee per production line.

The Cisco Networking Academy had been operating under a different model. Individual academic programs would have local academies for their own students. These local academies reported to a regional academy that was

responsible for providing a variety of services to the local academies. The policies of the Cisco Networking Academy granted regional academies the authority to establish their own price for providing these services to local academies.

Instructor Preparation

When using a turnkey solution for IT education, the vendor may have expectations of those who will be providing the instruction. Some vendors may require the instructor to obtain the certification for which the teaching materials pertain before being allowed to teach that class. With this requirement, the decision has to be made as to who will be responsible for the cost of the certification. This issue is complicated further if the intended instructor does not pass the certification exam on the first attempt. Will it be the responsibility of the individual instructor or the institution to pay for the subsequent examinations? Also, how will not passing a certification examination impact the instructor's employment?

In addition to the cost of the certification exam, there may be a cost for preparing the instructor for the examination. The Cisco Networking Academy requires that an individual complete a training session before being granted authorization to teach their curriculum. The cost to attend these training sessions was usually incorporated into the fees paid to the regional academy.

Equipment

A major cost associated with any information technology curriculum is the hardware. Adopting vendor sponsored learning materials does not necessarily remove or reduce this cost factor. It can be quite the contrary.

The standard bundle of equipment recommended for the Cisco Networking Academy costs in excess of \$10,000. Depending on the number of enrolled students, a single bundle of hardware may be insufficient to provide all of the students with reasonable access to the equipment needed to complete the labs. In a class of twenty students, a minimum of four bundles would be needed to allow students to work in small groups during a class session. If required to work on labs outside of class time, fewer bundles could be purchased. However, this may require students to reserve time on the equipment during a limited set of

open lab hours. If that equipment is shared by multiple classes, then the competition for lab time increases significantly.

In addition to networking equipment, personal computers and servers will be required to access or use the learning materials offered by the vendors. Personal computers will be required to access resources in many of the turnkey solutions. The vendors provide e-learning websites to provide the curriculum to the students.

With many of the vendor sponsored learning materials, a personal computer may not be sufficient. Topics that deal with enterprise infrastructure services are going to require servers. Within the Microsoft IT Academy, courses may cover Windows Server 2008, Exchange, SQL Server, or Share Point. The VMWare curriculum explores a broad spectrum of virtualization topics including server virtualization, cloud computing, and virtual desktop infrastructure. NetApp and EMC both focus on enterprise storage issues. Enterprise level software and services require a server with enough processing power, RAM, and storage capacity to support them. A basic rack mount server to support these applications will cost several thousands of dollars. The cost is compounded when trying to provide enough servers for multiple students or groups of students to work on simultaneously during a lab session.

Software

Students need the opportunity to work with the latest versions of operating systems and applications. With that knowledge, students will be better prepared to provide recommendations on how to use the software to effectively support the organization's goals and objectives. The retail cost to purchase single copies of the software from Microsoft and VMWare can easily exceed \$5,000. As with the hardware, providing enough licenses for students to use on lab hardware drives the cost up quickly.

Another issue to consider is the students' access to the software from their own personal computers. Many students must work at least one part-time job to help pay for their college expenses. This can make it nearly impossible for students to take advantage of open lab hours. If students could load the required software on their own hardware, they could work on their

labs when they had time available. Also, it would give students the chance to explore the capabilities of the software beyond what was covered in class. However, the retail cost of the software may be beyond the financial capabilities of the students.

Academic Freedom

The biggest potential cost to using vendor sponsored learning materials is a loss of academic freedom. In higher education, it is the responsibility of the faculty member to determine the materials to be covered, the pedagogical strategies, and methods of assessment. The faculty member must have the autonomy to make decisions that will help the students accomplish the learning outcomes of a course.

Utilizing vendors sponsored materials holds the risk of sacrificing a degree of academic freedom. This can occur when the learning materials are not in alignment with the course objectives. The extent to which this may occur depends on the expectations of the vendor.

The Cisco Networking Academy offers a well-structured learning environment. While the Cisco Networking Academy offers several different courses, the primary purpose is to prepare students for the CCNA certification examination. Cisco organizes the materials into four sections. As part of the license agreement to participate in the Academy, the educational institution has to agree to annual quality assurance reviews. The purpose of these reviews, in part, is to ensure that local academies are providing effective training according to Cisco guidelines. The review incorporates a site visit at which students, instructors, and administrators are interviewed. As an academician, this can be seen as an intrusion on a faculty member's academic freedom to choose how to teach a class.

The loss of academic freedom can also be seen in the assessment process of some of the turnkey solutions. This is especially true of practical examinations that rely on vendor developed simulators. These simulators can have overly restrictive criteria. Whether the student is working with Excel, Windows Server 2008, or configuring an access control list in the Cisco IOS, there are typically multiple methods to successfully accomplish a single task. The simulators are typically programmed to

anticipate a single method. The student will not receive credit for the task unless that predetermined method is utilized.

4. BENEFITS

Cutting Edge Materials

The vendors that are engaged in developing learning materials for use in higher education are the leaders in their respective industries. Whether it is Cisco and networking or the combined storage market presence of NetApp and EMC, these vendors are creating the technologies and practices that will be used in enterprise infrastructures. It is this knowledge that they are incorporating into their learning materials. The transfer of knowledge from vendor to students is facilitated through their e-learning websites. Vendors have the discretion to update their e-learning materials when needed without the time delay required to update a traditional textbook.

The NetApp Academic Alliance offers the Learning Resource App. This is a desktop portal application used to pull together the most current resources for a topic. There are prepared packages for the Learning Resource App that cover virtualization, cloud computing, and private cloud infrastructure. Instructors can also work with a NetApp representative to populate the contents of the Learning Resource App. The contents may include publicly available information or NetApp proprietary learning materials. There may be white papers, webinars, videos, or e-learning modules. The flexibility this provides allows an instructor to collaborate with industry professionals to customize a set of resources that directly address the goals of a particular course. It can accommodate a week long review of a topic or provide enough resources for an entire semester.

For an information systems class, the instructor may choose to focus on the business impact of virtual desktop infrastructure. The Learning Resource App could then include white papers that provide an overview of the technology; case studies on the impact of virtual desktop infrastructure on organizations with respect to cost and productivity changes; and webinars with industry professionals discussing the topic.

By contrast, an information technology class may be more interested in the technical aspect of virtual desktop infrastructure. The instructor

may desire technical documents on design and installation of a virtual desktop infrastructure implementation. The case studies may focus more on highlighting the network infrastructure required to deliver a virtual desktop experience that minimizes delay. The Learning Resource App may link students to e-learning activities that provide visual instruction on the installation and configuration of a virtual desktop infrastructure solution. Ultimately, the instructor can collaborate with NetApp to gather the most appropriate resources available for the students.

Industrial Strength Tools

It is always optimal to provide students with the opportunity to have hands-on experiences with the technology that they are likely to encounter when they enter the workforce. However, providing enough hardware and software to achieve the goal is cost prohibitive. Participating in these vendor learning communities can provide access to "tools" that may lower the cost of educating the students for both the academic unit and the student.

Data storage has become a critical aspect of any enterprises technology infrastructure. There has been exponential growth of data resulting from corporate databases, e-mail, websites and other digital activities. Information technology administrators are trying to find effective and cost efficient strategies of managing the large volume of corporate data. Trying to provide students with experiential learning opportunities in data storage may not be possible without access to the tools that can be available through vendor learning communities.

The NetApp Academic Alliance provides faculty and students with access to resources that are used by their own engineers. NetApp allows instructors and students to use their VSIM virtual machine. The VSIM virtual machine contains the operating system found in NetApp's enterprise storage devices. Along with the NetApp System Manager software, instructors are able to develop labs that require students to develop and implement comprehensive data storage strategies.

In small groups, students in a data storage class in the Computer Technology program at Ball State University used the VSIM to create an iSCSI SAN environment in which they created LUNs that were attached as volumes on

production network servers. The students then used Active Directory and NetApp System Manager to create a secured storage environment based on a set of organizational design requirements presented by the instructor. This was all accomplished without having to purchase any additional hardware or software beyond the desktop computers and network already available in the classroom.

The experiential learning opportunity just described did leave out a key component. In addition to the tools available through NetApp, a virtualization solution was required. For this, the resources through the VMWare IT Academy provided students with the tools needed to run virtual machines for the NetApp VSIM and production servers. Participating higher education programs are able to use VMWare Workstation, vSphere, vCenter, and other virtualization products at no cost by VMWare. Access to these tools benefits the students by being able to implement virtualization solutions that are dominating how information technology is being implemented in enterprises. It also serves as a cost savings for the academic program by reducing the amount of hardware required to provide students with a robust experiential learning environment.

The Cisco Networking Academy offers Packet Tracer to participating programs and their students. Packet Tracer is a network simulation application in which instructors and students can design, build, and configure complex network topologies. In a networking class, the instructor can provide students with a topology that they then have to configure and test to verify functionality. Packet Tracer supports a broad range of networking protocols. Packet Tracer's simulation mode can be used to graphically display how fundamental protocols within TCP/IP function. In realtime mode, the simulator supports a variety of routing protocols (rip, ospf, eigrp, bgp), switching protocols (vlan, vtp, multilayer switching, QOS, etc.), wireless access points, and end devices (computers, servers, printers).

Students are able to download and install Packet Tracer onto their own computers from the Cisco Networking Academy website. While it is not a substitute for working on actual hardware, it does allow students to practice their network design and configuration skills outside of the classroom. Recent upgrades to Packet Tracer allow a topology created on one computer to

interact with a topology created on a different computer. With this capability, instructors can create scenarios in which students are network administrators responsible for integrating two separate networks after a corporate merger.

Student Recruitment

The use of vendor sponsored learning materials can increase an academic program's visibility to potential students. When engaging in recruitment activities, faculty and admissions personnel can share how industry leading vendors are contributing to the student's learning experience. They can also share the impact that this exposure may have on the student's employability upon graduation.

There is also a linkage between high schools and higher education available with the Cisco Networking Academy. The original intent of the Cisco Networking Academy was to increase the number of students coming out of high school who wanted to pursue careers in information technology. The Cisco Networking Academy website indicates that their curriculum is being used at over 600 high schools and 2600 colleges and universities worldwide (Cisco Networking Academy, 2012). At the training opportunities offered through the Cisco Networking Academy, high school and college instructors have the opportunity to interact. From these interactions, high school instructors are given the chance to encourage their students to continue their education at the higher education institutions that are also using the Cisco Networking Academy.

These interactions have led to more formalized arrangements between high schools and colleges. In an era of Advanced Placement and dual credits coming out of high school, potential students were asking whether their participation in the Cisco Networking Academy in high school could be applied towards their college education. To varying degrees, higher education has responded to these requests (Ball State University Cisco Academy Training Center, 2012).

Some higher education programs will give incoming students general credits for their successful completion of the Cisco Networking Academy. In this situation, the student would not receive credit for a specific class in the degree's curriculum. Instead, the credits would only be applied towards the total number of

credits hours required by the institution to graduate.

Other higher education programs have taken the next step by offering students credit for specific classes. This may be awarded by completing the Cisco Networking Academy curriculum and also successfully earning the CCNA certification. Another alternative has been establishing a dual-credit relationship between a higher education program and a specific high school (Montgomery County Public Schools, 2012; North Tech High School, 2012). Each of these college credit opportunities are being used as an enticement to recruit high school students to matriculate to an institution's information technology degree program.

5. BALANCING ACT

Retain Academic Control

The most important thing an instructor should do when utilizing vendor sponsored learning materials is to retain academic control over the class. It is incumbent upon the instructor or curriculum designer to review the materials offered by these vendors and determine the degree to which those materials support the learning objectives of a course. The use of these vendor materials can be criticized as a "sell out" to the technology vendors. The basis for this criticism is the assumption that students are only being exposed to the equivalent of corporate "propaganda" that espouses their own products. In response, there is merit to this argument. However, it is limited.

Cisco, NetApp, EMC, and other vendors have recognized this criticism and attempt to provide their educational materials in a vendor neutral manner. This is accomplished by emphasizing the concepts, theories, protocols, and design considerations that underlie the technology. These learning objectives are completely independent of varying manufacturers of the technology.

It is when the learning materials make the transition from theory to practice that vendor specific materials come into play. At some point, it becomes necessary in an experiential learning environment to interact with hardware and software in order to develop the applied skills demanded by employers. It is reasonable to adopt a vendor's product in order to provide students with chance to develop these applied

skills. As long as the student understands the underlying foundations, the primary difference between configuring a Cisco Catalyst switch and an HP switch is the syntax. VLANs and the IEEE 802.1Q protocol work the same way on both devices.

If this logic is accepted, then the use of vendor sponsored learning materials does not automatically constitute a compromise of an instructor's academic freedom. At the same time, it is not an endorsement for faculty to blindly accept the content, delivery, or assessment strategies provided by the vendor. There is nothing restricting an instructor from creating an additional assessment outside of the confines of a particular vendor's learning environment. The students can be given a task of the instructor's choice and have the flexibility to utilize any method that is appropriate to solve the task. The instructor must strike a balance that provides students with relevant content and resources while meeting the requirements of the vendor.

Tool Box

To achieve that balance, an instructor needs to consider the strengths and weaknesses of the resources at his or her disposal. When an academic program has arrangements with multiple vendors, it is like having a well-equipped tool box. The trick is finding the right tool for the job at hand. An individual vendor is likely to present lesson plans based on the tools that they provide. An instructor with access to a broader set of tools should be able to develop a more comprehensive learning experience by integrating resources from different aspects of an enterprise infrastructure. In so doing, the students begin to comprehend the interactions and interdependencies that occur between the network infrastructure, server hardware, operating systems, and enterprise applications that are found in corporate information systems.

In a systems administration course at Ball State University students were introduced to DNS and DHCP. Students were asked to configure these services on a virtual machine of a server operating system on their individual desktop computer and be done. However, how often are end users located on the same physical computer that is hosting those services? Enterprise servers are usually located on a different part of the network.

Access to the various vendor resources has allowed the design of that lab to be more robust. The limitations of the previous example and expand upon. Having adopted various vendor learning opportunities into the Computer Technology program at Ball State University, the instructor hands out a network topology and the students have to develop an appropriate IP subnet strategy. Students then use Packet Tracer to create a test build of the network infrastructure and verify that the IP subnet strategy and network device configurations are correct. The configurations from Packet Tracer can then be imported into actual Cisco switches and routers in accordance with the topology. Students then connect desktop computers to different subnets on that physical topology. With VMWare Workstation obtained through the VMWare IT Academy installed on one of those desktop computers, students create a virtual machine for the server with Windows Server 2008, R2 ISO downloaded from the Microsoft IT Academy via DreamSpark.

By taking this approach to a DNS or DHCP lab assignment, students learn much more than just how to create a scope within DHCP. Instead of being given a set of IP addresses to use, students experience the impact of the IP strategy they had developed. They have to diagnose that the range of addresses for their subnets was wrong if they received IP address overlap errors on the routers or DHCP scopes. After correcting the IP subnet strategy, students would then have to reconfigure IP addresses on network devices, static IP addresses on the server, IP addresses of DNS entries, and scope configurations in DHCP. By combining the available tools, students develop an appreciation for the development and planning stages when designing an information technology infrastructure. It also fosters critical thinking skills that are needed to be an effective technology troubleshooter.

Low Cost Providers

Both Microsoft and Oracle charge set fees to participate in their academies and so there are no lower cost alternatives for these resources. When possible, however, seek out the low cost providers of vendor sponsored learning materials. With the Cisco Networking Academy, academic programs could choose the regional academy through which they would access the Cisco materials. Since these regional academies were able to determine their own price based on

the additional services they provided there local academies, curriculum designers could shop around for the regional academy that provided the services they needed at a price that was within their budget.

Other vendors have taken the position that they will not charge higher education to participate in their learning communities. They provide access to higher education programs free of charge. NetApp, VMWare, and EMC have adopted the philosophy that providing higher education with their learning materials is an investment. For every dollar put into their learning communities, they anticipate a delayed return on investment. The objective for these vendors is to increase the number of information technology professionals who are skilled in their product lines.

6. CONCLUSIONS

With declining budgets in higher education, the challenge of providing students with the resources they need has become increasingly difficult. Curriculum designers face the constant challenge of providing students with hardware, software, and current learning materials.

The use of vendor sponsored learning materials can provide curriculum designers in information technology programs with a broad range of cutting edge materials. Leading hardware and software developers in the information technology industry are granting higher education faculty with access to the newest releases of operating systems, server applications, simulators, and learning materials at little to no cost.

Despite the potential benefits, the decision to adopt vendor sponsored materials into an academic program should not be taken lightly. While the vendor may not charge much to use their materials, there are likely to be a number of support costs. These costs can stem from subscription fees, hardware, and software to support any single vendors learning materials. A more significant cost to consider is the potential loss of academic freedom when trying to fulfill appropriate usage requirements by the sponsoring vendor.

Ultimately, faculty need to retain academic control of what occurs in their courses. Instructors need to recognize that the vendor materials are tools. It is up to the instructor to

choose the most appropriate tools to assist the student in attaining the learning objectives for a given course. This is done by balancing the needs of the vendor with the needs of the students. When done effectively, students can be provided robust learning opportunities that foster critical thinking and develop a more comprehensive knowledge of the interactions between different technologies.

7. REFERENCES

- Al-Rawi, A., Bouslama, F., & Lansari, A. (2006). Preparing undergraduate students for IT certification. *Proceedings of the Informing Science + IT Education Conference, Manchester, England*, June 26-28. Retrieved from <http://proceedings.informingscience.org/InSITE2006/IISITAIRa185.pdf>
- Bahensky, J.A., Ward, M.M., Nyarko, K., & Li, P. (2011). HIT implementation in critical access hospitals: Extent of implementation and business strategies supporting IT use. *Journal of Medical Systems*, 35(4), 599-607.
- Ball State University Cisco Academy Training Center. (2012). *Cisco Articulation Agreements*. Retrieved August 19, 2012, from <http://catc.iweb.bsu.edu/index.html>.
- Cisco. (2012). *Cisco Networking Academy*. Retrieved September 24, 2012, from <http://www.cisco.com/web/learning/netacad/index.html>.
- Microsoft. (2012). *Microsoft IT Academy Program*. Retrieved September 24, 2012, from <http://www.microsoft.com/en-us/itacademy/default.aspx>.
- Montgomery County Public Schools. (2012). *Articulation Award Form*. Retrieved September 29, 2012, from <http://www.montgomeryschoolsmd.org/uploadedFiles/curriculum/careerprograms/infotech/Artic%20award%20form%20Cisco%281%29.pdf>.
- NetApp. (2012). *Academic Alliances*. Retrieved September 24, 2012, from <http://www.netapp.com/us/company/leadership/academic-alliances/academic-alliances-overview.html>.
- North Tech High School. (2012). *Articulation Agreements*. Retrieved September 29, 2012, from <http://www.northtechnical.org/w3/docs/ArticulationAgreements.pdf>.
- Oracle Academy. (2012). *Oracle Academy: Software, Training, Resources and More*. Retrieved September 24, 2012, from <https://academy.oracle.com/index.html>.
- Randall, M. H., & Zirkle, C. (2005). Information technology student-based certification in formal education settings: Who benefits and what is needed. *Journal of Information Technology Education*, 4, 287-306. Retrieved from <http://www.jite.org/documents/Vol4/v4p287-306Randall78.pdf>
- Sands, C. (2003). Techie training for students. *Tech Learning*. Retrieved July 05, 2012, from <http://www.techlearning.com/story/showArticle.jhtml?articleID=15202086>
- Stiroh, K. J. (2002). Information technology and the U.S. productivity revival: What do the industry data say? *The American Economic Review*, 92, 1559-1576.
- U.S. Bureau of Labor Statistics. (2012). Network and Computer Systems Administrators: Occupational Outlook Handbook. <http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm#tab-6>
- World Economic Forum. (2012). *The Global Information Technology Report 2012*. Retrieved September 10, 2012, from <http://www.weforum.org/reports/global-information-technology-report-2012>.
- Ziob, L. L. (2000). Time is flying: 10 years of IT certifications. *Certification Magazine*. Retrieved April 30, 2005, from <http://www.certmag.com/issues/feb00/features.cfm>
- Zywiak, W. (2011). CSC healthcare workforce shortages. *Healthcare Information and Management Society*. Retrieved July 1, 2012 from

http://www.himss.org/content/files/csc_us_healthcare_workforce_shortages_hit.pdf