AC 2010-1485: DEVELOPMENT AND IMPLEMENTATION OF A MASTERS PROGRAM IN COMPUTER INFORMATION TECHNOLOGY

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Development and Implementation of a Masters Program in Computer Information Technology

Abstract

In this paper, we describe the process of developing and implementing the masters program in computer information technology (MSCIT) at Northern Kentucky University (NKU). The major goal of this paper is to present the structure of the curriculum. The curriculum is divided into the following components: bridge courses, intermediate core courses, advanced core courses, elective courses. We incorporate flexibility in our program by including many interdisciplinary elective courses. We also include in this paper how we assessed the need of such a program. For this, we carried out following steps: conduct a survey to analyze the industry demand, conduct a survey that explore students' interest in this program, analyze the job demand in Cincinnati metro area by investigating current job offers, investigate existing graduate IT programs at other universities, and prediction of job market trends as described by department of labor.

Introduction

In this paper, we describe the process of developing and implementing the Masters of Science of Computer Information Technology (MSCIT) program at Northern Kentucky University (NKU). We discuss the background information about NKU and how MSCIT program fits within NKU. Consequently, we present the need of this kind of program. Then, we elaborate the structure of MSCIT program curriculum. We compare and contrast the similar masters program at other universities. At the end, we summarize our discussion.

Background

Having opened its doors in 1968, Northern Kentucky University is a relatively young, very progressive, comprehensive, public university located seven miles south of Cincinnati, Ohio. NKU provides its students with an outstanding educational experience, preparing them for the job market and for more advanced education. The NKU is a public institution with a student enrollment of approximately 15,000. NKU offers 70 bachelor's degrees, six associate degrees, 20 master programs, one Juris Doctor and one Doctor of Education in Educational Leadership, as well as more than 30 graduate certificates. Currently, the Computer Science and Computer Information Technology programs are located within the College of Informatics while the Business Informatics program is housed in the College of Business.

The College is designed to provide leadership in technology for the Northern Kentucky region. It acts as a catalyst for innovation, a repository of expertise, and an academy that produces graduates who meet the community's need for properly trained and capable information technology workers. A goal of the college is to place the region at the forefront of the nation in

skilled knowledge workers. Thus, one objective of the new College is the creation of degree programs that address specific employer needs in the rapidly evolving arena of informatics.

Within the new College of Informatics, the existing undergraduate degree in Computer Information Technology flourished. The number of students enrolled in this program has been grown steadily in the last 4 years to more than 200 (as of Fall 2008). At the same time, while still a young discipline, Computer Information Technology had matured as an academic discipline and it started to become a major computing area at a large number of United States universities.

Given all these factors, it is not a surprise that the department of Computer Science initiated a series of discussions regarding a new Master of Science in Computer Information Technology (MSCIT) degree program. During 2008, the department studied changes taking place across a variety of institutions of higher education. Particular attention was paid to the effectiveness of these existing programs to meet the community's need for highly qualified computer information technology employees. In April of 2008, an Academic Planning Form outlining this program was developed and submitted for consideration. A formal committee was established to examine existing and potential academic programs in information technology (IT), to explore the opportunities created by the implementation of the MSCIT program, and to develop the MSCIT graduate degree.

Other Related Masters Programs at NKU

The MSCIT program has an interdisciplinary orientation and draw upon resources across the College of Informatics and the University. Nevertheless its natural home is within the Department of Computer Science building as it does upon the foundation of the undergraduate CIT program and the growing number of faculty with an applied IT orientation in the department.

The landscape of graduate education in IT-related fields is populated by three existing programs in the college:

- **Master of Science in Computer Science (MSCS).** Inaugurated in 2000, this program is designed for practitioners seeking to enhance their software engineering skills beyond the skill set of mere programmers. It exposes them to the latest developments in software construction, while simultaneously seeking to make them more agile practitioners by connecting them to the deep ideas underlying contemporary computer science.

- **Master of Business Informatics (MBI).** Created in 2001, this program provides business perspectives on the IT world. The curriculum deals with topics such as e-commerce, IT project management, databases, enterprise resource planning, and advanced business application programming, all from a decidedly managerial focus.

- **Master of Health Informatics (MHI).** This is primarily a degree designed for healthcare professionals seeking to play a leading role in the deployment of information technologies in their field. The program was created in 2006.

The MSCIT program complements these programs. It is centered firmly on technology, with business providing the necessary context. Although students develop advanced skills in specific IT technologies, the primary focus is not on technology training but on cultivating deep insights into contemporary IT, so that graduates of the MSCIT program can have a broader impact on the IT workplace– moving beyond mere doing, to teach, lead, and create.

One of the key cornerstones of the College of Informatics to have emerged over its three-year history is its grounding in Data Privacy and Security. The MSCIT program reflects this special strength by weaving these themes into most of its courses.

Another crucial element of the College is its Infrastructure Management Institute (IMI). The program leverage IMI's contacts with the business community to enrich its capstone best practices seminar, where students' ability to hone their thinking and communication skills in a group context are developed. An elective in Social Informatics is also available for students who want to cultivate a deeper understanding of technology as an arena for social interaction, as is the case in the modern workplace.

In short, the placement of the program in the interdisciplinary College of Informatics makes it stand out from the crowd of various IT graduate programs currently offered in this country. The program is not static; it will evolve as the college evolves, and as it matures it will deepen its connections with the local IT industry.

The Need for the MSCIT Program

Our society's dependence on information technology, and the sophistication of such technology, has evolved to a point where an in-depth knowledge of IT concepts and best practices is an important asset for every IT employee. We are at the point where a four-year IT program is not always enough for acquiring the requisite levels of IT mastery in many workplaces. The success of the Bachelor of Science in Computer Information Technology degree (still a young program at NKU) as well as the success of other IT programs across the country shows the need for a well qualified workforce of IT leaders. The MSCIT Committee believed that a Master of Science program in Computer Information Technology will be able to increase the quality of the IT workforce in the region. It is worth mentioning that the MSCIT does not target only IT graduates, it also allows graduates from other fields (especially in the sciences or engineering) to acquire up-to-date IT competencies and to become more competitive on the job market.

The Master of Science in Computer Information Technology directly supports the goals and mission of the university. The degree is designed to meet the needs of the community's varied employers in the IT industry, broadly defined, ranging from small IT providers to large IT organizations. This is occurring at time when the implementation and use of information technology is of critical importance in any industry.

In collaboration with regional business, civic, and government entities, Northern Kentucky University has worked diligently to attract technology-oriented businesses to the Northern Kentucky area. This MSCIT program provide a unique and effective resource by which the University may meet these employers' increasing needs, particularly by complementing existing

technology- and computing-oriented courses offered by the University. The program is consistent with the practical, career orientation of all the College of Informatics programs at Northern Kentucky University.

The need for the program and its curriculum was developed based upon the following methodology:

1. A literature review of the computer information technology field was undertaken, organized, and used to inform this process. We explored the ACM Computing Curricula for Information Technology[1].
2. Detailed analyses of similar programs were undertaken (discussed later).
3. Structured meetings with several members of the Dean's Advisory Board of the College of Informatics were organized.
4. One survey of employers and IT professionals in metro-Cincinnati area was conducted by investigating current job offers, and prediction of job market trends as described by department of labor.
5. One survey of potential students was undertaken.

Structure of the MSCIT Program

The curriculum for the Master of Science in Computer Information Technology draws principally from the Department of Computer Science. Existing courses in the Business Informatics Department and Communication Department (both in the College of Informatics) are also used as electives for this program.

The Master of Science in CIT requires a minimum of 30 graduate credits. Requirements are broken down in following way:

- 6 credits in Required Intermediate Core Classes. These classes may be waived if taken as an undergraduate.
- 12 credits in Required Advanced Core Classes.
- At least 18 credits in Elective Classes from which a minimum of 9 credits must be in Advanced Electives (600 level classes).
- At least 21 credits in CIT classes from which a minimum of 15 credits must be CIT 600-level classes (these credits include Intermediate Core, Advanced Core and Elective Classes).
- The students without the necessary IT background may be required to take one or two of the available Bridge Classes (as discussed later).

The overriding principle in curriculum design is that this is a true graduate program emphasizing comprehensive and in-depth knowledge that goes beyond what is expected from a bachelor program. Considering the quality of the program, we also allow students with various computing backgrounds a smooth transition into the MSCIT program.

Table 1 summarizes the credits that would be earned in the MSCIT program by students with various backgrounds.

Table 1. Required MSCIT Credits by Student Background

	NKU BS in CIT		Others
	Net/Security Track	DB/Web Track	
Bridge	0	0	0-6*
Intermediate Core	0-3	0-3	0-6
Advanced Core	12	12	12
Electives < 600	9	9	9
Electives ≥ 600	9	9	9
Min Number:	30 (up to 33)	30 (up to 33)	30 (up to 36)

* - These credits do not count towards the degree. These courses allow students with no IT background to take advanced CIT graduate classes.

Bridge Courses

Computer Information Technology is still an emerging discipline that lacks standardization. Therefore, the students who enroll in this program may have a very diverse background or may not have the necessary undergraduate background for advanced coursework in CIT. These bridge courses were introduced in the program in order to allow students with a limited knowledge of IT areas to be successful in this program. Courses that prepare students for graduate level coursework are referred to as "Bridge" courses. The following two courses are available for students accepted in the MSCIT program who do not have the required coursework or practical experience in IT.

The first course in this category (IT Fundamentals) contains the basics of UNIX administration, computer security and networking. The second course (Scripting) contains the basics of web and script programming, as well as an introduction to databases. These two courses form a set of skills and knowledge required for the majority of classes in this graduate program. We anticipate that only a small percentage of students may need to take these courses. A student may be required to take one or both of the bridge courses by the MSCIT Program Director. The required courses in this category can be determined, after review of transcripts and consultation with the student. The bridge courses do not count toward the 30 graduate credits required for this program. The MSCIT Program Director may require completion of one or both of the Bridge courses if the undergraduate equivalents are older than eight years or if grades of less than C were earned.

Bridge Courses	Credits
CIT 500 - Information Technology Fundamentals	3
CIT 501 - Scripting	3

Intermediate Core Courses

The small set of intermediary core courses (Network Design/Troubleshooting and Database Administration) reflect two major components of the discipline, networking and databases, and these courses create an intermediate set of knowledge about these two areas. The following two courses are all required if they have not already been completed at the undergraduate level. The required courses in this category are determined by the MSCIT Program Director, after a review of your transcripts and consultation with the student.

Intermediate Core Courses	Credits
CIT 547 - Network Design/Troubleshooting	3
CIT 572 - Database Administration	3

Advanced Core Courses

Computer Information Technology graduates are expected to be comfortable with wide-range of information technologies and very knowledgeable in a specific area. A small number of required core courses allow greater flexibility to the program; the students get benefit from being able to customize it to their needs by selecting their preferred electives. The 12-credit required core implemented for this program reflects the flexibility. The following all four core courses are required in MSCIT.

Advanced Core Courses	Credits
CIT 668 - System Architecture	3
CIT 672 - Advanced Database Administration	3
CIT 696 - Best Practices in Information Technology Seminar	3
MBI 650 - Information Technology Project Management	3

The first two classes from this category give an in-depth perspective on the CIT field in two very important areas: systems architecture and databases. Both of these classes cover an advanced set of concepts, and the students are expected to have the relevant background experiences necessary for applying these concepts in practice as well as contributing to insightful classroom discussions. The third class constitutes the capstone experience for a MSCIT graduate. The capstone consists of a weekly seminar that deals with students' IT-experience and lectures/discussions on applied topics. Required readings of IT papers in various domains is a core part of this course. We also anticipate IT-related presentations of various invited industry participants. The capstone also provides a critical program evaluation method based upon the feedback of industry participants and performance of the students. The fourth class offers a broad perspective of the project management, which allows a MSCIT graduate to be a better team member and a better leader in an IT organization.

Elective Courses

The requirement of elective courses encompasses the variety of the CIT discipline. There are many specializations possible and we plan to offer our students the opportunity to customize this

program according to their needs. The choice of electives also recognizes the potential of varying backgrounds of students entering the program. Our electives emphasize several areas which are recognized as the main components of the CIT discipline: security, networking, system administration, web technology, and databases. This program is designed to provide the required skill sets in many of the mentioned areas. It is through the electives that the interdisciplinary breadth of the program is implemented. Courses in business informatics as well as communication are weighted just as heavily as technical courses in this category.

Students must take at least 18 credit hours of the courses below, at least 9 hours of which must be from the Advanced Elective Classes (600 level). All these courses must be taken in graduate status.

Intermediate Elective Courses	Credits
CIT 530 - Computer Forensics	3
CIT 536 - Web Server Administration	3
CIT 565 - Storage Administration	3
CIT 570 - Advanced Network and System Administration	3
CIT 584 - Network Security	3
CIT 586 - Three Tier Web Applications	3
CIT 594 - Intermediate Graduate Topics: Computer Information Technology	3
CIT 599 - Intermediate Independent Study	1 - 3
CSC 507 - Concepts of Programming Languages	3
CSC 533 - Computer Networks	3
CSC 550 - Database Management Systems	3
CSC 582 - Computer Security	3
PHI 510 - Ethics in Information Technology	3

Advanced Elective Courses	Credits
CIT 630 - Advanced Computer Forensics	3
CIT 637 - Wireless Networks	3
CIT 644 - Web Security	3
CIT 661 - Routing	3
CIT 662 - Switching	3
CIT 677 - Data Mining Tools and Techniques	3
CIT 694 - Advanced Graduate Topics: Computer Information Technology	3
CIT 599/699 - Advanced Independent Study	1 - 3
CSC 645 - Software Interface Design and Human Factors	3
CSC 670 - Social Implications of Computing	3
CSC 682 - Advanced Computer Security	3
COM 700 - Social Informatics	3
MBI 615 - Strategic Management of Technology and Innovation	3
MBI 625 - Information Systems in Organizations	3

MBI 630 - Systems Analysis and Design	3
MBI 640 - Data Communication, Networking and Security	3
MBI 645 - Electronic Commerce	3
MBI 647 - ERP Business Process Analysis Using SAP	3
MBI 657 - ERP Business Process Integration Using SAP	3
MBI 667 - ERP Business Intelligence Using SAP	3
MBI 677 - ERP Programming for SAP	3
MBI 682 - Information Security & Controls	3
MBI 685 - Corporate IS Management	3

Other Considerations

Transfer Credit: Students may transfer up to 9 semester hours of appropriate, acceptable graduate coursework from other institutions. A student must have earned a minimum grade of B in such courses. These courses must be deemed appropriate to the student's program of study at the time of admission into the program by the department chair on the advice of the director. Transfer of graduate credit must be completed before students earn 12 semester hours at NKU.

Academic Standing: A GPA of at least 3.00 must be maintained for all courses taken with graduate standing. At most two C grades can be counted toward the degree. A course may be repeated only once, and only two courses may be repeated. Only courses with a grade of C or below can be repeated; only the repeat grade is used in GPA determination. Students whose GPA falls below 3.00 will be placed on probation; those remaining on probation for more than 9 semester hours of coursework will be dropped from the program.

Sample two-year program plan

A sample two-year program plan is presented here.

	Fall		Spring	
Year 1	CIT 572* (ic)	3	CIT 672 (ac)	3
	CIT 517* (ic)	3	CIT 530 (e)	3
	MBI 650 (ac)	3	CIT 570 (e)	3
	Total Hours	9	Total hours	9
	Fall		Spring	
Year 2	CIT 668 (ar)	3	CIT 696 (ac)	3
	CIT 630 (e)	3	MBI 615 (e)	3
	COM 700 (e)	3	CIT 661 (e)	3
	Total Hours	9	Total hours	9

* - only if not taken as undergraduates

(ic) Intermediate Core Course, (ac)Advanced Core Course, (e) Elective Course

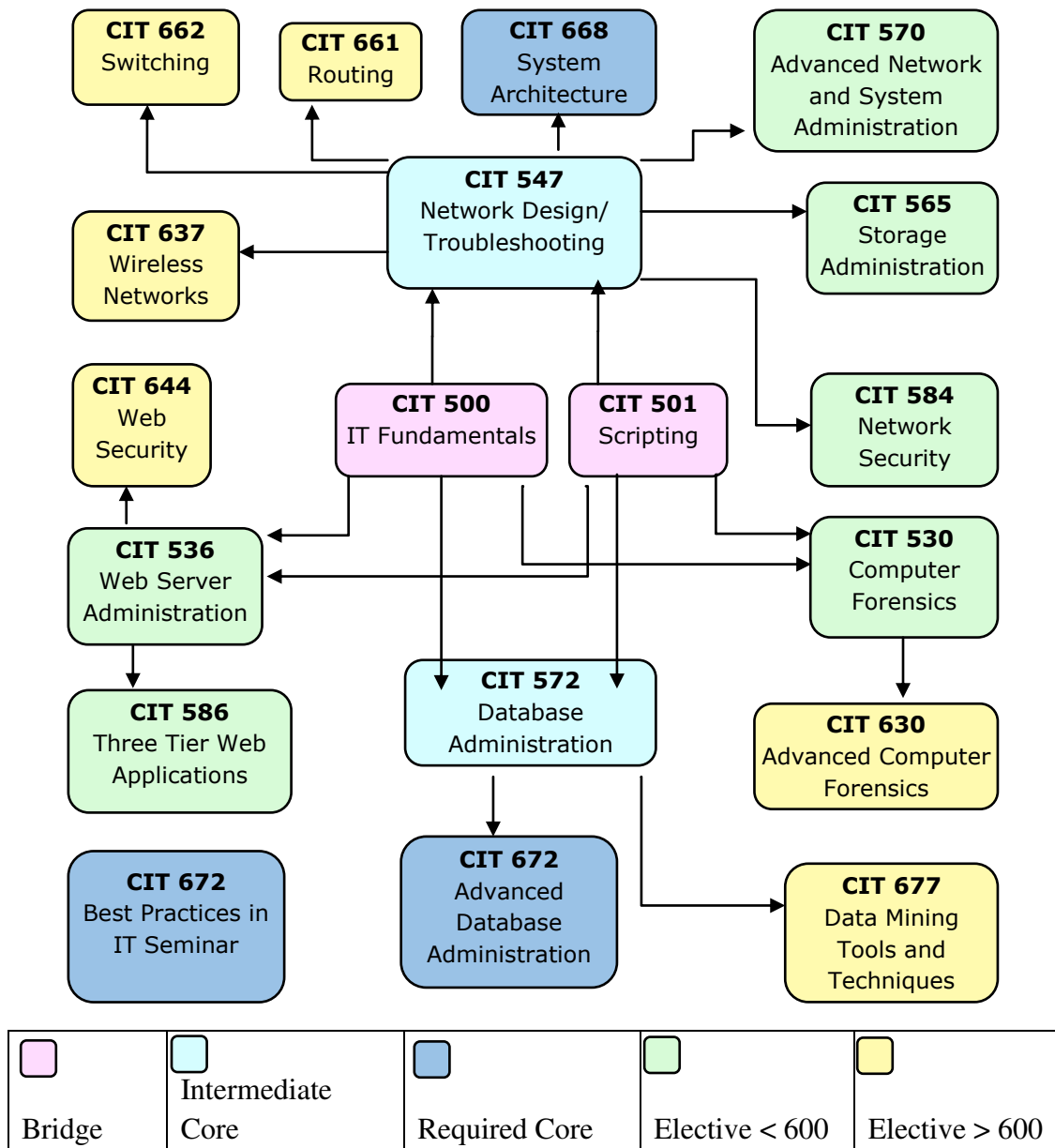**Figure 1. Sample Two-Year Plan of MSCIT Student**

Figure 2. Flowchart of MSCIT

MBI 650 is the only non-CIT class required in the CIT program. Other non-CIT electives are available.

As the sample plan indicates, a computer information technology major can complete the requirements during this time period i.e., two years.

Learning Outcomes

The learning outcomes for this degree were developed by the faculty committee using multiple sources to inform the process. This included a review of programs at Universities and Colleges

on a nationwide basis, discussions with faculty in related departments across the NKU campus, discussions with Dean's Advisory Board members, one student survey, one employer/professional survey, consultation of the ACM Computing Curricula Information Technology Volume[1], etc. The objectives of the program are driven by the skill-sets and knowledge identified through this process. These skill-sets and specialized knowledge can be directly explicated into learning outcomes. A list of these is provided in Table 2, along with courses associated with meeting this learning outcome.

Table 2. Learning Outcomes and Associated Courses

Representative Learning Outcomes	Associated Courses
Technical Skills:	Course Listing:
Network Design, Security, Administration Knowledge	CIT 547, CIT 570, CIT 584, CIT 661, CIT 662
Database Administration Knowledge	CIT 572, CIT 672
Web Server Administration and Security Knowledge	CIT 536, CIT 644
Storage Management Knowledge	CIT 565
Data Analysis and Mining Techniques	CIT 677
Computer Forensics Knowledge	CIT 530, CIT 630
Web Development Skills	CIT 501, CIT 586
Wireless Networks Knowledge	CIT 637
System Administration and Architecture Knowledge	CIT 500, CIT 570, CIT 668
Project Management Skills	MBI 650
Organizational Competencies (partial list):	Course Listing:
Communication	All classes address elements of these competencies.
Teamwork, Collaborative Decision-Making	The capstone course focus on these organizational competencies.
Critical Thinking, Problem Solving	
Lifelong Learning, Quick Study	
Translation of Legacy Concepts, Tech. Evolution	
Problem Solving	
Leadership	

Learning Outcome Assessment and Feedback

The efficacy of the curriculum relative to the learning outcomes will be continuously evaluated. This will take the form of the following modalities:
1. Student performance in the courses
2. Student performance on key indicators specific to each course
3. Student evaluations of the courses

4. Discussions with the College of Informatics Advisory Board
5. The success of students in securing employment
6. Follow-up surveys with graduates of the program

Feedback from these sources will be carefully evaluated by the director of the program and faculty teaching the courses. The data for this analysis will be accumulated annually and evaluated. When appropriate, changes will be made to the curriculum and individual courses in order to achieve improved student learning outcomes.

Short Description of Several Non-NKU Masters Programs in Information Technology

Rensselaer Polytechnic Institute[4] (RPI) was among the first universities to offer advanced master's degrees and doctoral study in the highly creative, interdisciplinary field of Information Technology. Department of Engineering & Science offer Master of Science in Information Technology program with requirement of 30 or more credits. The RPI model resembles with our MSCIT program with some differences of not including Software Design and HCI courses as they may relate more in our existing MS in Computer Science program.

University of Pennsylvania[7], School of Engineering and Applied Science, offers Master of Computer and Information Technology (MCIT) with degree requirement of 30 Credits or more. MCIT consists of ten graduate courses, six required courses and four electives. This program is for students with undergraduate degree NOT in computer science. This program does not resemble our proposed degree; it is more similar to an undergraduate in CS or Computer Engineering degree.

The Master of Science in Information Technology program offered at Northwestern University[2] consists of 12 courses and takes two academic years to complete with degree requirement of 36 quarter credits or more. This program doesn't have flexibility that our MSCIT program has in terms of electives and courses. Northwestern program requires more courses as they have Quarter system while we have semester system. We differentiate from their model by not including Telecommunication Engineering, Strategic Marketing and The Law of IT courses in the degree. We believe that these topics are not directly related to our MSCIT program.

The Masters Program in Information Technology (MSIT) at Rochester Institute of Technology[5] (RIT) is similar to our program which is designed with a highly flexible framework that allows students to design a program of study that suits their own goals and interests within the discipline. It requires 48 quarter credits or more to get masters degree. Their concept of "concentrations" is a bit fuzzy. It is extremely broad and does allow for concentrations from other departments.

Oslo University College[3] offers Master of Network and System Administration with degree requirement of 30 Credits or more. Oslo University College is the premier academic institution

in the field of System Administration and one of the leaders of the European Union IST-EMANICS Network of Excellence for Network Management. Oslo's program is more focused than ours, as it does not contain courses that specifically focus on database or web administration. Students take required courses and a master's project.

Master of Science in Information Technology is being offered at University of Maryland University College[6]. This program provides a broad technical understanding of current and evolving technologies in the IT field with an emphasis on moving technology from the laboratory to the realm of business development through its program core courses. The curriculum requires 36 credits of coursework and is divided into 15 credits of required program core coursework, and 21 credits of required coursework, including a 3-credit capstone course, from one of the program specializations. Unlike our program, this degree program has a strong Information Systems and Management focus. The program is also much larger than ours, with many courses beyond the required core, including 7 courses specific to each specialty. Despite such scope, it's much weaker than our program in the core areas of system and network administration.

Master in Information Technology (MIT) is being offered at Virginia Polytechnic Institute and State University[8]. Students can complete 10 courses in less than 3 years. Along with the Master's degree, individual certificates can be granted for the completion of modules. Students must complete a minimum of 30 credit hours to obtain the Master's Degree (ten courses): all four foundation courses (3 credits each) and six module courses (3 credits each). Two courses within three separate modules must be completed to fulfill the degree requirements. The program model is different from our MSCIT program. Their program has a different concentration. It is mainly targeted at working professionals in particular industries such as wireless communication, computer engineering, and business information systems. Our program concentrates on providing practical hands-on knowledge of system and network administration to students.

Conclusions

In this paper, we describe the process of developing and implementing the masters program in computer information technology (MSCIT) at Northern Kentucky University (NKU). The major goal of this paper is to present the structure of the curriculum. The curriculum is divided into the following components: bridge courses, intermediate core courses, advanced core courses, elective courses. Processes by which specific course offerings were chosen is detailed: objectives of the courses, and desired outcomes for students. We incorporate flexibility in our program by including many interdisciplinary elective courses. We also briefly include in this paper how we assessed the need of such a program. We compare and contrast the similar masters program at other universities. At the end, we concluded our discussion on MSCIT program development.

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