AC 2004-957: MODEL CURRICULUM FOR UNDERGRADUATE DEGREE PROGRAMS IN INFORMATION SYSTEMS

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Model Curriculum for Undergraduate Degree Programs in Information Systems

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Abstract

Growing demand for information technology (IT) skills from industry and government is putting an enormous pressure on academic institutions to produce graduates that have an understanding of a broad range of technologies and have the necessary skills to be productive as they join the workforce. The Information Systems (IS) discipline is becoming an essential part of business and government organizations, which require professionals from diverse backgrounds. Academic institutions in the US and worldwide are constantly refining their curricula in an attempt to address the needs of industry and government. However, these curricula are not developed based on worldwide recognized standards and at times lack critical components.

The objective of this paper is to propose a comprehensive model IS curriculum based on recommendations of two internationally recognized organizations: the IS 2002 and ABET (Accreditation Board for Engineering and Technology). In order to meet the accreditation requirements, the IS 2002 recommendations states that a minimum of 30 credit hours in IS are required. Moreover, the ABET criteria specifies recommendations for all the model components including general education (GE), major core courses, major electives and general elective courses. The proposed model is based on the above requirements and provides a framework to integrate problem solving skills in IS courses at various levels of the model curriculum. It is anticipated that universities and colleges will benefit from this study by using the proposed model curriculum as a basis to tailor their own curricula and address society needs.

1. Introduction

Shortage of skilled Information Technology (IT) workers puts enormous pressure on colleges and universities to prepare students for future job markets and to expose them to a broad range of technologies and methods. Business today needs college graduates to make an impact immediately and become productive employees, almost immediately after joining the workforce. These institutions must provide students with the knowledge, problem-solving skills, and tools needed for a successful entry-level job.

Many academic institutions in the US and worldwide are aiming to generate an IS curriculum that can balance the needs to produce graduates with the skills required by business and government. Furthermore, these institutions have to provide the education needed to produce responsible and effective citizens as well as lifelong learners. However, IS are complex systems requiring both technical and organizational expertise for design, development, and management. The IS field affects not only operations but also competitive strategy, therefore universities and
colleges are stressed to produce IS curricula that give their college graduates an edge in the job market.

Information systems curricula exist within disparate colleges and schools. Less than half of the programs are in colleges or schools of business. The remaining programs are in academic units such as arts and science, science and mathematics, and liberal arts. With increasing frequency, information systems programs find homes in department or schools of computing or information technology, or computer and information science. All aspects of the computing field are facing rapid, continuous change. As a result, university level Information Systems (IS) curricula need frequent updating to remain effective.

In the US, the Georgia Southern University\(^1\) (GSU) has developed an IT curriculum that meets its local needs. The program was developed taking into consideration the industry needs, which lead to a set of outcomes that addressed those needs. However, the IS program at GSU did not take into account the IS 2002 recommendations\(^2\), because it is not a traditional IT program. The IT curriculum at GSU has a total of 144 credit hours, which is above the average of 120 to 126 credit-hour programs.

Outside the US, the University of Bahrain changed its old curriculum to satisfy international accreditation criteria, to satisfy the job market demands and to reshape their courses to establish a balance between the amount of theory and practice in each course\(^3\). Furthermore, the new curriculum is designed to better prepare graduates to join the local workforce or to allow them to pursue a graduate degree in international institutions. Though, the curriculum development includes recognized recommendations, there seems to be no coherence in how the listed basic factors are used to develop the curriculum.

Continuous curriculum development started with the advent of IS 97\(^4\). The most current revision of information systems curriculum is IS 2002, which has been approved by ACM, AIS, and the IEEE Computer Society\(^5\). ABET\(^5\) formed a commission, the Computing Accreditation Commission (CAC), to accredit information systems and computer science programs; CAC has been in operation since October 2001. Another organization associated with ABET\(^7\) is CSAB (http://csab.org), which has the responsibility for developing accreditation criteria and selecting and training academic program evaluators. The recent ABET accreditation standards emphasize outcome assessment--measuring how well students meet the program objectives and that the program has measurements to assure continuous quality improvement\(^5, 6, 7\).

In this paper, a comprehensive model curriculum that fulfills the IS 2002 recommendations, the ABET criteria and the integration of problem solving skills at all levels is proposed. In order to meet the accreditation requirements, the proposed model curriculum uses the IS 2002 recommendations, which states that a minimum of 30 credit hours in IS are required. Moreover, the model addresses all ABET criteria, which provides recommendations for all the components including general education (GE), major core courses, major electives and general elective courses. The proposed model is based on the above requirements and provides a framework to integrate problem solving skills in IS courses at various levels of the model curriculum. The rest of the paper is organized as follows: Section 2 introduces the IS 2002 recommendations for curriculum development, section 3 lists the criteria for accrediting IS programs, section 4
provides the details of the proposed IS curriculum, section 5 discuss the issue of embedding problem solving skills in the IS curriculum, section 6 discuss some of the major issues in the IS curriculum, and section 7 is the conclusion.

2. IS 2002 Recommendations

Most academic units have mechanisms to maintain currency of curricula. However, if an IS academic unit were providing graduates solely to local business and government, the input on program contents could be derived from representatives of local organizations that hire the graduates. However, local employment is not the sole objective for undergraduate major in Information Systems. Students from IS programs accepts jobs in widely dispersed geographical areas. Therefore, the availability of curriculum models enables local academic units to maintain academic programs that are consistent both with regional and national employment needs and with the common body of knowledge of the IS field.

IS 2002 identified four characteristics of the IS profession and integrated them into their curriculum recommendation. These are:

1. IS professionals must have a broad business and real world perspective.
2. IS professionals must have strong analytical and critical thinking skills.
3. IS professionals must have interpersonal communication and team skills and have strong ethical principles.
4. IS professional must design and implement information technology solutions that enhance organizational performance.

The IS 2002 curriculum requires an embedded problem solving and critical thinking framework in all courses. The curriculum has 30 credit hours of formal information systems courses but also assumes use of prerequisite or corequisite courses in communications, mathematics, and statistics, and business functions. The communications prerequisite courses should provide students with listening skills and the knowledge to be effective in written and oral communication. The mathematics and statistics prerequisites should provide basic quantitative and qualitative techniques. The business courses should cover common business functions, economics, and international considerations. The architecture of the information systems curriculum consists of five curriculum presentation areas: information systems fundamentals; information system theory and practice; information technology; information systems development; and information systems deployment and management processes. The five presentation areas consist of ten courses and one prerequisite course. These are:

- IS 2002.P0- Personal Productivity with IS Technology
- IS 2002.1- Fundamentals of Information Systems
- IS 2002.3- Information Systems Theory and Practice
- IS 2002.4- Information Technology Hardware and System Software
- IS 2002.5- Programming, Data, File and Object Structures
- IS 2002.6- Networks and Telecommunication
- IS 2002.7- Analysis and Logical Design
- IS 2002.8- Physical Design and Implementation with DBMS
Taking the IS 2002 model curriculum and ABET criteria for accreditation we have developed a complete undergraduate IS curriculum which consists of general education, major core, major electives, and general electives courses.

3. Criteria for Accrediting Information Systems Programs

ABET requirement covers eight areas; these are:
✓ Objectives and Assessments
✓ Students
✓ Faculty
✓ Curriculum
✓ Technology Infrastructure
✓ Institutional Support and Financial Resources
✓ Program Delivery
✓ Institutional Facilities

The focus of this paper is on the curriculum component, which includes a description of the curriculum intent, the curriculum standards, and the curriculum description.

Intent:
The curriculum combines professional requirements with general education requirements and electives to prepare students for a professional career in the information systems field, for further study in information systems, and for functioning in modern society. The professional requirements include coverage of basic and advanced topics in information systems as well as an emphasis on an IS environment. Curricula are consistent with widely recognized models and standards.

Standards:
Curriculum standards are specified in terms of semester-hours of study. Thirty semester-hours generally constitutes one year of full-time study and is equivalent to 45 quarter-hours. A course or a specific part of a course can only be applied toward one standard.

General:
✓ The curriculum must include at least 30 semester-hours of study in information systems topics.
✓ The curriculum must contain at least 15 semester-hours of study in information systems environment, such as business.
✓ The curriculum must include at least 9 semester-hours of study in quantitative analysis.
✓ The curriculum must include at least 30 semester-hours of study in general education to broaden the background of the student.
Information Systems:

- All students must take a broad-based core of fundamental information systems material consisting of at least 12 semester hours.
- The core materials must provide basic coverage of the hardware and software, a modern programming language, data management, networking and telecommunications, analysis and design, and the role of IS in organizations.
- Theoretical foundations, analysis, and design must be stressed throughout the program.
- Students must be exposed to a variety of information and computing systems and must become proficient in one modern programming language.
- All students must take at least 12 semester hours of advanced course work in information systems that provides breadth and builds on the IS core to provide depth.

Information Systems Environment:

- The 15 semester hours must be a cohesive body of knowledge to prepare the students to function effectively as an IS professional in the IS environment.

Quantitative Analysis:

- The curriculum must include at least 9 semester-hours of quantitative analysis beyond pre-calculus.
- Statistics must be included.
- Calculus or discrete mathematics must be included.

Additional Areas of Study:

- The oral and written communications skills of the student must be developed and applied in the program.
- There must be sufficient coverage of global, economic, social and ethical implications of computing to give students an understanding of a broad range of issues in these areas.
- Collaborative skills must be developed and applied in the program.

4. Model Curriculum for Information Systems

The proposed model curriculum for the Information Systems major consists of six components as shown in Figure 1; General Education, Major Core Courses, Information Systems Electives, General Electives, Information Systems Environment, and Quantitative Analysis.

![Figure 1. Components of the IS Model Curriculum](image)
Details of each of the six components of the IS model curriculum are given in the following subsections.

4.1 General Education (39 semester hours)

General education (GE) is an essential part of every student’s program of study. GE explores and promotes understanding of the interrelationship among the liberal arts and sciences including the arts, history, humanities, mathematics, and the natural, social and behavioral, and computer sciences. GE provides a foundation for the student to pursue lifelong learning and involved citizenship in the human community. These studies broaden and deepen understanding of the world through free and critical inquiry. A general education encourages creativity and the discovery, acquisition and application of knowledge in the pursuit of excellence.

In the US, the required GE semester hours vary from 34 to 47 depending on the institution goals and objectives. ABET criteria for accreditation require minimum of 30 credit hours of GE, in this model we have recommended 39 semester hours. GE includes three areas of study, basic studies, introductory studies and ethics.

Basic Studies (12 semester hours)
Basic studies courses serve the student by supplying critical thinking skills, knowledge and techniques that enhance and enrich subsequent coursework. They provide necessary preparation for success in whatever area of study the student chooses. These courses are:
  
  o Introduction to Computer Information Systems (3)
  o Introduction to Speech (3)
  o English Composition II (3)
  o College Algebra or Statistics I or Calculus and Analytic Geometry (3)

Introductory Studies (24 semester hours)
Introductory studies provide the student with a varied and rich learning experience that is the essence of a liberal arts and science education. These courses provide a foundation for advanced studies regardless of major. Students must select two courses, with a minimum of six semester hours, from each of the following areas:
  
  o History (6)
  o Arts and Humanities (6)
    ▪ Art Appreciation
    ▪ Communication (recommended for IS students)
    ▪ Language
    ▪ Literature
    ▪ Philosophy
    ▪ Religious studies
  
  o Natural Sciences and Mathematics (6)
    ▪ Astronomy
    ▪ Biology
    ▪ Chemistry
    ▪ Geology
- Mathematics (recommended for IS students)
- Statistics (recommended for IS students)
- Physics

  - Social and Behavioral Sciences (6)
    - Economics (micro and macro) (recommended for IS students)
    - Geography
    - Political Science
    - Psychology
    - Sociology

Ethics (3 semester hours)
Every student must complete an ethics course; it could be either a course in philosophy or an approved college ethics course.

4.2 Information Systems Core Courses (33 semester hours)

The core materials must provide basic coverage of the hardware and software, a modern programming language, data management, networking and telecommunications, analysis and design, and the role of IS in organizations as shown in Figure 2.

The major core courses in the model curriculum uses the IS 2002 recommendations. It consist of 33 credit hours that can be mapped into the following:
- Personal Computer Productivity Tools (3)
- Introduction to Information Systems (3)
- Electronic Business Strategy, Architecture and Design (3)
- IT Hardware and Software (3)
- Object Oriented Programming (3)
- Advanced Object Oriented Programming (3)
- Networks and Data Communications (3)
- System Analysis and Design (3)
- Database Systems I (3)
- Database Systems II: ORACLE (3)
- Project Management (3)

4.3 Information Systems Environment (15 semester hours)

ABET requires 15 semester hours to prepare the student to function effectively as an IS professional in the IS environments. The courses taken are to broaden the student’s background in the area in which the information systems knowledge is to be applied. For example, in the business environment, the student would take courses in the following areas: management, accounting, organizational behavior, marketing, finance, microeconomics, and macroeconomics. If the program is located in a business school, these courses are frequently specified by institutional requirements. To satisfy ABET requirements five courses are recommended, these are:
Figure 2. IS Core Model Curriculum

- Financial Accounting (3)
- Principles of Economics I (Micro) (3), GE
- Principles of Economics II (Macro) (3), GE
- Financial Management (3)
- Organizational Behavior (3)

Some of the above courses can be taken to satisfy the GE requirements.

4.4 Quantitative Analysis (9 semester hours)

To satisfy ABET requirements nine semester hours are recommended, these are:
- Statistics I (3), GE
- Discrete mathematics (3)
- Statistics II (3)

However, one of the above three courses can be included in the general education courses.

4.5 Information Systems Electives (18 semester hours)

Eighteen semester hours selected from the following courses are recommended:
- Introduction to COBOL Programming
- Operating Systems
- Introduction to Visual Basic.NET Programming
- Data Structures and Algorithms
- Object Oriented Analysis and Design
- Topics in Information Systems
4.6 General Electives (15 semester hours)

These hours can be taken from the IS college or any other college, depending on the student interest. The total number of hours should be 126 to meet the graduation requirement. However, ABET requires a minimum of 120 semester hours only. The following courses are recommended as general electives:

- Microeconomics (GE)
- Accounting I (Financial)
- Accounting II (Managerial)
- Business Finance
- Principles of Marketing
- Organizational Behavior
- General Psychology

The proposed model curriculum addresses all components from GE to IS and General electives. Moreover, the IS 2002 recommendations go on to provide guidelines for course description, and recommend the use of modern programming languages and the integration of problem solving in the curriculum. The following two sections addresses embedding problem solving in the IS curriculum and discuss some issues regarding the IS 2002 recommendations.

5. Embedding Problem Solving in the Curriculum

A critical statement in the IS 2002 emphasizes that an IS curriculum requires an embedded problem solving and critical thinking framework in all courses\(^2\). Even though many institutions agree that critical thinking and problem solving are important, their integration in the curriculum has been limited\(^1,3\). Indeed, the problem-solving component is mainly addressed in programming courses. Consequently, students associate problem solving concepts with programming and do not think of problem solving outside this context.

The proposed model curriculum emphasizes problem solving in all IS courses. Furthermore, critical thinking skills are emphasized in general education courses, which is an ABET requirement\(^5\). In the implementation of the model curriculum, the problem solving and critical thinking components are gradually built into the IS course sequence. All course syllabi have to explicitly identify the course contribution to achieving the problem solving and critical thinking components. Furthermore, the curriculum can be strengthened by including independent study components that provide students with the opportunity to gain in depth experience in problem solving.

Furthermore, a web based common course syllabus can be used to facilitate the access of course content information, as well as the consistency and transparency of the syllabi. Faculty can use the common course syllabus as a basis to develop their own syllabus and to explicitly include a
problem-solving component. IS faculty should design their courses to help students identify pieces of evidence to show achievement of problem solving skills and develop the ability to reflect on the learning process. The purpose of assessment is focused on student learning where they are expected to participate actively in the assessment of their own learning and are continuously provided with feedback from faculty.  

6. Issues in IS Curriculum

There are a number of issues and challenges in designing and implementing IS curricula. One of these issues is the selection of a modern appropriate programming language that fulfills the requirements of the ABET criteria as well as the IS 2002 recommendations. ABET requires the student to be proficient in a modern programming language, however, the IS 2002 recommendations include only one course in programming. To become proficient in a modern programming language, students must take at least two courses in problem solving and programming.  

As to the selection of the programming language, Java, a modern Object Oriented language, can be used to satisfy ABET requirement. In fact many universities are using Java as the primary programming language. However, instructors acknowledge that two courses in Java are usually not adequate to make IS students proficient in that language. Although most institutions in the US use Java as the primary language, Visual Basic.NET is a better alternative. Visual Basic.NET is an object-oriented programming language that supports information hiding, encapsulation, inheritance, and polymorphism and is easier to learn than Java. Also, students can create applications much faster using Visual Basic.NET.  

Another issue is that even though the IS 2002 recommendations provide course descriptions, some of the course material is complex and cannot be found in a single comprehensive textbook. For example, the IT hardware and software systems course requires the use of several uncorrelated textbooks. For this reason, it is very common to find a curriculum that does not include all the ten IS 2002 recommended courses. On the other hand, this may provide authors with the opportunity to develop a comprehensive textbook that addresses all the topics.  

7. Conclusions

The computing field is facing continuous change as a result of demands from business and government. Academic institutions are facing a great challenge in developing and updating IS curricula to respond to the growing demand for IS graduates that can adapt to the rapidly changing needs of business. There are however, many IS curricula that are solely driven by either academic or industry needs. There is a need for an IS curriculum that is based on nationally recognized standards that can fulfill both demands.  

A complete undergraduate IS curriculum based on ABET and IS 2002 is developed. The curriculum includes courses in general education, core IS courses, IS electives, environmental requirements, analytical and statistical requirements, and general electives. It is anticipated that the proposed model curriculum will enables universities and colleges world wide to develop and
maintain academic programs that are based on the common body of knowledge of the IS field and be consistent both with regional and national employment needs.

8. References


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Biography

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Akram Al-Rawi is a Sun certified Java Programmer and a Professor of CIS at Zayed University, UAE. He has worked at several academic institutions of which the last two were the University of Missouri-Columbia and Columbia College, MO. His teaching interests include programming languages, logic design, and computer architecture. His research interests include computer simulation, web-caching architecture, and curriculum design.

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