Health Informatics as an ABET-CAC Accreditable IS Program

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Abstract

This paper builds on prior work defending innovative information systems programs as ABET-accreditable. A proposal for a four-year degree program in health informatics, initiated at the authors' university to combat enrollment declines and to therefore help information systems to survive and thrive, is described. The program proposal is then evaluated against ABET-CAC criteria for information systems degree programs. The results of the evaluation were used to refine the authors' program proposal and provide further evidence of the defensibility of innovative IS degree programs as ABET-accreditable.

Keywords: ABET, accreditation, Computing, Health Informatics

1. HEALTH INFORMATICS AS CURRICULUM INNOVATION

The co-authors of the paper are faculty members in an information systems (IS) program at a computing school, the University of South Alabama School of Computer and Information Sciences (SCIS), where students must choose among three separate, accredited degree programs: Information Systems (IS), Information Technology (IT), and Computer Science (CS). An era of enrollment decline has seen the pipeline of majors reduce to a trickle, and intensify the competition among the three competing programs.

While there has been a decline in computing enrollments, the need for computing professionals is still strong, especially in the domain of healthcare. The growth in the need for health information technology (HIT) workers has been fueled by recent legislative actions taken by the United States (U.S.) government. In order to remedy the slow rate of adoption of information technology by healthcare providers, the U.S. government enacted the Health Information Technology for Economic and Clinical Health Act (HITECH Act) as part of the American Recovery and Reinvestment Act of 2009. The HITECH Act encourages Medicaid and Medicare providers to implement an electronic health records (EHR) system and meet a set of meaningful use rules established by the government by providing incentive payments directly to providers. Medicare providers that that do not meet these requirements by 2015 will be penalized in their reimbursements by the government. Currently, Medicaid providers face no similar penalty (Lynn, 2011).

For many years the use of HIT has been limited, and the need for technology workers who understand health care has been met by traditional technology graduates learning on the job. However, the passage of the HITECH Act has caused demand for such workers to far outstrip the ability of healthcare organizations to supply these retooled workers. Leading up to 2015, there is a projected need for between 30,000 and 50,000 skilled HIT workers. These numbers are based on estimates by the ONC, Bureau of Labor Statistics, and HIMSS (http://www.himss.org/Content/Files/CSC_US_Healthcare_Workforce_Shortages_HIT.pdf). Providers need a workforce that is able to "hit the ground running" in the healthcare setting.

It is no longer sufficient for colleges and universities to produce students who have knowledge of only the traditional business environment since, as Hersh (2010) notes "a well-trained HIT professional should have knowledge not only of information technology, but also of health care, business and management, and other disciplines." To meet the needs of the healthcare industry, it is necessary to create a new curriculum that produces outcomes expected of a traditional information systems graduate, along with healthcare clinical environment training needed to understand the deployment and use of HIT in a modern healthcare organization (Longenecker et al., 2011; Campbell, et al., 2011).

HI: A New Pipeline

With the HIT workforce needs as a justification, a multidisciplinary health informatics (HI) certificate program was designed and implemented at South Alabama. The certificate program was the result of collaboration among faculty and deans of programs in information systems, nursing, the allied health professions, and health care industry representatives. Initially, HI course enrollments drew from students majoring in either health sciences or IS. We quickly found that HI students, with only a computer literacy background, could grasp the IS concepts; while the IS students, without clinical training or experience, could likewise pick up the healthcare context. Both sets of students would adequately produce healthcare systems analysis and design artifacts.

Building upon the success of the certificate program, a full degree program in HI was proposed. The expansion of the certificate program to a major is designed to attract students in three groups: those interested in a niche healthcare profession; those whose application for health science programs were declined because of program enrollment limits; and those attracted to the computing first but with a secondary interest in health care. Through the allied health/nursing pipeline, the program promises to attract more female students to high tech careers, as well.

The development of a health informatics (HI) degree program as an information systems program, while addressing a workforce need, both nationally and locally, is also seen as a strategy for the survival and growth of IS academic programs. By tapping into another market, i.e. another source of students, the HI degree program is a means for IS survival. Rather than competing within a computing school with a strategy of differentiation, the faculty in the IS program is expanding into new markets with its new product, the health informatics degree program. The program is will be interdisciplinary— program delivery will be a collaborative effort of faculty from three academic units: the School of Computer and Information Systems, the College of Nursing, and the College of Allied Health Professionals. The program will be administered by a curriculum chair who will oversee all aspects of the program. The program is expected to enroll between 30-100 students per year.

This paper is one of three papers on the proposed HI degree program appearing in the ISECON 2011 proceedings. The Campbell et al. (2011) paper provides the background of the program and its interdisciplinary design details, including curriculum areas. The purpose of this paper is to describe our efforts to define the HI program as an IS-accreditable degree program. As IS faculty experienced with ABET accreditation, we argue that health informatics is accreditable as an innovative IS program. For an analysis of the HI curriculum against model curricula in IS and HI, see Longenecker et al. (2011).

2. APPLYING ABET CRITERIA TO THE HEALTH INFORMATICS DEGREE

Prior work (Wood et al., 2010) has demonstrated that an innovative IS program can be argued to be an ABET-accreditable IS program, that is, meeting the Accreditation Board for Engineering and Technology, Inc. (ABET, Inc.) Computing Accreditation Commission's (CAC) criteria for accrediting computing programs, including the ABET-CAC general and IS program-specific criteria. In the prior work, a cyber forensics and security program was argued to be accreditable as an IS program. The authors defended the need for such professionals and illustrated how program and course outcomes could be mapped into the ABET-CAC program outcomes criteria for information systems programs (ABET-CAC, 2010). This paper builds upon the prior approach to demonstrate that our health informatics program, likewise, is accreditable as an IS program. We will address not only the program outcomes issues, but other key accreditation issues that apply to our situation.

Critical Accreditation Issues

Because the authors already have participated in the ABET-CAC accreditation process for our current undergraduate computing programs, portions of the ABET requirements will be less challenging to meet. ABET requirements are broken into eight general criteria, with additional IS-program-specific criteria specified in some of the general areas. The eight general areas are students, program educational objectives, student outcomes, continuous improvement, curriculum, faculty, facilities, and institutional support. The IS-specific criteria are in three areas: student outcomes, curriculum, and faculty. Assuming our experience with achieving our current accreditation can be leveraged, we will model the processes for continuous improvement for the health informatics program according to the current processes in our existing IS program. The authors' school already has the processes, polices, and procedures for monitoring student performance and progress, advising and career guidance, admission and transfer credit, and for documenting that graduates meet program requirements. Since the curriculum is composed of existing courses taught by IS faculty in facilities already vetted by the accreditation of the IS program, and since the program is a collaboration of deans of accredited programs, we expect the same assessment of faculty, facilities, and institutional support criteria for the health informatics program as for the existing IS program. The remaining three areas, program educational objectives, student outcomes, and curriculum, provide the newest and most challenging issues.

Program Educational Objectives

Program educational objectives are "broad statements that describe what graduates are expected to attain within a few years of graduation" and that should be "based on the needs of the program's constituencies." For the health informatics program to be ABET-accreditable, constituents of the program must be identified, and program objectives written that are consistent with their needs.

The health informatics program has the following constituencies, and their representatives. See Table 1.

After first engaging representatives of the local employers, consulting government healthcare IT workforce reports, establishing internships where our IS graduates worked in healthcare/clinical settings, and consulting the IS 2010 model curriculum (Topi et al., 2010), we developed the following broad statements, adapted from Campbell et al. (2011):

Within a few years of graduation, graduates of the health informatics program should be able to…

1. *use information technologies in the healthcare/clinical setting to improve the performance of healthcare providers*
2. *use information technologies in the healthcare/clinical setting to improve health care outcomes and reduce healthcare costs*

3. *use information technologies in the healthcare/clinical setting to improve patient safety (reduce medical errors)*
4. *establish a professional career in the healthcare/clinical IT workforce*

Table 1 - HI Program Constituencies

Constituency	Representatives
Local employers	a university hospital and local EMR vendor
National employers	government-defined health IT roles and the IS 2010 model curriculum
Alumni	IS graduates working for local employers (eventually, HI graduates working for local employers)
Faculty	IS/health informatics faculty

These programs collectively have been defined to meet constituency needs. Objective 1 has been crafted in a way that builds on the McNurlin and Sprague (2006) IS theme of improving the performance of people in organizations, but applied to a healthcare context. It therefore provides a mission for IS faculty and alumni familiar with the theme and its implications. Objectives 2 and 3 are closely aligned with the spirit of the government's national HIT vision, such as meaningful use. Both 2 and 3 serve the needs of local employers bound to creating meaningful use of health information technology. The focus on patient safety in Outcome 3 encompasses the ethical components of the program, including patient privacy. Finally, objective 4 is written to address the career needs of HI graduates.

Student Outcomes

Similar to program educational objectives, the student outcomes are broad statements of what students must be able to know or do, except that it is "by the time of graduation" rather than a few years out. As such, these broad statements reflect more of what the curriculum is producing, and less of what government, industry, and alumni need later on. They must, of course, relate back to the constituency needs as expressed in the program educational objectives.

In constructing an HI curriculum, we conceived of the HI program as an IS program with a healthcare environment. See Curriculum, below. As such, a combination of courses in the existing IS program, along with courses in the health sciences and business, were considered to make up the degree. We also explicitly considered the ABET general and IS program student outcomes criteria (ABET-CAC, p. 3), commonly referred to as the "a through j", which must be demonstrated to be enabled, in formulating these student outcomes, referenced from Campbell et al., (2011): *The program must enable students to attain, by the time of graduation, the ability to perform…*

- *Analysis: evaluate process workflows, perform process workflow redesign through user requirements analysis, and participate in implementation of redesigned process workflows*
- *Evaluation: assist in vendor and software selection, evaluate technology/software/ system alternatives, and assist in network planning and needs assessment*
- *Management: manage implementation project plans, act as liaison among healthcare providers, IT staff, and systems vendors, and communicate existing and emerging trends to healthcare providers and IT staff*
- *Data management: manage healthcare data and record structures, work with IT staff to ensure documentation/security/privacy requirements for medical records, and analyze and present data for healthcare decision making such as evidence-based practice*
- *Assessment: apply a working knowledge of biostatistics and epidemiology to assess healthcare outcomes and risks*

A mapping of the student outcomes to the ABET student outcomes criteria is shown in Appendix 1.

Critical Curriculum Issues

The general and IS program curriculum area provided five critical issues:

- covering the fundamentals of a modern programming language
- providing fundamental coverage of the five core areas
- providing advanced coverage that builds on the core

- covering mathematics beyond the pre-calculus level
- providing for an IS environment

Each of these issues are covered in the following sub-sections and summarized in Table 2.

Programming Language

We are proposing an innovative, yet potentially controversial, position regarding the modern programming language requirement for health informatics. ABET requires "coverage of the fundamentals of a modern programming language" (ABET-CAC, p. 6). To meet the modern programming language requirement, many schools and ABET evaluators might require a traditional programming course, taught in an object-oriented, standalone programming language, such as C++, Java, or Visual Basic. Requiring such a course would likely meet with resistance from faculty, however, who would find the course inappropriate for the major. The chosen professional focus of the HI program is not on the application developer role, for which programming fundamentals are critical. Instead, we are focusing on roles such as health information management exchange specialist (Hersh, 2010, p. 201) and the program's mission "to work closely with primary healthcare providers to select an appropriate vendor solution for electronic medical/health records (EMR/HER), integrate that solution into existing processes, policies, and technologies, and to utilize that solution to deliver 'meaningful use' that results in better medical and health outcomes"(Pardue, 2009). Application development has been removed as a prescribed core from the IS 2010 model curriculum (Topi et al., 2010, p. 27) underscoring that not all IS professional roles require application development skill. Recognizing that traditional programming skills is not required by HI professional roles, we are targeting, and receiving the support of the IS 2010 model curriculum, we decided not to require a traditional standalone programming language course.

In satisfying the fundamentals of a modern programming language requirement of ABET, we chose to use coverage of the structured query language (SQL) taught in the first data management course. Although it has been around for a long time, SQL is as relevant as ever, and meets the criterion of "modern." It is classified as a fourth generation programming language. In the coverage of SQL in our first data management course, students learn to write both data definition language (DDL) and data manipulation language (DML) queries in SQL. In the latter area, students learn all four create/read/update/delete (CRUD) operations; how to wrap a query inside of a stored procedure; and how to create triggers for event-driven actions. Through coverage of SQL, we are training students in 4GL data definition and manipulation, solving problems comparable in complexity to those solved by 3GLs. We assert that this depth of coverage in problem-solving with SQL meets the modern programming language requirement.

Core Area Coverage

ABET also requires coverage of "data management, networking and data communications, systems analysis and design and the role of Information Systems in organizations" and "advanced course work that builds on the fundamental course work to provide depth" (ABET-CAC, 2010, p. 6). We propose that the health informatics program meets this requirement, as well as the aforementioned modern programming language requirement. See Appendix 2 for a summary.

Advanced Coverage

ABET requires "advanced course work that builds on the fundamental course work to provide depth." The following courses build upon the foundation courses, providing advanced coverage.

- ISC 450 Health Information Systems Analysis and Design
- ISC 455 Health Decision Support Systems
- ISC 462 Information Systems Strategy and Policy
- ISC 475 Information Systems Project Management
- CIS 496 Computer and Information Sciences Internship

The ISC 450 course builds upon the fundamentals of health informatics covered in ISC 300 and ISC 410 to provide critical coverage of systems analysis and design skills applied to the healthcare context. However, the course significantly extends the scope of systems to the enterprise environment, and utilizes product automation to implement developed workflows.

This includes screen and reports design and implementation.

The ISC 455 is a combination of modern programming language and data management. ISC 455 focuses on "the design and management of electronic medical record systems and clinical decision support systems" including technical and management issues and tools for "extracting information from medical data". This course builds on the fundamentals of health informatics covered in ISC 300 and 410, as well as the practical experiences in ISC 450.

Both ISC 462 and ISC 475 provide advanced coverage that builds on prior course work. These courses cover information strategy and policy issues and project management in the IT context, respectively.

All health informatics students will be required to complete a relevant internship in their last semester: CIS 496. The internship duties will possibly draw upon the entire curriculum and all core areas. It will enable students to make a more significant immediate contribution when they enter the HIT workforce.

Together, seven courses are identified as providing fundamentals coverage and the five courses providing advanced coverage make up 36 credit hours, equivalent to the one year of curriculum coverage of IS areas required by ABET.

Math Coverage

Another curriculum requirement is the ABET-CAC general criteria requirement for coverage of "mathematics appropriate to the discipline beyond the pre-calculus level". In satisfying this requirement, we make the assumption that "mathematics" does not mean, literally, that the course has to have "math" in the title, i.e. offered by the mathematics department. For ABET, it is the course content that is important—if it is taught by mathematics faculty or not. Thus a course that covers the topics of discrete mathematics may be defended by a computer science program as satisfying the discrete mathematics requirement although it is in the catalog as a computer science course. Likewise a quantitative methods or quantitative analysis course that covers mathematics topics beyond pre-calculus can be defended as satisfying ABET-CAC's general criteria mathematics requirement. A broader interpretation of mathematics "appropriate to the discipline" is supported by statements in two relevant curriculum guidelines. Under a discussion of "mathematical foundations" as one of five foundational knowledge and skill areas, the IS 2010 model recommends that "to support in-depth analysis of data, IS professionals should have a strong background in statistics and probability. For those who are interested in building a strong skill set in algorithmic thinking, discrete mathematics is important" (Topi et al., p. 22). The IMIA, in its curriculum guidelines for educating the biomedical health informatics (BMHI) professional, lists "mathematics" as a knowledge/skill domain area, comprised of "algebra, analysis, logic, numerical mathematics, probability theory and statistics, cryptography" (Mantas et al., 2010, p. 113).

We believe that statistics satisfies the foundational quantitative analysis skills requirement of HI professionals. In fact, ABET also requires, for IS graduates, that curricula cover "quantitative analysis or methods including statistics." Taking both the mathematics and quantitative analysis requirements into account, assuming a broad definition of "mathematics," and following the guidelines in IS 2010 and IMIA, we believe that requiring two courses in statistics or quantitative methods/analysis to be the discipline-appropriate preparation for HI. To be compliant with ABET, the first statistics course must be built on a foundation of pre-calculus algebra. A second, more advanced statistics or quantitative methods course that covers mathematic beyond pre-calculus is also required.

IS Environment

The IS environment is a requirement that the curriculum include "one-half year of course work that must include varied topics that provide background in an environment in which the information systems will be applied professionally." An environment does not and cannot constitute a single, focused knowledge area such as applications in mathematics, art, technology, law, statistics, or desktop publishing. Instead, an environment represents an *ecosystem* in which information systems are employed. The environment surrounds and impacts the systems and technologies that support it and whose inputs, processes or outputs are closely intertwined with their information systems. As we are conceiving the

health informatics degree as IS applied in a healthcare context, we are defining our IS environment as 22 credit hours of courses in the health sciences, which collectively are viewed as an ecosystem of healthcare. We expect most of our HI majors to migrate from programs in nursing and the allied health professions. This implies that they will have a background by the junior year of biomedical sciences course involving a year in human physiology and anatomy. In their pre-professional studies we will request that they add courses in accounting and management principles. At the junior and senior level, what is important for HI majors is to have developed a broad awareness of the breadth and complexity of the healthcare environment. We call this the HI clinical environment.

Table 2 - Critical Curriculum Issues

Issue	Response
Programming language	SQL for DDL and DML appropriate for the HI professional experience
Core Areas	12 courses cover core areas
Advanced Coverage	Five senior-level courses; one as an internship
Math Coverage	Two statistics courses
IS Environment	Healthcare Ecosystem of 22 hours of health science courses

Therefore, we recommend that the students take preliminary coursework from nursing, clinical pharmacology, radiology, occupational and physical therapy, and cardiorespiratory therapy issues. To be sure, different universities will have access to a variety of different courses. Our course selection forms an ecosystem which provides a rich student exposure to healthcare. The importance of the clinical environment is to prepare students for the upper division health informatics courses that require students to use their knowledge of the healthcare domain. With a foundation in the clinical environment, students can begin to understand the issues surrounding EMR/EHR integration and apply analysis, data management, evaluation, assessment, and management skills towards delivering HIT solutions that provide meaningful use and positive health care outcomes. The details of the clinical environment are described in Longenecker et al. (2011).

3. CONCLUSIONS

In summary, we have shown that a health informatics degree program is defendable as an ABET-accreditable IS program. We have identified an ecosystem of healthcare as an IS environment. We have identified program objectives and outcomes that meet local and national constituency needs. We have defended an approach to meeting the modern programming language requirement without preparing the majors as application developers, per se. And, we have presented a proposed curriculum that meets the required core areas of coverage and has the required depth of coverage. For a computing school with an established, accredited IS program, these are the most challenging accreditation issues, in our view.

We must point out two important limitations to our claim that the health informatics program described in this paper is ABET-accreditable as an IS program. The first limitation is that the health informatics program has not yet been implemented. However, most if not all of the courses have been, a health informatics certificate program is currently in place, and the authors' have taught in an accredited IS program for several years. The second limitation is that our claim is just that, our own defense of the program against published ABET accreditation criteria, written in the spirit of a self-study. The approval of this defense would be up to the scrutiny of program evaluators in a future ABET review.

With our IS accreditation, however, we can use this experience as a basis on which to compare our approach towards accrediting the proposed HI program. We believe the approach taken with program objectives and outcomes is consistent with the approach used with past, accredited programs. We believe that our approach to defining core and advanced areas of coverage is similar to what we have done for accrediting our information systems (IS) program, with the notable exception of the modern programming language requirement. The approach taken with math is also different, in that our school has required one calculus (or discrete math) and two statistics courses in the past. Our elimination of calculus is a departure. A 15 hour business environment required for IS,

justified for its preparing students in the organizational context, is similar to our approach in requiring the 22 hours of clinical environment for HI. We believe the riskiest areas for accreditation to be defending the modern programming language requirement.

Taking ABET-CAC program requirements into account early, in the proposal stage of the HI program, in fact, proved valuable. Familiarity with ABET requirements drove us to identify constituents early and identify outcomes to meet their needs. These outcomes, along with ABET curriculum requirements, were helpful in defining, refining and grouping courses. A poorly described "list of courses", as one faculty member described an early HI curriculum proposal, became an organized, mission-mapped, well-understood, and defensible program of study. We recommend that other faculty considering an HI degree program follow our example by adopting and considering the spirit of the ABET-CAC approach early, along with the IS model curriculum and health informatics program guidelines (Longenecker et al., 2011).

4. EPILOGUE: ISECON/CONISAR 2011

Interaction with colleagues while at ISECON/CONISAR 2011 has resulted in three issues for consideration. One issue is whether or not to omit the ISC 360 Systems Analysis and Design course. Arguably, each of ISC 360 Information Systems Analysis and Design and ISC 450 Health Systems Analysis and Design apply the same theoretical foundations to different, but similar application domains, and so requiring both is redundant. However, there is concern that some fundamentals concepts and experiences may be missed if the ISC 360 is omitted. A final decision has not been made.

A second issue revolves around our argument that coverage of SQL in the database course was sufficient to meet the modern programming language requirement. While most feedback was supportive, one reviewer cautioned that ABET might expect students to be taking a course using a standalone, object-oriented, programming language. Additionally, support for our position was specifically limited to our health informatics program, and not to all types of IS programs. We are moving towards the position that the strength of one's case for meeting the ABET modern programming language requirement depends on the goals of the program under review. Because the goals of the HI program are to prepare HI professionals who do not require the traditional programming skills, we believe our position, that coverage of SQL in the database course is sufficient to meet the modern programming language requirement, is defensible.

A third issue regarding the clinical environment arose from feedback from reviewers and colleagues at ISECON/CONISAR 2011, and colleagues in the College of Nursing and College of Allied Health Professions. We have began a review of the proposed collection of clinical environment courses to ensure that these courses satisfied the breadth-first overview expected of an IS Environment in an Information Systems curriculum.

5. REFERENCES

ABET Computing Accreditation Commission - ABET CAC (2010). *Criteria for Accrediting Computing Programs*. ABET, Inc. October 2010, Baltimore, Maryland.

Campbell, S. M., Pardue, J. H., Longenecker, H. E. Jr., Barnett, H. L., and Landry, J. P. (2011). Treating the healthcare workforce crisis: a prescription for a health informatics curriculum. *Information Systems Education Conference, ISECON 2011*.

Hersh, W. (2010). The health information technology workforce: Estimations of demand and a framework for requirements. *Applied Clinical Informatics*, 1(2), 197-212. Retrieved July 12, 2011, from http://dx.doi.org/10.4338/ACI-2009-11-R-001.

Longenecker, H. E., Campbell, S. M., Landry, J. P., Pardue, J. H., and Daigle, R. J. (2011). A health informatics curriculum compatible with IS 2010 and IMIA recommendations for an undergraduate degree. *Information Systems Education Conference, ISECON 2011*.

Lynn (2011). Meaningful use Mondays – Medicare vs. Medicaid penalties and other differences. EMR and HIPAA. Retrieved July 13, 2011 from http://www.emrandhipaa.com/lynn/2011/01/17/meaningful-use-mondays-medicare-vs-medicaid-penalties-and-other-differences/

Mantas, J., Ammenwerth, E., Demiris, G., Hasman, A., Haux, R., Hersh, W., Hovenga, E., Lun, K.C., Marin, H., Martin-Sanchez, F., and Wright, G. (2010). Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics. *Methods of Information in Medicine*, 49(2), 105-120. Retrieved July 12, 2011, from http://dx.doi.org/10.3414/ME5119.

McNurlin, B. C. & Sprague, R. H. Jr. (2006). *Information Systems Management in Practice*, Seventh Edition, Pearson Prentice Hall, Upper Saddle River, NJ.

Pardue, J. H. (2009). REC grant narrative and SCIS curriculum. School of CIS internal document. October 10, 2009. University of South Alabama, Mobile, AL.

Topi. H., Valacich, J. S., Wright, R. T., Kaiser, K., Nunamaker, J. F., Sipior, J. C., & de Vreede, G. J. (2010). IS 2010: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. *Association for Computing Machinery and Association for Information Systems*. http://www.acm.org/education/curricula/IS%202010%20ACM%20final.pdf, 15-22.

Wood, D. F., Kohun, F. G., Ali, A., Paulett, K., and Davis, G. A (2010). Cyber Forensics and Security as an ABET-CAC Accreditable Program. *Information Systems Education Journal*, 8 (60). http://isedj.org/8/60/. ISSN: 1545-679X. (A preliminary version appears in The Proceedings of ISECON 2009: §2355. ISSN: 1542-7382.)

Appendices

Appendix 1 - Mapping of Health Informatics Student Outcomes to ABET Student Outcomes Criteria to Courses

Health Informatics Student Outcomes	ABET Student Outcomes Criteria	Courses
Analysis - evaluate process workflows, perform process workflow redesign through user requirements analysis, and participate in implementation of redesigned process workflows	b-An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution c-An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs j- An understanding of processes that support the delivery and management of information systems within a specific application environment.	ISC 300 Health Informatics Clinical Environment ISC 360 Information Systems Analysis and Design ISC 450 Health Sys Analysis and Design
Evaluation - assist in vendor and software selection, evaluate technology/software/system alternatives, and assist in network planning and needs assessment	b-An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution c-An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs i-An ability to use current techniques, skills, and tools necessary for computing practice. j- An understanding of processes that support the delivery and management of information systems within a specific application environment.	ISC 245 Information Systems in Organizations ISC 272 Systems Architecture CIS 321 Data Communications and Networking ISC 450 Health Sys Analysis and Design MGT 325 Operations Management
Management - manage implementation project plans, act as liaison among healthcare providers, IT staff, and systems vendors, and communicate existing and emerging trends to healthcare providers and IT staff	d-An ability to function effectively on teams to accomplish a common goal f-An ability to communicate effectively with a range of audiences h-Recognition of the need for and an ability to engage in continuing professional development i-An ability to use current techniques, skills, and tools necessary for computing practice. j- An understanding of processes that support the delivery and management of information systems within a specific application environment.	ACC 211 Principles of Accounting I MGT 300 Management Theory and Practice ISC 300 Health Informatics Clinical Environment ISC 410 Health Informatics ISC 475 Information Systems Project Management CA 110 Public Speaking CA 275 Small Group Communication
Data management - manage healthcare data and record structures, work with IT staff to ensure documentation/security/privacy requirements for medical records, and analyze and present data for healthcare decision making such as evidence-based practice	b-An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution c-An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs e-An understanding of professional, ethical, legal, security and social	CIS 324 Database Design, Development, and Management ISC 410 Health Informatics ISC 455 Health Decision Support Sys ISC 462 Information Systems Strategy and Policy

	issues and responsibilities g-An ability to analyze the local and global impact of computing on individuals, organizations, and society j- An understanding of processes that support the delivery and management of information systems within a specific application environment.	
Assessment - apply a working knowledge of biostatistics and epidemiology to assess healthcare outcomes and risks	a-An ability to apply knowledge of computing and mathematics appropriate to the discipline j- An understanding of processes that support the delivery and management of information systems within a specific application environment.	BUS 245 Applied Business Statistics I BUS 255 Applied Business Statistics II BMD 210 Infectious Disease in Health Care Environments ISC 455 Health Decision Support Systems

Appendix 2 - Health Informatics Core Area Coverage

Course	Core Area(s) Covered	Advanced, builds on…
ISC 245 Information Systems in Organizations	Role of information systems in organizations	n/a
ISC 272 System Architecture	Networking and data communications	n/a
ISC 300 Health Informatics Clinical Environment	Role of information systems in organizations	n/a
CIS 321 Data Communications and Networking	Networking and data communications	n/a
CIS 324 Database Design Development and Management	Modern programming language Data management	n/a
ISC 360 Systems Analysis and Design	Systems analysis and design	n/a
ISC 410 Health Informatics	Role of information systems in organizations	n/a
ISC 450 Health Information Systems Analysis and Design	Systems analysis and design	300, 410
ISC 455 Health Decision Support Systems	Modern programming language Data management	300, 410
ISC 462 Information Systems Strategy and Policy	Role of information systems in organizations	245, 272, 321, 324
ISC 475 Information Systems Project Management	Role of information systems in organizations	245, 272, 321, 324
CIS 496 Computer and Information Sciences Internship	All areas	Entire curriculum