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Health informatics program design and outcomes: Learning from an early offering at a mid-level university

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Abstract Curriculum development is particularly challenging in computing-related disciplines as the computing industry changes more quickly than most. As information technology degrees have become relatively pervasive, some institutions that offer information systems degrees have recognized a need to develop specialist studies in information systems. This detailed case study shows the forces related to a successful implementation of new Health Informatics degrees. The case describes both an unsuccessful and then a successful attempt at essentially the same curriculum development. Although the case includes some local political factors, these represent typical considerations that a curriculum developer is likely to encounter.

Keywords Health informatics · IS curriculum development · IMIA curriculum · Healthcare information technology · Health informatics education · Healthcare curriculum

1 Introduction

Given the current emphasis on employing IT systems in healthcare institutions to cut costs and improve quality, there is a growing demand for professionals with training in health informatics (HI). Recent reports suggest that the HI market is poised to grow to about USD 104 Billion by 2020 and that lack of IT knowledge could serve as an impediment (Sherry, 2015). Further, a survey of HI leaders shows that about 67 % of

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healthcare providers face an IT skill shortage (Terry, 2013). Against this backdrop there is a growing interest in offering academic programs in HI to address the demand in the market. The database maintained by the Association for Information Systems (Wilson, 2014) shows that several HI-related programs have emerged in recent years. Hence, it is of relevance to understand the trajectory undergone by institutions that have been pioneers in HI curriculum design and deployment. This knowledge is not only informative for other institutions but also may help provide insights into aspects that they need to embrace or avoid in order to be successful. This case report presents an analysis of the growth path of the HI program at Idaho State University (ISU), one of the very first programs in the nation, and offer recommendations to other institutions based on our experience.

2 Models of curriculum development

Curriculum design and redesign is a continuous process (Drinka and Yen, 2008), as business models, business needs, and technology are constantly changing (Koohang et al., 2010). Throughout the ongoing evolution of our curriculum program, various design approaches and curriculum models have influenced our efforts. The Rapid Curriculum Development methodology proposed by Davey and Tatnall (2000), an approach that extends the broad spectrum ecological model with input from actor network theory, seemed a good fit for our efforts. This approach makes use of directed processes involving academics and other stakeholders through a series of meetings with specific agendas (Tatnall and Davey, 2002). Other approaches for guiding the curriculum redesign, such as Drinka and Yen's (2008) adaptation and modification of the Capability Maturity Model and Tatnall and Davey's (2002, 2004) ecological approach for curriculum development influenced our efforts but were not an ideal fit.

Our curriculum committees were most comfortable with models of change based upon a process of research, development and diffusion, which is based on the premise that change comes about when rational people are convinced by the arguments presented to them to implement the change (Nordvall, 1982). This type of model relies on logical and rational decisions, meaning that curriculum change depends on the use of convincing arguments based on programs of research (Tatnall and Davey, 2004). Models of this sort suggest that curriculum development follows a logical process of establishing the objectives of the program, matching these to curriculum elements, developing materials, and disseminating the curriculum among educators so that others may adopt it (Tatnall and Davey, 2002).

Ultimately, our curriculum development efforts more closely followed the four-step continuous improvement process framework for developing a comprehensive curriculum (Brewer et al., 2006). This process, which is made up of data collection, evaluation, curriculum design, and curriculum implementation, is responsive to local and regional needs throughout the life of the program. This is critical because industry is one of the key stakeholder groups whose input is critical in curriculum development (Lightfoot, 1999). Ensuring that a curriculum addresses the skills required by industry is imperative in order to ensure graduates of a degree program meet expectations (Coady and Berg, 2014).

3 Early history of health IT at ISU

The State Board of Education controls all levels of state funded education in Idaho. The Board assigned our university specific responsibilities in delivering programs in the health professions, directing us to formulate our academic plan and generate programs with a primary emphasis on health professions. However, the College of Business contributed only indirectly to that mission by providing students with a well-rounded education in business.

In the mid-2000s, however, Computer Information Systems (CIS) professor Kenneth Trimmer envisioned, developed, and championed a Bachelor of Business Administration degree in Health Care Information Systems Management (HISM). The degree was developed in cooperation with the Kasiska School of Health Professions, the most influential and high profile school within the university. Curriculum development was based on the concept of reusability. Because our department already offered a major in Computer Information Systems, the new degree was built around extant courses, leveraging existing resources. The original HISM degree was a combination of the core business courses, all courses required by the Computer Information Systems minor, and a variety of courses offered by Kasiska's Health Care Administration program (Miller, 2006), as seen in Table 1.

The HISM degree first was made available to students in the 2008–2009 academic catalog. According to the statistics tracked by AIS SIG-Health (Wilson, 2009), ISU's HISM program was one of the first three undergraduate Health-IS programs offered in the United States. In addition, it is one of two undergraduate health informatics programs west of the Mississippi, The degree was introduced during a major downturn in IS enrollments worldwide and was never heavily promoted, but nevertheless managed to attract a small but steady number of majors.

The goal of the HISM degree was to ensure that graduates had the knowledge, skills, and abilities necessary to function in an Electronic Medical Records environment, which requires sufficient IT-oriented knowledge to operate the computer information system, a broad base in business administration, statistics, accounting, and the remaining typical "core" topics provided by an undergraduate business program, a basic understanding of the healthcare environment, exposure to project management, and experience in the form of hands-on exposure to IT within the healthcare environment (Trimmer et al., 2007). The degree was structured to provide such knowledge, skills, and abilities.

4 Increased emphasis on health care

When the current dean of the College of Business began his tenure, he realized that a generic college of business at a mid-level university offered limited differentiation from hundreds of similar programs. Porter (1980) proposed a competitive strategy framework based on the concept that strategy should target either cost leadership, differentiation, or focus. Drawing on this framework, the Dean presented to the Leadership Board three alternative strategies to consider, including (1) serve as a low cost provider, (2) become a name school, or (3) develop a niche (Fig. 1).

The Dean reasoned that with the advent and widespread acceptance of Massive Open Online Courses (MOOCs), low cost is now zero, effectively removing *becoming the low*

Table 1 List of HISM courses

Core Business Requirements	
ACCT 2201	Principles of Accounting I
ACCT 2202	Principles of Accounting II
BA 2200	Professional Development Seminar I
BA 3301	Professional Development Seminar II
BA 3302	Professional Development Seminar III
BA 4400	Professional Development Seminar IV
CIS 3301	Information Systems and Problem Solving
CIS 3302	Information Systems
FIN 3315	Corporate Financial Management
FIN 3317	Fundamentals of Investments
MGT 2216	Business Statistics
MGT 2217	Advanced Business Statistics
MGT 2261	Legal Environment of Organizations
MGT 3329	Operations and Production Management
MGT 4460	Problems in Policy and Management
CIS Courses provided by the College of Business	
CIS 1120	Interactive Web Development
CIS 2285	Software and Systems Architecture
CIS 4403	Systems Analysis and Logical Design
CIS 4407	Database Design and Implementation
CIS 4411	Intermediate Information Assurance
CIS 4485	Communications Systems
MGT 4482	Project Management
Courses provided by Health Care Administration	
HCA 1115	U.S. Health System
HCA 3330	Health Information Systems
HCA 3150	Organizational Behavior in Healthcare
HCA 4460	Health Care Operations and Quality
HCA 4473	Marketing for Healthcare Organizations
HCA 4489	Health Care Information Systems Practicum

cost provider as an effective strategy. Given that it takes time and immense resources to achieve the status of prestigious business schools like Harvard, Wharton, Columbia, etc., *becoming a name school* was not a feasible option. That left *developing a niche*, or a core area of competency that uniquely differentiates the college from its competitors.

The first stage of any curriculum development is to identify a need that has been made come necessary by a changing environment and that is relevant to the capabilities of the university and responds to the changing environment. Given that the university had already been assigned specific responsibilities in delivering programs in the health professions, the dean prudently recommended that the college more closely align its mission with that of the University, leading to a niche focusing on the business of health care. Further, given that the college had an established, albeit little known degree
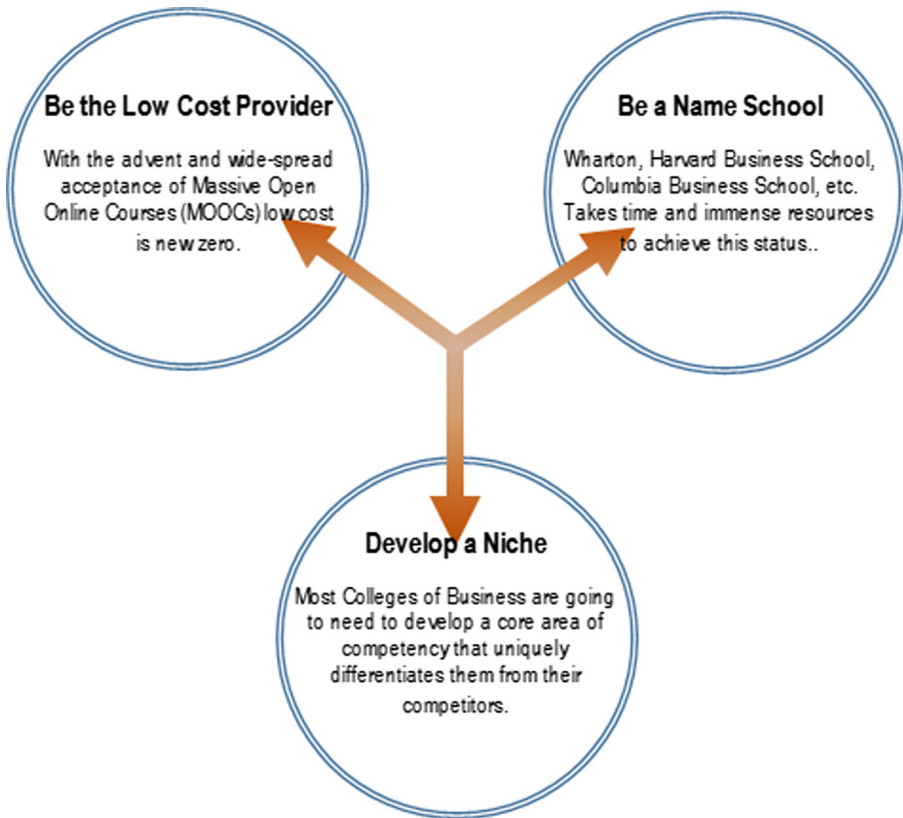
Be the Low Cost Provider

With the advent and wide-spread acceptance of Massive Open Online Courses (MOOCs) low cost is new zero.

Be a Name School

Wharton, Harvard Business School, Columbia Business School, etc. Takes time and immense resources to achieve this status..

Develop a Niche

Most Colleges of Business are going to need to develop a core area of competency that uniquely differentiates them from their competitors.

Fig. 1 Three alternative strategies for colleges of business

related to the health professions, he recommended dedicating more resources to leveraging that degree. The College of Business had found its niche, and the HI program provided the cornerstone on which to establish that new identity.

This stage in the curriculum development process is critical as it both serves as the basis for later decision making and provides the rationale required for high level discussions within the University as well as at higher levels (in our case the State Board of Education.)

5 Metamorphosis into health informatics

Since the HISM degree existed in University records, the decision was made by the Dean, the Leadership Board, and the College faculty to use that as the basis for the new business of health care niche. The HISM was renamed Health Informatics, because like its namesake the program strives to harness the synergistic effects of integrating computing technology within the healthcare domain to improve operational accessibility, efficiency, and effectiveness.

The next step was to identify capacity gaps in the college of business. The obvious gap was the lack of faculty qualified to teach health informatics courses. The existing

faculty was well qualified to teach standard information systems courses like Programming, Systems Analysis and Design, Networking, and Database Design and Implementation, but had no experience with health-oriented courses. As existing faculty departed and positions became available, our faculty searches focused on informatics candidates with coursework, experience, and a research focus in health informatics, specifically in the following areas:

- mobile healthcare applications,
- the use and impact of health informatics systems on the performance of individuals, teams and organizations in the health profession ,
- electronic medical records,
- consumer health informatics and privacy issues.

These areas were determined through interviews with HISM graduates working in the HI field, as discussed in the section on Market Research. Three new Ph.D.'s with specializations in various aspects of HI were hired to deliver the program. The influx of expert faculty was followed by a revision of the HISM curriculum. Any curriculum initiative should be based on some identification of the needs of either the industry or of graduate attributes. Several factors were identified by the research around this requirement: First, given the demand for health informaticists, the department felt the program focus on EMRs was too limiting. Second, feedback from graduates of the HISM program indicated a need for more technical rigor through additional programming courses. Third, informal discussions with state and regional leaders in the healthcare field indicated a need to include data analytics. Finally, and most important, while the HISM degree combined a series of information systems courses and a series of health administration courses, there was identified a need for a real health informatics component that integrated computing technology with the healthcare domain.

As the faculty worked to restructure the health informatics curriculum, new health informatics courses were proposed, including Health Informatics, Health Information Governance, Healthcare Workflow Process Analysis and Redesign, and Health Data Analytics. The degree was expanded from 33 credits to 39 (where a typical business degree consists of 24 to 30 credits) to allow for the addition of the new courses and to strengthen programming knowledge. The course requirements can be seen in Table 2. The completed interdisciplinary curriculum requires the core business courses, as well as 39 credit hours from three primary fields:

- 18 credit hours from Informatics
- 9 credit hours from Health Care Administration
- 12 credit hours from Health Informatics

5.1 Goals/competencies the program promotes

The program is designed to provide graduates with a thorough understanding of health care, information technology, information systems, and business, and graduates will be able to apply these competencies to pursue a growing range of rewarding healthcare

Table 2 List of Undergraduate HI courses

Core Business Requirements	
ACCT 2201	Principles of Accounting I
ACCT 2202	Principles of Accounting II
BA 1110	The World of Business
BA 2210	Introduction to Professional Development I
BA 3310	Exploring Professional Development II
BA 4410	Implementing Professional Development III
ECON 2201	Principles of Macroeconomics
ECON 2202	Principles of Microeconomics
INFO 3301	Introduction to Informatics and Analytics
FIN 3315	Corporate Financial Management
MGT 2216	Business Statistics
MGT 2217	Advanced Business Statistics
MGT 2261	Legal Environment of Organizations
MGT 3329	Operations and Production Management
MGT 4460	Strategic Management
Core Informatics Courses provided by the College of Business	
INFO 1181	Informatics & Programming I
INFO 1182	Informatics & Programming II
INFO 2285	Software & Systems Architecture
INFO 3307	Systems Analysis and Design
INFO 3380	Networking & Virtualization
INFO 4407	Database Design & Implementation
Health Informatics Courses provided by the College of Business	
INFO 3330	Health Informatics
INFO 4422	Health Information Governance
INFO 4424	Healthcare Workflow Process Analysis and Redesign
INFO 4426	Health Data Analytics
Courses provided by Health Care Administration	
HCA 1115	U.S. Health System
HCA 3350	Organizational Behavior in Healthcare
HCA 4460	Health Care Operations and Quality
HCA 4473	Healthcare Strategic Planning and Marketing
HCA 4489	Health Care Informatics Practicum

For descriptions of any of these courses, visit this link and click any course for details: http://homepages.cob. isu.edu/informatics/advising/hi/healthInformaticsMajor2016.htm

positions in both the private and public sectors. Upon completion of this degree program graduates will have the ability to:

• Work collaboratively across disciplines to analyze and solve key issues in health informatics.

- Implement and manage health informatics solutions in ways that respect the prevailing culture, organizational context, and policies relating to health.
- Assess the information technology needs and resources of individuals, organizations, and communities.
- Design health informatics solutions to address current trends and the challenges facing the healthcare industry.
- Communicate complex ideas effectively, both orally and in writing, to different audiences and stakeholder groups as well as articulate responses to national and global healthcare challenges.
- Manage and lead across the spectrum of healthcare settings.

5.2 Market research

A graduate takes 4 years in the making, so market research is an ephemeral process in any curriculum development. The curriculum revision was initiated in mid-2012 and employed three strategies: interviews with graduates, a review of publicly available curriculum statements, and a literature search. Research began by contacting HISM graduates working in the HI field to inquire what knowledge, skills, and abilities they felt they lacked upon entering the field, and what changes in the HI field they had experienced that might call for changes in the curriculum. This was followed by an examination of other HI-related programs in the United States, found primarily on the Association for Information Systems (AIS) Health IS Programs website (Wilson, 2014) and on the American Medical Information Association website (AMIA, 2015). The AIS Health IS Programs list "focuses on health-related academic programs that are based in or substantially comprised of Information Systems, Information Science, and/or Computer Science academic units" (Wilson, 2014). The AMIA list, however, also includes programs that are not IS/IT-intensive, such as those in nursing informatics, biomedical informatics, and clinical informatics. Our final set of exemplar programs was comprised of seven higher education institutions listed in Table 3. While no such list can be comprehensive due to non-reporting or other issues, it provided an acceptable starting point from which to begin examining other undergraduate health informatics curricula.

The curriculum revision also examined recent literature on health informatics curricula, including Hersh (2010), Campbell et al. (2011), Spil et al. (2011), Landry et al. (2012), Longenecker et al. (2012), and Chatterjee et al. (2013). We also used material from the Health IT Curriculum Resources for Educators (2012) website.

The team met several times to share their views, research findings, and experience, and after much discussion and many compromises concluded that the health informatics courses listed in Table 2 would address the most critical needs. The team operated under the premise that modifications, additions, or deletions could be made at some point in the future. The curriculum revisions were approved at the university level in November 2013 and the major became available in fall 2014.

Table 3 HI Bachelor's Programs

Name of Institution	Length of Program	Program/Course Delivery Mode: Online or On-campus	Accreditation
College of Coastal Georgia	120 credit hours	The program and classes are offered purely on-campus.	No HI specific accreditation
Dakota State University	120 credit hours	The program is offered both online and on-campus.	CAHIIM
University of South Carolina - Upstate	57 credit hours (beyond the Associates degree.)	The majority of courses are offered online.	CAHIIM
Georgia State University	120 credit hours	Some courses may be offered online.	No HI specific accreditation
Idaho State University	128 credit hours	Some classes are offered online.	No HI specific accreditation
Indiana University - Purdue University	120 credit hours	Some courses are only offered online.	CAHIIM
Oregon Institute of Technology	181 credit hours	The program is offered both online and on-campus.	No HI specific accreditation

6 Progression to a graduate degree

In recent years, a considerable number of graduates expressed interest in a graduate degree in Health Informatics. Therefore, once the undergraduate degree revision had been completed and the degree was available to students, the faculty turned their attention to a graduate degree. The curriculum committee reviewed resources such as the Commission on Accreditation for Health Informatics and Information Management Education's 2014 Health Informatics Master's Degree Curriculum Requirements (CAHIIM, 2014a) and examined current graduate programs listed on the CAHIIM Program Directory (CAHIIM, 2014b).

To make the most efficient use of our resources, the curriculum design again embraced the concept of reusability. The program (Table 4) includes graduate versions of the four new Health Informatics courses developed for the undergraduate curriculum. A limited number of select senior level courses can be taken for graduate credit as long as a graduate component in the form of additional scholarly activities is required. Specific requirements for such courses can be found at http://coursecat.isu.edu/graduate/generalinfoandpolicies/courselevelcreditsgrading/

Additional courses were proposed and included in the graduate curriculum, including a course in Statistical Methods for Data Analytics, Electronic Health Records, a Management of Informatics Projects course, and a graduate-level Health Clinical Practicum. At the recommendation of our colleagues in the Kasiska School of Health Professions, the graduate curriculum includes the Health Law and Bioethics course taught by faculty in the Health Care Administration program and a US and Global Health Systems course offered by the Master of Public Health program.

The committee debated whether the degree should require a project, a thesis, or an option of either. A project generally requires the application of concepts in real-world context. A thesis is usually more research oriented, and is more suitable for those students who intend to continue their graduate studies. While there was some concern

Table 4 Courses included in MSHI

Required Courses provided by the College of Business	
INFO 5417	Statistical Methods for Data Analytics
INFO 5520	Health Informatics
INFO 5522	Health Information Governance
INFO 5524	Healthcare Workflow Process Analysis and Redesign
INFO 5526	Health Data Analytics
INFO 6528	Electronic Health Records
INFO 6540	Health Clinical Practicum
INFO 6670	Management of Informatics Projects
Required Courses provided by School of Health Professions	
HCA 6625	Healthcare Law and Bioethics
MPH 6607	US and Global Health Systems
Thesis Option	
INFO 6650	Informatics Thesis
INFO 6650	Informatics Thesis
Project Option	
INFO 6660	Informatics Project
INFO 6xxx	Informatics 6000-level Elective
Prerequisite Knowledge	
INFO 1150	Software and Systems Architecture
INFO 1181	Informatics and Programming I
INFO 1182	Informatics and Programming II
INFO 3307	Systems Analysis and Design
INFO 4407	Database Design and Implementation

Descriptions of any of these courses can be found by visiting this link and clicking any course: http://homepages.cob.isu.edu/informatics/mshi/mshiMajor.htm

among faculty about the need to provide customized guidance for each student who chooses to develop a thesis, the decision was made to include the thesis option for those students who plan to continue their studies in Ph.D. programs in IS, CS, or any other related fields of study. As a result, the degree offers students two options: a thesis option with 30 credits of coursework plus 6 credits of thesis, or a project option with 33 credits of coursework plus 3 credits of Informatics Project.

Like typical graduate degrees, the graduate HI degree builds upon the knowledge typically gained through the completion of an undergraduate degree. Students without a degree in the computing sciences, such as business informatics, health informatics, computer information systems, or computer science will be required to successfully complete five "leveling courses" as listed in the Prerequisite Knowledge section.

In order to guarantee the quality and increase the recognition of our HI programs, we plan to apply for an HI accreditation such as the one jointly offered by AMIA and CAHIIM (AMIA, 2014). Given that only part of the national HI programs are accredited at this time, getting accreditation for our HI programs may serve to help our program stand out.

7 Degree differentiation

In developing our curriculum we sought out ways to make it stand out. One of the primary strategies for achieving a competitive advantage is product differentiation. A differentiation strategy involves the firm creating a product/service, which is considered unique in some aspect that the customer values (Dirisu et al., 2013). The goal of product differentiation in higher education is to ensure that potential students and their families "perceive the product (educational package) offered by an individual college or university to possess characteristics that help make it appear unique and distinguishable compared with those offered by other institutions" (Paulsen, 2001, p.195). Degree programs can enhance their marketing potential by discovering and defining what makes them unique and how those qualities address the needs of their target market (Risdall, 2015). Higher education services can be perceived by customers to differ in ways beyond tangible differences in programs of study and course content (Becker and Toutkoushian, 2013).The HI degree that we offer has several features that differentiate it from others.

Affiliation with a School of Health Professions Our program is a joint offering between a very established, well-credentialed College of Business and a very prestigious School of Health Sciences. The School of Health Sciences is the lead health sciences institution in the state of Idaho. The undergraduate degree includes a set of courses taught by faculty from the Health Care Administration program, including the practicum. The graduate program includes a course taught by Health Care Administration and another from the Public Health program. Our HI degrees are delivered in cooperation with the University's Kasiska School of Health Professions, and their expertise in health care makes their insights into HI faculty searches and curriculum development/revisions invaluable. Hence, their Associate Dean and Director has a standing invitation from the Informatics department to actively participate in such decisions.

   While our health informatics faculty members are able to teach a variety of courses focusing on health, informatics, and health informatics, we still felt it benefitted students for the major to include courses from the School of Health Professions. Combining features from multiple disciplines exposes students to the fundamentals of IT as well as the function, operation, and nature of health care. Our curriculum provides students with exposure to the interaction and interdependencies of technology with other key elements in health care, including the Health Insurance Portability and Accountability Act (HIPAA) compliance, Joint Commission on Accreditation of Healthcare Organizations (JCAHO) accreditation, FDA regulations, and evidence-based practices. Our joint major provides an effective bridge between health sciences and information systems.

Inclusion of a practicum Prior to designing the first HISM degree, a number of professionals in various health organizations were interviewed regarding the baccalaureate qualifications needed to be adequately prepared for a health IT position. One finding was that it was considered essential for students to have hands-on exposure to IT within the healthcare environment (Trimmer et al., 2007). Hence, both our undergraduate and graduate programs have a health informatics practicum as their

cornerstone, requiring field experience in a health informatics setting consistent with the student's career goals. The practicum is arranged and supervised by faculty in Health Care Administration. Many of the practicums are arranged with the Department of Family Medicine. Our practicum involves supervised field experience of professional-level duties, requiring the practical application of theory or conceptual knowledge. The practicum requires 128 h of hands-on experience, typically 8 h per week over a 16 week semester, and at the end of the semester the student submits their work portfolio along with a presentation about what he/she accomplished. The practicum is intended to provide students with the opportunity to synthesize all previous coursework, to develop competence in professional practice, to apply knowledge to the solution of real health informatics problems. It also makes it possible for students to emphasize actual experience on their resume.

Technical rigor Our health informatics degree is technically rigorous to prepare our graduates to handle a broad range of health informatics-related employment opportunities. Our health informatics program focuses on developing the competencies and skills needed to work with leading edge technologies as well as to implement process change, system design, and management within the unique constraints and practices associated with the healthcare industry. The program prepares graduates for a variety of work settings, including hospitals, physician networks and practice groups, insurance companies, regulatory agencies, and industry suppliers such as pharmaceutical companies, biotechnology companies, and vendors of hospital equipment and medical supplies.

Subject-matter experts An academic expert is a specialist in a field, one who has academic coursework in their field and performs scholarly research in that discipline. As noted above, the existing faculty members had degrees in information systems or other IT-related disciplines and were well qualified to teach standard information systems courses, but lacked experience developing and teaching health-oriented courses. When recruiting new faculty, our search process focused on faculty with coursework, research, and experience in health informatics. We wanted to insure that our faculty were qualified and prepared to deliver a leading edge health informatics program and insure that the curriculum provides for all aspects of a health informatics education. Students are the department's top priority, and our focus is on maintaining a dynamic, open, rich context for student learning.

Women in technology In 2015, women accounted for only 25 % of the computing workforce (NCWIT, 2016). Our health informatics program strongly encourages greater numbers of female students enrolled in our programs. Toward that end, our department has become affiliated with the National Center for Women & Information Technology Academic Alliance to gain greater access to leading-edge best practices for recruiting and retaining women.

8 Lessons learned and recommendations

Curriculum reuse and extensibility Our curriculum development efforts are generally constrained by a lack of available funds for initial investment in courses for the

program and lack of funding to hire additional faculty if required to cover a large number of new courses. While faculty appointments were approved for the new undergraduate HI degree, all development efforts leaned heavily on "reusability." This involved including as many existing courses as possible even when those courses are offered by another School or College, or where minor revisions of course content could be made to align old courses with the new programs. Hence, when developing the HISM degree, the thriving CIS degree served as a basis on which to build the HISM curriculum. The original HISM degree was a combination of the core business courses, all courses required by the *Cis minor*, and a variety of courses offered by Health Care Administration (Trimmer et al., 2007). The original degree required the introduction of no new courses. It was only when we became more established and had hired faculty with HI backgrounds that we began offering specialized HI courses. Both the Health Informatics undergraduate revision and the graduate degree make heavy reuse of existing courses.

Diversify Basing our HISM program on our CIS program resulted in two majors. That allows us to attract students interested in CIS in general and students interested in a CIS niche. While our HISM degree survived, it never attracted large numbers of students. The thriving CIS program allowed us the luxury of offering the niche HISM degree. Had we for any reason offered only a HISM degree, our program and faculty would not have survived the slow recovery from the dot.com bust (Aiken et al., 2014) and its effect on IT program enrollments.

Health informatics practicum Work integrated learning provides students with real-world experiences, and allows for the application of knowledge and general principles to real situations, problems, and concerns (Billett, 2007; Calway and Murphy, 2007; Harrison and Wilson, 2010). The intent of applied education is to connect the theoretical and conceptual contribution of the classroom with the practical world of the practice setting. It has been found to improve students' confidence (Dressler and Keeling, 2004), knowledge of the discipline (Eames, 2000), and integration with the profession (Wilson, 1989). The HI Practicum has several specific objectives:

- To gain practical experience based on the understanding and application of theoretical knowledge.
- To observe the analysis of and solutions to problems arising in professional work settings.
- To participate in a representative range of professional activities in the work setting.
- To interact with colleagues in a professional work environment.
- To provide an opportunity to test the waters and the culture in various aspects of the field.
- To provide work experience to facilitate future job searches.

Depth of technical understanding Our curriculum development efforts are built around the premise that all computing disciplines require a set of the fundamental competencies and skills needed to work with leading edge technologies as well as to keep abreast of emerging technologies and applications in an ever-changing field. Toward that end, all undergraduate degrees offered by our department – health

informatics, business informatics, and computer science – share a common set of core courses. All majors require Software and Systems Architecture, Programming I, Programming II, Systems Analysis and Design, Database Design, and Networking and Virtualization. The technical rigor that characterizes these courses challenges students' thinking in new and interesting ways and prepares them with the analytical and technical skills to address informatics challenges across a broad spectrum.

Targeted domain knowledge In restructuring our curriculum we addressed the need for a real health informatics component, that is, courses that integrate computing technology with the healthcare domain. The original HISM degree combined a series of information systems courses and a series of health administration, but there was no real intersection of the two disciplines. The degree failed to convey to students how the application of information systems within health care could impact and transform the quality of health care, and instead left that to students to discover from their practicum. The new degree addresses this shortcoming by providing targeted health informatics courses.

Promotion strategy and resources An excellent curriculum is no benefit to anyone if prospective students do not find the program. Traditional sources of marketing cannot be ignored, but a sensible curriculum development includes a plan for marketing that takes into account the way prospective students obtain information. This should include social media and other mobile platforms for communicating, such as "trending" on Facebook/Twitter, using search engine advertising (e.g., AdWords) for related keyword searches, etc.

Extend your sphere of influence Our program is regionally focused in a sparsely populated state. It has become clear that in order to reach the largest student base, we will have no choice but to offer a combination of traditional courses broadcast to satellite campuses across the state, as well as making our courses available online. Once content for each course has been developed and delivered in a traditional and broadcast setting, professors begin to make courses available online as well. This allows us to extend our reach beyond the immediate area, making us more enticing to students across the state and beyond who lack the flexibility or means to attend local classes.

9 Summary and conclusion

Mid-level Universities continue to face competitive pressure in the educational environment that includes both a decreasing rate of high school graduates immediately going onto college and the options that students now have of gaining online qualifications from a high profile university. This leads to an imperative to identify the future, especially of generic programs such as information systems. The approach cited in this case was to identify a niche where evidence existed of significant demand.

Our health informatics programs were developed to address a critical need throughout the US and beyond. Demand for HI professionals continues to exceed supply. This paper explained the origins of one of the earliest health informatics undergraduate programs in the United States, and detailed its curricular evolution and advancement to

a graduate degree. The factors that provided a catalyst for the evolution have been thoroughly examined.

Almost all curriculum development efforts will be subject to some resource constraints. In this case the main constraints were a lack of faculty qualified to teach in the health informatics specialization and limited funding for initial investment in courses for the program. Faculty appointments were approved to replace departing faculty, so the department was able to address the first issue. However, even with the influx of new faculty members the department workload was close to 100 % covering classes for the established Business Informatics major. Given the funding constraints, it was clear that a new curriculum would not be approved if it included several new courses that would require even more additional faculty to teach them. Hence, curriculum development leaned heavily on "reusability." This involved establishing a common core of courses appropriate across all of our majors, taking advantage of existing courses offered by other schools, and repurposing some existing undergraduate HI courses by adding a graduate component to them so they are eligible for graduate credit.

Curriculum development is not simply a process of identifying some text books and building a program around them, but rather of employing and implementing a transformation process. Curriculum development must be driven by a need that is relevant to the capabilities of the university and based on some identification of the needs of either the industry or of graduates. Although it is difficult to predict the needs of the market four years into the future, it is imperative that faculty be alert to industry trends through participation in professional organizations, staying current with industry development through the media, and seeking feedback from former graduates. Careful observation of industry's pulse allows academia to be agile and responsive to better serve industry and our graduates.

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