A Professional Science Master Degree in Health Informatics

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ABSTRACT

The demand for health informatics professionals is a response to the growing medical data bases resulting from governmental initiatives, as well as globalization of geographical information systems. This is compounded by the diversity of professions at all levels of health care. Health informatics goal is to develop integrated information systems for the exchange of data within the health care system, while ensuring security, confidentiality, and privacy. This paper proposes a Professional Master Degree in Health Informatics, which considers the multidisciplinary aspects of health care, recognizes the need for standardized assessment to ensure quality, and moves toward fulfillment of the demands placed on informatics in the health care forum.

Key Words

Health Informatics, Professional Science Master, Curriculum Design, Program Assessment, Program Outcomes

I. INTRODUCTION

Health informatics is the science of systematically processing data, information, and knowledge in medicine and clinical research [6]. The term "health" encompasses the multiple professions involved in the delivery of health care. These professions not only involve individuals considered to be at the forefront of delivery, such as medical doctors, dentists, physician assistants, nurse practitioners, and nurses; but also include laboratory and imagery technicians, pharmacists, social scientists, librarians, financial and budget managers, and public health and clinical researchers. Informatics has become a critical component in the management and effective use of ever-changing and continuously-growing data generated in clinical care and research. [3], [6], [8], [10]. As the medical field technologically advances and grows, demands for the organization and management of information increase in complexity. Challenges facing health informatics in response to these demands include the development of coherent and integrated information systems, consideration of the high degree of information exchange resulting from the multidiscipline nature of health care and research, and security associated with confidentiality, privacy, and propriety issues [6], [16].

In the forum of public health, health informatics includes applications of knowledge from computer/information science, management, organizational theory, psychology, political science, communications, epidemiology, toxicology, microbiology, and law [4], [7], [16]. Its varied applications focus on health trends within populations, rather than clinical settings. Demand for proficiency in health informatics at the patient and population level is expected to grow, and to match medical advancement and increased health care accessibility. Professionals educated in health informatics are needed to meet these challenges, resulting in the improvement in the quality and efficiency of health care [4], [6], [8], [10].

The call for an electronic medical record for all Americans by 2014, which was made by President Bush in his 2004 State of the Union Address, recognized the demands and challenges of health informatics. President Obama continued this pledge, as well as called for digitized medical records within five years and passed the American Recovery and Reinvestment Act [ARRA] with Congress [12]. This Act provided significant momentum to health care reform through informatics technology [12]. In order to fulfill this pledge it is estimated that 50,000 health informatics professionals will be required [7]. The Canadian government is also committed to universal electronic medical records for its citizens by 2016 [14]. The overall goal of governmental incentives is the promotion of health within populations, prevention of disease with regard to effectiveness, expediency, cost, and acceptability, and direct governmental responsiveness to health issues [12] [16]. In order to meet the 2014 goal, the ARRA has provided funding for

the development of health informatics curriculum, degree programs, and competency certification to train and increase the workforce in response to health care reform [12].

Projected workforce needs are also being addressed by the American Medical Informatics Association's 10 x10 initiative program. The goal of this initiative was to train 10,000 health care professions in the field of health informatics by 2010 [7]. Likewise, medical schools and health care systems in the United States, France, Germany, and the Netherlands have incorporated health informatics into their medical curricula and training. However, many nations are lagging behind despite the impending flood of universal electronic medical records their governments are calling for and the dire need of health informatics professionals [5], [6], [14]. Such projection-based goals are feasible in developed countries; however, the health informatics work force needs of developing countries are unknown, yet anticipated to exceed that of developed countries [7].

On national and global levels, geographical information system technology and its entry into industry resulted in the generation of numerous data sets. [11]. These data sets were created independently and therefore lack a common structure, as well as a reluctance of their creators to share this information. Many more data sets are not documented. These issues call for the continued improvement and implementation of support mechanisms, and development of guidelines for geoportal technologies. Geoportals and repositories for data can provide the infrastructure to support the management of data and open its accessibility to the public for research, industry, academia, and public health policy [11]. Global consideration of health informatics still needs to encompass work force profiles, cultural and language variations, and recruitment and training across various and non-compatible systems [7]

Library science and informatics share the same objective, that being the management, sorting, and delivery of information: however the professional boundary between the two disciplines is becoming less distinctive [13]. Library science is typically seen as a sub-discipline of informatics that focuses on the user's need and the purpose of information. This focus has become less the domain of a "traditional library", but has transcended its physical confinement through digital media and network infrastructures. As the focus of library science broadens it overlaps with the broader focus of informatics. Both engage in information management and the development of its delivery, with librarians contributing to the former and informaticians contributing to the latter. Librarians, as expert searchers, have the training in data base organization and understand the "architecture" of search systems, which allows them to provide relevant and high impact information despite lacking expertise in specific subject matter [15]. This complementary relationship benefits the developing field of health informatics as the repositories of information with their reservoir of data digitally coexisting with research and medical institutions. This symbiotic relationship is integral in the development and implementation of medical knowledge bases.

Because all health care professionals will be confronted with health informatics as global data sets consolidate and medical knowledge bases grow due to nations' conversion to electronic medical records, professionals will be exposed to informatics education within their professional studies and during career development. The variety of professions and their specific needs within health care require different modes of education methodologies, and require qualified educators that demonstrate competence in health informatics. The overarching outcome for informatics users in health care is to enable health care professionals to efficiently and responsibly use information processing methodology and technology; whereas, graduates specializing in informatics must be prepared for careers in health informatics in academic, health care, or industrial settings [3], [8], [10].

Master and higher graduate degrees provide the skills and knowledge for researchers, system developers, and educators. Most health informatics programs are at the graduate level and either share curricula with related programs or have a separate tract. Of 177 surveyed programs, 91gradaute level degrees fall within the bioinformatics area [1]. Those outside of bioinformatics are in the focused areas of nursing, dentistry, and Cheminformatics. Likewise, the housing of health informatics programs is also variable, with graduate programs affiliated with health science (31%), medical (25%), public health (16%), and computer science (16%) schools. Within these schools 37% of the health informatics programs are interdepartmental, and the remainder housed in biology (21%) and computer/information science [13%] departments, and medical schools (10%), [9]. Survey of admissions into the Health Informatics program at the University of Victoria indicated most students entered the program directly upon completion of their bachelor degree and have at least five years of work experience. Approximately half of their graduates intend to enter academia [2]. This reflects the general trend of Health Informatics programs, which are typically oriented towards primary health providers from various disciplines with the goal of producing educators and

researchers. Development of contemporary health informatics programs must recognize the need for health informatics professionals at all levels of healthcare, and adopt a broader focus if the ARRA goal of universal electronic health record is to be attained, developed, and managed.

The aim of this paper is to propose a curriculum design for a Professional Science Master in Health Informatics to contribute to meeting the enormous demand for health informatics professionals. The Professional Science Master will prepare leaders, researchers, entrepreneurs, and educators in the Health Informatics field.

II. Health Informatics Tasks

As health informatics continues to develop, priorities and goals need to be identified. The following is a tentative composition for the design of a Professional Master Degree Program [1], [9], [12], [16].

- Interdisciplinary professionals required for business practice, healthcare delivery and medical research require re-engineering of information systems, so that information can be shared.
- Facilitate the electronic gathering, storing, and interchange of patient data for analysis in a collaborative manner.
- Synergize health informatics with evidence-based medicine and its implementation through the development of clinical guide lines.
- Educate and train healthcare providers to use health informatics and its accompanying technology effectively.
- Improve security for patient confidentiality in regards to diagnostic reporting, use of patient clinical records for research, or finances.
- Create an informed patient environment through linking educational systems that involve prevention, diagnosis, and treatment to electronic patient records and distance care.
- Identify new technologic opportunities for their use in healthcare, such as bioinformatics.
- Enhance the fields of epidemiology and public health.
- Support transducers and mobile devices that report a patient's physiologic status.
- Contribute to good practice decision-making policies in the management and financial aspects of healthcare and public health.
- Reduce health care disparities within populations.

III. Health informatics applications

Health informatics has many critical real life applications. Examples of its applications include: [1], [4], [9], [11], [12], [16].

- Development of patient-oriented interactive computer-based programs that provide information, support, patient status, and decision-making formats for underserved populations and high risk patients.
- Conversion of medical records into electronic formats to be shared amongst the various professional levels within the health care system.
- Re-engineer processes to maintain quality of health at permissible costs.
- Surveillance of disease incidence and vaccination patterns to identify trends, make predictions, and improve efficiency.
- Development of e-health (electronic accessible) and m-health (mobile phone accessible) applications in underserved populations.
- Create health spatial data infrastructures supported by geoportals, such as the OneGeology Portal, which delivers environmental data for medical research

II. Grants supporting bodies

A number of organizations provide support for health informatics research and educational programs. Among these are the following:

- National Institute of Health
- National Library of Medicine
- Strategic Health IT Advanced Research Projects [SHARP]
- Informatics Training for Global Health Program
- International Medical Informatics Association
- Beacon Community Program
- Robert Wood Johnson Foundation

III. PROFESSIONAL SCIENCE MASTER

A. Program Objectives

1) Develop within graduates the level of Health Informatics proficiency needed for the professional practice.
2) Instill within graduates the ability to effectively communicate ideas and outcomes, both orally and in writing, in a logical manner.
3) Develop within graduates the appreciation for and an understanding of the need to maintain high ethical standards.
4) Instill within graduates the ability to demonstrate effective leadership and entrepreneurial thinking.
5) Prepare graduates for pursuing a doctoral degree in Health Informatics.

B. Program Outcomes

Students should be able to:

1. Students will be able to demonstrate proficiency in storing, retrieving, and interpreting health-related data sets in computer systems, and an awareness of their limitations.
2. Students will be aware of the need to communicate effectively to recognize the specific informational needs of different professionals in health care such as researchers, physicians, nurses, health economists, laboratory technicians, and librarians.
3. Students will be able to understand the role of information systems in the development and implementation of interactive programs that monitor patient physiology or provide supportive services.
4. Students will be able to recognize the various types of data, and effectively filter information and adopt new methods of searching information.
5. Students will be able to assess the quality of data as it pertains to specific health care areas and ensure its accuracy.
6. Students will be able to define and implement the principles of data protection, confidentiality, and privacy rights as they pertain to health care.
7. Students will be able to comprehend the supportive role of informatics in research, diagnostics, health management, public health, and decision making processes.
8. Students will be able to value ethical principles as they apply to patient rights and the data management.
9. Students will be able to demonstrate knowledge of leadership effectiveness in various health informatics fields, and innovational thinking, as well as functioning in teams.

C. Admission Requirements

In order to be admitted to the program, the applicant:

1. Must hold a bachelor's degree [or equivalent] with a minimum GPA of 3.0.
2. Must have a bachelor degree in health informatics, computer science/informatics, health science, health administration, biology, or public health.
3. Must have taken courses in a programming language (such as C++, Java, or Perl), Data Structures, Machine Organization, Calculus and Discrete Mathematics.
4. Must make up for deficiencies in undergraduate preparation by taking some prerequisite courses.
5. May have courses waived after passing a department test with a grade of at least a "B", if applicants have academic or work experience equivalent to any of the courses mentioned above.

D. Degree Requirements

The Professional Science Master in Health Informatics consists of 45 credits of coursework. Students must complete a 3-month internship in a health care industry, or a healthcare research institution. The 45 credits are distributed as follows:

- Health Informatics Core 12 cr.
- Health Informatics Elective 03cr.
- Leadership and Entrepreneurship 12 cr.
- Computing Core 12 cr.
- Computing Elective 03 cr.
- Research 03-06 cr.

E. Course Requirements

Courses representing each of the above areas are provided in Tables I - VI below. If a thesis is pursued, only one course of the list of classes in Tables II and V below is needed.

TABLE I

HEALTH INFORMATICS CORE

Course Title	Credits
Introduction to Health Informatics	3
Clinical Informatics	3
Consumer Health Informatics	3
Public Health Informatics	3

TABLE II
HEALTH INFORMATICS ELECTIVES

Course Title	Credits
Electronic Health Care Records	3
Clinical Decision Support	3
Telemedicine	3
E-Heath Systems	3
Legal and Business Issues	3
Health Systems Simulation	3
Advanced Topics	3

TABLE III
LEADERSHIP AND ENTREPRENEURSHIP CORE

Course Title	Credits
Healthcare Management	3
Healthcare IT Project Management	3
Health Informatics Entrepreneurship	3
Health Informatics Internship	3

TABLE IV
COMPUTING CORE

Course Title	Credits
Software Engineering	3
Web Technology	3
Security and Privacy	3
Data Mining	3

TABLE V
COMPUTING ELECTIVES

Course Title	Credits
Geographic Information Systems	3
Database Design	3
Systems Design	3
Software Requirements Engineering	3
Knowledge Management	3
Human Computer Interface	3
Quantitative Methods	3

TABLE VI
RESEARCH

Course Title	Credits
Health Informatics Design Project	3
Health Informatics Thesis	6

F. Degree Assessment

Many Health Informatics programs are customized to the suit the students professional needs in healthcare. As a result programs can become informal and self-directed [2]. The following assessment measures are recommended to assure overall program quality:

1) Individual course assessment to ensure that each course is achieving its learning outcomes and supporting the program outcomes.
2) A comprehensive program self study will be prepared for the purposes of any program review.
3) A Graduate Survey will be employed to measure students' satisfaction with individual courses and the program as a whole.
4) A survey for the students taking the Health Informatics Design Project course or Thesis will be provided to measure the extent to which the program will achieve its learning outcomes and how well their learning experience matches the program objectives.
5) A Comprehensive Test will be devised to measure how well students are prepared to meet the learning objectives. This test will be offered as part of a capstone course with a weight of 30% and focus on the course requirements for the general knowledge areas recommended above
6) An Exit Survey will be offered to students completing the program to solicit their feedback on the program and on how to improve it.
7) An Alumni Survey will be used to discover how well our graduates feel they were prepared for their current position.
8) An Employer Survey will be prepared to obtain the feedback of employers on how well our graduates are prepared for their positions.
9) An Internship Survey will be used to measure students' performance in prospective organizations.

IV. CONCLUSION

The growing demand for health informatics professionals is a direct result of developed countries moving forward with universal electronic medical records for their citizens in an effort to efficiently

provide a higher quality and more cost effective health care system. As medical knowledge bases grow in size and complexity, the demand for their organization and management grows. The projected work force in health informatics required to manage this growth is in the ten of thousands for the immediate future, and is expected to increase with the development of geoportals supporting spatial data infrastructures. The former will facilitate the exchange of data amongst health and research institutions across state and national boundaries.

Professional Science Master Degree program design, proposed in this paper, is in direct response to the demand for health informatics professionals and encompasses the multidisciplinary aspect of heath care. Program objectives emphasize the basic knowledge areas of informatics, while program outcomes account for the professional diversity an informatician would encounter. Admission requirements and degree assessment ensure overall program quality, a necessity in face of the "specifically professionalized" trend health informatics programs tend to follow. Because of the professional diversity inherit in health care, housing of the program can occur in multiple departments or schools; however, most health informatics programs are found in health science, medical, and public health schools, or biology and computer /information science departments.

REFERENCES

[1] J. Brender, C. Nohr, and P. McNair, "Research Needs and Priorities in Health Informatics," *International Journal of Medical Informatics, Vol. 58-59*, pp. 257-28, 2000.

[2] H.D. Covvey and A. B. Pidduck, "Health Informatics Education, Working Paper," in *Waterloo HIP Position Paper*, pp. 1-50, 1999.

[3] S. Garde and E. Hovenga, "Australian Health Informatics Educational Framework," in *Australian Health Informatics Educational Framework*, pp. 1-15, 2005.

[4] D.H. Gustafson, R.P. Hawkins, E.W. Boberg, F. McTavish, B. Owens, M. Wise, H. Berhe, and S. Pingree, " CHESS: 10 Years of Research and Development in Consumer Health Informatics for Broad Populations, Including the Underserved," *International Journal of Medical Informatics*, Vol. 65, pp. 169-177, 2002.

[5] A. Hasman and A. Albert, "Eduction and Training in Health Informatics: Guidelines for European Curricula," *International Journal of Medical Informatics*, Vol. 45, pp. 91-110, 1997.

[6] R. Haux, "Aims and Tasks of Medical Informatics," *International Journal of Medical Informatics*, Vol. 44, pp. 9-20, 1997.

[7] W. Hersh, A. Margolis, F. Quiros, and P. Otero, "Building a Health Informatics Workforce in Developing Countries," *Health Affairs*, Vol. 29, No. 2, pp. 275-278, 2010.

[8] International Medical Informatics Association, "Recommendations of the International Medical Informatics Association [IMIA] on Education in Health and Medical Informatics" *Methods of Information* Medicine, Vol. 39, pp. 267-277, 2000.

[9] J. Kampov-Polevoi, and B. M. Hemminger, "Survey of Biomedical and Health Care Informatics Programs in the United States," *Journal of Medical Library Association*, Vol. 98, No. 2, pp. 178-181, 2010.

[10] J. Mantas, E. Ammenwerth, G. Demiris, A. Hasman, R. Haux, W. Hersh, E. Hovenga, K.C. Lun, H. Marin, F. Martin-Sanchez, and G. Wright, "Recommendations of the International Medical Informatics Association [IMIA] on Education in Biomedical and Health Informatics," *Methods of Information Medicine*, Vol. 2, pp. 1-16, 2010.

[11] T. Mathys, and M. N. K. Boulos, "Geospatial Resources for Supporting Data Standards, Guidance, and Best Practice in Health Informatics," *BMC Research Notes*, Vol. 4, No. 19, pp. 1-18, 2011.

[12] J. Murphy, "The Journey to Meaningful Use of Electronic Health Records," *Nursing Economic*, Vol. 28, No. 4, pp. 283-286, 2010.

[13] G.J. Perry, N.K. Roderer, and S. Assar, "A Current Perspective on Medical Informatics and Health Sciences Librarianship," in *Journal of Medical Library Association*, Vol. 93, No. 2, pp. 199-204, 2005.

[14] S. Strauss, "Canadian Medical Schools Slow to Integrate Health Informatics into Curriculum," *Canadian Medical Association Journal*, Vol. 182, No. 12, pp. E551-E552, 2010.

[15] E. C. Whipple, J.J. McGowan, B.E. Gixon, and A. Zafar, "The Selection of High-Impact Health Informatics Literature: A Comparison of Results between the Content Expert and Expect Searcher," *Journal of Medical Library Association*, Vol. 97, No. 3, pp. 212-218, 2009.

[16] W. A. Yasnoff, P. W. O'Carroll, D. Koo, R.W. Linkins, and E. M. Kilbourne, "Public Health Informatics: Improving and Transforming Public Health in the Information Age," *Journal of Public Health Management Practice*, Vol. 6, No. 6, pp. 67-75, 2000.