Health Informatics in the Classroom: An Empirical Study to Investigate Higher Education's Response to Healthcare Transformation

Noushin Ashrafi
Jean-Pierre Kuilboer
Chaitanya Joshi
Iris Ran
Priyanka Pande
Management Science and Information Systems Department
University of Massachusetts Boston
Boston, MA 02125, USA
noushin.ashrafi@umb.edu, jeanpierre.kuilboer@umb.edu,
cjoshi13@gmail.com, irisyuki1989@gmail.com,
Pandepriyanka42@gmail.com

ABSTRACT

The explosive advances in information technology combined with the current climate for health care reform have intensified the need for skilled individuals who can develop, understand, and manage medical information systems in organizations. Health Informatics facilitates quality care at a reasonable cost by allowing access to the right data by the right people at the right time. A new generation of professionals, trained in health informatics, can expedite the transformation in healthcare delivery. This study examines health informatics, big data in the field of healthcare, and the distinction between clinical and non-clinical health informatics. Curricula, of different scopes and depths, offered by higher education, are examined and questions of what, who, where in regard to offerings in the healthcare arena are addressed. Finally, we make suggestions for actions that academia can take to assure that public health professionals have the knowledge, tools, and training to advance the mission of public health. The results of this study should be of interest to those, who directly or indirectly, would benefit of educating a new generation of the workforce in health informatics.

Keywords: Health care, Careers, Decision support systems, Pedagogy, Soft skills.

1. INTRODUCTION

Healthcare professionals are confronted with pressures of government agencies and health insurance companies to improve their efficiency and effectiveness (Hasman and Albert, 1997). To assist healthcare professionals to achieve such efficacy, a great deal of money is spent to develop health information systems. Healthcare informatics has the potential to improve communication, and management of health information, which are the underlying ingredients of healthcare transformation. Since the lack of understanding of the principles of health informatics prohibits gaining a full advantage of these initiatives, it is increasingly essential that healthcare professionals raise their knowledge level of IT enabled solutions.

To begin, we need to agree on a working definition of Health Informatics (HI). For the purpose of this study we refer to the definition given by National Information Center on Health Services Research and Health Care Technology (NICHSR), which defines health informatics as "the interdisciplinary study of the design, development, adoption and application of IT-based innovations in healthcare services delivery, management and planning" (Procter, 2009). From this definition we can deduct that it is a discipline at the intersection of information science, computer science, and health care. Today, however, as technology and the volume, velocity, and variability of available data in healthcare is evolving, the discipline has embraced the notions of big data and analytics as well as decision support systems and electronic medical records. These concepts and their enabling technologies facilitate information driven decisions in healthcare sector.

As it is the case for all new concepts, there is a variation over the terminologies related to health care and technology. Google trend, based on google search, identifies and ranks the following terminologies as of August 2013 (Figure 1).

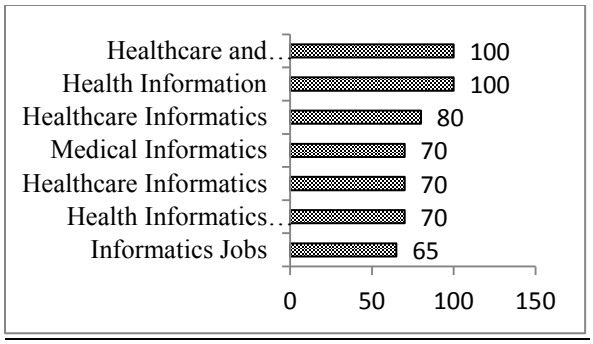

Figure 1. Google Trend for Most Cited Terminology on Healthcare and Informatics

An interesting observation is the inclusion of 'health informatics jobs' in the listing. The inevitability of technology in healthcare management has captured public attention and it is now the norm, not the exception, that healthcare staff, regardless of their positioning, clinical or non-clinical (administrative), need an additional layer of training for effective job performance. The traditional skills, offered by current curricula, consisted of managerial and leadership, team building, problem solving, communications, and project management. The additional layer focuses around technology and includes the knowledge of healthcare information systems, understanding of healthcare and information systems regulatory and audit requirements, and understanding of clinical applications and processes, each of which could be divided down to more details and more specific skills. The question is what is being done to fill the skill gap between traditional and new requirements appropriate in the information age, where data and information discovery and management are the key ingredients of decision making.

To have a better understanding of public interest in health informatics and related jobs we turned to Google trend again. Although not a scientific approach, this very realistic measure indicates the level of interest by the public for various concepts. We used this capability in the context of health informatics and results are displayed in Figure 2. The horizontal axis represents time (starting from 2004), and the vertical is used to assess the level of interest for 'health informatics' over time.

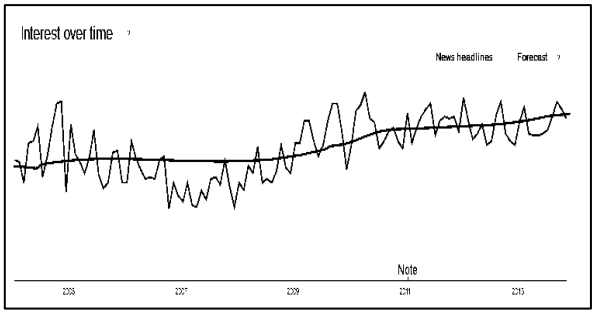

Figure 2. Google Trend for Public Interest in Health Informatics over Time (2004-2013)

We inserted a trend line, which shows an upward movement indicating an increasing interest in the concept of 'health informatics.' The graph's interactive capabilities allow allocating highs and lows over time.
http://www.google.com/trends/explore?q=health+informatics#q=health+informatics&cmpt=q&geo=US

The regional interest is conveyed through a map (Figure 3) where seven states with highest index numbers are Maryland, Georgia, Indiana, North Carolina, Missouri, Tennessee, and Oregon followed closely by Massachusetts with an index of 59.

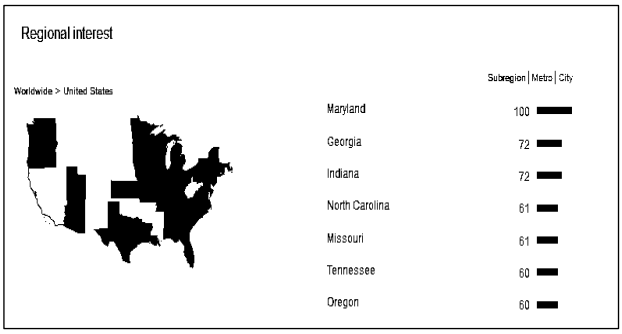

Figure 3. Regional Interest in Health Informatics

This map is indeed interesting when compared to the percentages of universities offering programs in healthcare informatics in each state, which underlines whether public interest in healthcare informatics has an impact on the number of universities in the region offering programs in HI. According to our sample data Florida, New York and Pennsylvania have the most institutions with health informatics programs followed by Massachusetts, Ohio, and Tennessee. Assuming that number of searches is an indication of the level of interest, it seems that other factors than public interest, are determinants for offerings by the higher education. This is loosely consistent with reports from the office of national coordinator for health information technology (ONC) that despite the level of public interest in health informatics and an evidence of its numerous benefits, its use is limited mainly for the lack of basic skills and knowledge of HI and the limited use of IT in the healthcare sector (Buntin et al., 2011).

Similarly, a study by the International Medical Informatics Association (IMIA) presents increasing evidence that health information technology (HIT) improves health, health care, public health, and biomedical research (Mantas et al., 2010). The study confirms that "the growth of HIT has also led to the recognition of the need for educational programs to train professionals to develop, implement, and evaluate these systems (Hovenga and Mantas, 2004). Following IMIA efforts, an article published in Australian Health Review (Garde et al., 2006) outlines health informatics skills that are perceived by health professionals as requirements to enable them to function properly in their jobs. The authors of the article conclude that pro-active development and management of health informatics education is essential for higher quality and efficient patient care (Garde et al., 2006).

While the need for education in health informatics has been recognized in other parts of the world such as Europe (Hasman, 1995; Moehr, 2006; Haux et al., 2006; Stamouli et al., 2012), New Zealand (Norris and Brittain, 2000), and Australia (Prideaux, 2003; Garde et al., 2005), the United States has been slow to catch up with the movement. There are quite a few articles that address the lack of health informatics competency in the healthcare workforce (Yasnoff et al., 2001; Hersh, 2008; Nagle 2013), but very few take a comprehensive look at the efforts by the higher education to address this deficiency. Exceptions are those studies that focus on informatics as required competencies for nurses (Travis and Brennan, 1998; Gassert, 2008; Hart, 2008; McNeil and Odom, 2000; McNeil et al., 2005; Staggers et al., 2002; Westra and Delaney, 2008; Barton, 2005) and bio medical informatics (Huang, 2007; Hersh, 2009; Hersh 2010; Hoffman and Ash, 2001). Murdoch and Detsky (2013) address the contribution of non-clinical informatics to quality improvement and cost control in public health.

The big data phenomenon, a driving force in so many fields, has arrived in healthcare, and is evident by the explosive growth of clinical and non-clinical applications. To use this wealth of data in healthcare industry, healthcare staffs both from clinical and non-clinical sides need the appropriate kind of education and training that involves the use of technology. The question remains whether the educational system is aware of such need and what is being done about it. This study addresses that question by taking a comprehensive look at the offerings by universities and community colleges (both online and offline) and examines the curricula at different levels from certificates to undergraduate to graduate including MBA and doctoral programs. We drill down to courses descriptions offered by different educational institutions and explore their relevance to actual needs as expressed in the existing literature.

An analysis of the extent to which educational system is responding to health care reform helps healthcare professionals as well as academics to have a better view of the landscape of health informatics in terms of skills needed versus offerings by academe. This study aims towards such understanding and is supported by data collected on offerings on healthcare education with an emphasis on informatics. Finally, we make recommendations for actions that academia can take to assure that public health professionals have the knowledge, tools, and training to advance the mission of public health.

The organization of this paper is the following. Section 2 provides a summary of the relevant work in the area of healthcare today. Section 3 describes the role of big data and analytics in healthcare informatics. Section 4 relates academia to healthcare informatics. Section 5 looks at our sample data and provides tables and charts to summarize our findings. Section 6 is our conclusion and suggestions for further research.

2. LITERATURE REVIEW: TECHNOLOGY AND HEALTHCARE

Can health Informatics substantially improve health care delivery or is it a fad? The literature review reveals a stream of research emphasizing the role of health informatics to assure a holistic approach to healthcare management. It has been argued that having access to "big picture," rather than piecemeal approach to healthcare management is a necessity as it eliminates redundancy and reduces cost while allowing healthcare providers to make better medical decisions – ultimately leading to better patient care.

Burke and Ingraham (2008) note that the healthcare providers are struggling with consumer-directed healthcare and access to quality and cost metrics while focusing on compliance with evidence-based care protocols. They add that in the middle of this ecosystem there is a flood of information, which is expanding exponentially. Healthcare providers and payers need to make informed decisions by having insights into re-imbursements, utilizations and staffing, capital management, and many other related areas. The healthcare industry continues to capture more and more data, yet, discovering the value hidden in an organization's diverse and distributed data is an ongoing challenge.

The information overload in healthcare sector is no secret. However, without incorporating all relevant data, across-the-board improvements would be difficult at best. Byrnes (2012) addresses the well-known fact that executive teams, in every industry, are struggling with too much information. He suggests using technology to create electronic reports that include composite measures, or roll ups, for executives in the healthcare sector while providing actionable and more detailed information to the front line health work force. Coddington and Moore (2012) write about decision-support systems that are typically fed data from cost accounting systems, electronic health records, and other sources. Figlioli (2011, pp. 150) contends that "The bottom line is that the technologies needed to better manage patient information exist. We need to use these technologies to shape and use our data to make actionable insights that improve outcomes and lower costs for each individual."

Frye (2010) reports on using technology to build optimal decision support. He advocates the use of business intelligence in healthcare to track, benchmark, and continually adjust in order to achieve an optimal rate of return and not to lag behind advances in technology, diagnoses and treatment. Ghosh and Scott (2011) conducted a case study to address antecedents and catalysts for developing a healthcare analytic capability. Their work was based on interviews with clinical and administrative staff and how the Veterans Health Administration (VHA) effectively aggregated medical records from multiple care facilities to build a reliable analytic capability. Giniat (2011) and Glaser and Stone (2008) argue for the use of data analytics as a key discipline for healthcare finance. Giniat contends for analytics to improve operational performance, ensuring effective management of operations, gaining efficiencies and reacting to surrounding conditions more quickly, and projecting the future or trends. Mettler and Vimarlund (2009) suggest "In today's fast changing healthcare sector, decision makers are facing a growing demand for both clinical and administrative information in order to comply with legal and customer-specific requirements."

To summarize, all these studies emphasize the need for use of technology not only in clinical, but also non-clinical aspect of healthcare. This goes beyond doctors, nurses, lab

technicians, and pharmacists and includes a vast segment of people employed in the health care sector who need training in handling big data that exists in healthcare.

3. BIG DATA IN CLINICAL AND NON-CLINICAL HEALTH INFORMATICS

Over the past few years, analytics and Big Data have been used in more and more areas, from the Presidential election of 2012 to driving improved business intelligence for pharmaceutical companies and healthcare organizations. Big data refers to the use of specialized tools and techniques to understand and distill meaningful insights of massive amounts of information (Salon, 2013). Big data represents not only volume, but also complexity, variability, and velocity; three important characteristics of data in healthcare. Analytics is the process of pulling useful information from data and turning it into useful knowledge with a wide range of uses in healthcare, it is a particularly useful tool to track the quality of care in a patient population. It is also the impetus for clinical decision support, which enables physicians to make better informed decisions about the care they provide.

A report by McKinsey & Company (Groves et al., 2013), underscores the two major areas where big data is revolutionizing health care; one area with clinical impact is to use big data to build a "decision support system" that health care providers can use to evaluate their proposed treatments. The other area, the non-clinical side, uses big data in the areas of reimbursements, utilization and staffing, capital management, emergency care spending and many other areas to change the health system in such a way to help reduce the mounting costs of healthcare delivery.

Consistent with this view, Hasman (1995) and Hasman and Albert (1997), early believers in the necessity of educating and training in healthcare informatics, suggest that health informatics systems help two groups of healthcare staff: those that are in direct contact with the patients such as doctors, nurses, dentists, pharmacists, radiologists, pathologists, and technicians; and administrative staff ranging from hospital clerks to health administrators and policy makers. For an effective healthcare delivery these two groups have to communicate effortlessly and continuously, which is only achieved when the right data is available to the right people at the right time.

For the academia to offer curricula in health informatics, there must be a clear understanding of where, when, and for whom IT competency is a required job description.

Two separate but related aspects to healthcare informatics should be identified: clinical and non-clinical (administrative). Both areas involve resources, devices, and methods to optimize the acquisition, storage, retrieval, and use of information in health care industry.

However while technology can be the same, the data sources, users, and objectives are different. Table 1 illustrates these differences and the required technology used by the two.

	Clinical Informatics	Non-clinical Informatics
Data source	Medical images, Bio-medical, clinical trials, medical records	Medical records, financial records, administration records
Users	Health professionals, responsible for patient care delivery	Administrative staff, involved in healthcare management
Objectives	Facilitates diagnosis, treatment, and research	Facilitates communications, collaboration, administration, and management
Technology	Databases, data warehouses, data mining, data standards, decision support, networking and telemedicine	

Table 1: Similarities and Differences between Clinical and Non-Clinical Informatics

People trained in clinical informatics help transform health care by analyzing, designing, implementing, and evaluating information and communication systems that enhance individual and population health outcomes, improve [patient] care, and strengthen the clinician-patient relationship. Skills required are a combination of the knowledge of concepts related to patient care and an understanding of informatics concepts, methods, and tools. According to (Gardner et al., 2009) the goal is to develop, implement, and refine clinical decision support systems, while assessing information and knowledge needs of health care professionals and patients. Clinical processes have to be refined and clinical information systems have to be developed, implemented, managed, evaluated, and continuously improved.

The building block of clinical informatics is medical-based data and primarily deals with information in health care used by medical staff such as physicians and nurses (Gardner et al., 2009; Safran et al., 2009; Morris et al., 2013). It is applied in the areas of , clinical care, dentistry, pharmacy, public health, occupational therapy, physical therapy and (bio)medical research. It involves computers, clinical guidelines, formal medical terminologies, and information and communication systems. To foster patient care that is safe, efficient, effective, timely, patient-centered, and equitable, clinicians should collaborate with other health care and information technology professionals.

The set of skills for clinical informatics constitutes a combination of IT technical knowledge, clinical understanding, and project management experience to represent the typical workload of clinicians. As the nation's healthcare system increasingly relies on electronic data to improve the quality of care, the need for those who use technology to support the management of information within an organization, is becoming increasingly critical at healthcare organizations. Informatics has become increasingly integrated into the management of clinical care and those who master the art of combining patient care with health IT skills are in a better position to demand more pay,

expand their growth potential and become an integral part of a growing dynamic health organization.

Health informatics also refers to using technology to communicate, manage knowledge, mitigate error, and support decision making (Bates et al., 2001; Greiner and Knebel, 2003). For the purpose of this paper, we call this non-clinical or administrative health informatics. This branch will focus on consumer health informatics, Electronic health records, computerized provider order entry, Information system planning and project management, privacy, confidentiality, and data security, Information integration and knowledge management. Non-clinical health informatics is an emerging field that requires a workforce that has adequate expertise both in IT and an understanding of healthcare. Evidence-based care, data mining, data warehouse, information integration, and knowledge management are the necessary requirements for both clinical and non-clinical health informatics.

The need for programs of different scopes to help lead the transformation of healthcare by providing a new generation of professionals trained in health informatics is not a new concept, although the focus has shifted. Decades ago the need for a body of knowledge focused on the science of generating and handling electronic health and medical records was well established (Browman, 2000; Iakovidis, 1998; Grimson, 2001). The irony is that at that time there was a belief that electronic information systems would be an answer to the bottleneck problem of paper-based business processes in healthcare. The reality of today is that valuable data assets are stored in electronic silos and across the organizations and possibly not used to their fullest capacity. This veracity leads to the conclusion that creating electronic health records while necessary was not a sufficient condition to improve healthcare delivery. Healthcare personnel must have the training and know-how to use technology to gain a holistic view of healthcare processes. The urgent need for training and education in both areas of clinical and non-clinical informatics with the ultimate goal of gaining insight to improve care and cost management is fast approaching. The next section explores the relationship between academia and the growing need in this area.

4. ACADEMIA AND HEALTH INFORMATICS

The higher education, by the virtue of its mission 'a catalyst for change' has the obligation to demonstrate the understanding of the educational needs of the nation and offer curricula of value to student population. It is the business of the educational sector to deliver programs that cover a wide variety of targets aimed at "building of educational, cultural, social and economic structures that will allow every individual to achieve his or her full human potential and contribute to the greater good of the community and the nation" (DiverseEducation, 2013). At this time of great concern for healthcare reform and its impact on the wellbeing of every individual, what better contribution than providing programs in healthcare that meet standards of quality equivalent with the benefits it promises.

Demand for skills in health care informatics, both clinical and non-clinical is on the rise. While other types of IT jobs are being outsourced, health care informatics specialists continue to hold positions in the U.S. due to the complex nature of the field, in general, and the high level of contact required between the informatics specialist and the supervisors, in particular. Burning Glass, a Boston-based labor market analytics firm partnered with the Education Advisory Board, a membership-based research company, used data from online job postings, and reported that jobs in the field of health informatics continues to rise. Since 2007, postings for health informatics jobs have increased 10 times faster than healthcare jobs overall. The study found that healthcare informatics includes a range of positions that involve the collection, handling and processing of clinical information for a variety of purposes, from billing to medical quality assurance. The progress towards the implementation of electronic health records and other IT projects that require frontline healthcare workers with IT skills to participate in a growing number of IT projects has poised healthcare workforce with informatics skills to expand their role at healthcare organizations.

The interest in healthcare and technology is spreading rapidly and the academia has been trying to keep up with the demand by providing all sorts of programs to accommodate the variety of potential students, which ranges from high school graduates to IT and healthcare professionals. The demand for Health care informatics specialists who can work in a variety of environments, including hospitals, clinics, healthcare and public health agencies, information technology firms, research institutes, and the insurance industry offers substantial opportunities for educators and training providers who can offer IT training to health care professionals and clinical training to IT professionals. A wide variety of career options in health care informatics provides a broad overview of some of the possible career paths that are available. According to the sixth annual Millennial Career Survey, published May 2013, 13 by the National Society of High School Scholars, an international honor society organization based in Atlanta, Healthcare and technology jobs have the most appeal to Generation Y. Generation Y, also known as millennials, are generally described as the 50 million people now between ages 18 and 30, the children of baby boomers or older members of Generation X. Millennials' interest to have real-world impact is manifested by the results of the survey that places healthcare organizations among the top 25 choices, which also included well-known brands such as Disney, Starbucks and Abercrombie & Fitch, as well as a few government agencies. Health Care Informatics is a rapidly expanding field with excellent career prospects. Job security is one positive aspect of a career in health care informatics.

The robust job market and the inclinations of millennials to enter the field provide a reasonable ground for higher education to offer relevant programs in health informatics. This study examines the contributions of educational system in the USA to address the need for programs of different scopes to help lead the transformation of healthcare.

To have a better understanding of the educational offerings in the field of Health Informatics, we focused on higher education and looked at the wide variety of educational institutions at the national level. The data was gathered from various sources including those accredited by government such as the Council on Education for Public

Health. Search engines such as google were used to expand the coverage of the study. Three Graduate students were assigned to the task of going over all the listings and carefully eliminate redundancies. They checked independently for accuracy and integrity of collected information. Two professors re-checked each student's results for validation of the data. After comparing findings and eliminating redundancies, there were 226 institutions left. The first step was to separate programs that dealt with policy and procedures of the management of healthcare from programs on health informatics, where the focus is on the use of technology in healthcare delivery. In our sample of 226 academic institutions, 128 offered programs in health informatics and 98 in healthcare management covering non-technical issues such as Leadership, policy, quality assurance, global, ethics and more.

This study is focused on health informatics, therefore, from here on all the data analysis is based on 128 institutions with programs in health informatics. To have a comprehensive view of the levels of the offerings, we started with separating the institutions based on their funding; public or private. We then looked at a variety of health informatics programs offered by these institutions from certificates to PhD programs- we considered both online and offline programs. We explored and distinguished two types of health informatics programs: clinical and non-clinical. We considered types of institution including community college, four-year universities, as well as online universities. To find out the relevance of the programs offered to concepts of healthcare transformation as we understood and discussed in this paper was the most interesting and challenging part of the study. To achieve this goal we investigated course contents by the type of programs such as undergraduate, graduate, certificate, and PhD and analyzed the description of courses. Finally we looked at the concentration of the universities offering programs in health informatics in 50 states and created a bar chart with the percentages of universities in each state. The results of our finding are illustrated in the next section and are interesting and, at times, surprising.

5. OUR FINDINGS

A careful study of 128 institutions responding to the need for providing education and training in health informatics skills revealed that there were 70 public universities, 58 private institutions offering programs in healthcare informatics. Figure 4 shows the percentages.

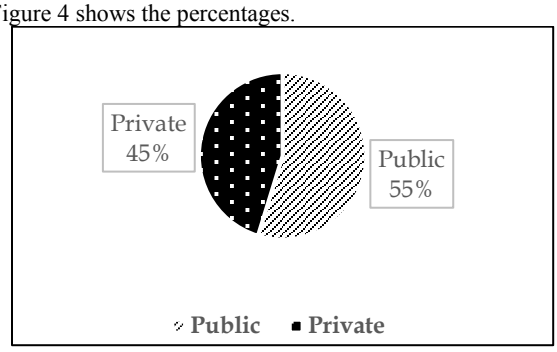

Figure 4. Percentages of Public versus Private Institutions Offering Programs in Healthcare Informatics

According to our sample data, there are almost equal percentages of private and public institutions offering programs in health informatics, which indicates equal participation to improve public health from both sectors.

One aspect of this study has been on the distinction between clinical and non-clinical (administrative) health informatics serving two different types of users (medical and administrative staff). Accordingly, it would be interesting to find the percentage of clinical versus non-clinical programs in health informatics. Surprisingly the differences are remarkable; 15 clinical, 83 non-clinical and 21 institutions offer both. We could not find sufficient information for 9 universities to determine whether the offerings were clinical or non-clinical informatics. One possible reason could be the new surge in developing health informatics programs and the difficulty of incorporating specialized and rather difficult knowledge in medical informatics.

Next we focused on curricula; three major categories were identified: undergraduate, graduate (including Ph.D., Masters, and MBA), and certificates (for both grad and undergrad). Our purpose was not only to find out the variety of the programs offered, but also the depth and the perceived trajectory for health informatics in education. For example, certificates are usually short term and may be discontinued once the interest disappears, whereas Ph.D. programs indicate the belief that the discipline is here to stay, i.e., educating the future generation of students.

Out of 128 institutions, 16 universities offer an undergraduate degree in health informatics, 72 have Masters programs, 17 have MBA specialization, and 13 offer Ph.D. programs. Among universities offering certificates, 48 offer graduate and 12 offer undergraduate certificates. There were 12 institutions offering some sort of program in HI that could be classified in any of the traditional categories. The concentration of programs at Masters level could suggest strong demand for continuous professional development where undergraduate education is augmented by a Masters degree in health informatics. This pattern can be also observed in certificates, where the number of graduate certificates is four times as much as undergraduate programs. A bar chart with percentages (Figure 5) provides a better basis for the comparison.

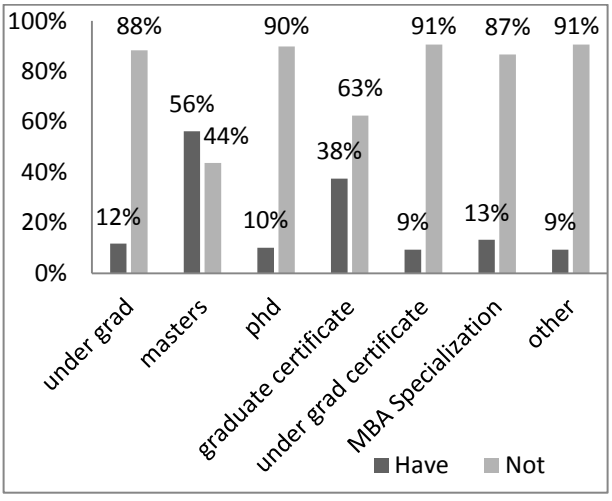

Figure 5. The Percentages of Programs in HI

Educational institutions usually offer programs to accommodate their constituencies, to gauge this interest; we looked at the type of institutions offering health informatics as part of their curricula. We distinguished the institutions by their types: four year universities, community colleges, and online universities. Among four year universities we identified those with PhD and or MBA programs. Since universities affiliated with the hospitals should have a special interest in offering programs in healthcare informatics, we wanted to identify the number of these universities to confirm this assumption. Table 2 illustrates these findings.

	Community College	**4- years university**	**University with MBA**	**University with Ph.D.**	**Online University**	**Hospital Affiliated**
Programs	13	31	105	78	61	48

Table 2. Number of Different Types of Educational Institutions Offering Health Informatics.

Obviously there is a great deal of overlap, for instance universities granting PhD had 78 program in all levels including undergraduate, graduate and PhD. Community colleges granting associate degree offer 13 programs. Four-year universities without any graduate studies are offering 31 programs in healthcare informatics. Universities with only MBA or/and master programs have the highest number of offerings of 105. Online universities offer 61 programs in both undergraduate and graduate levels. Hospital affiliated universities offer 48 programs in total. At this point we wanted to have an overall impression of the range of higher level educational systems covering health informatics. However, further research with a different focus could and should categorize the institutions and their offerings with more details.

Another inquiry was about the course content. Two faculty supervised graduate students to search posted course descriptions from different programs and classified the courses into three categories: core knowledge, technology, and clinical. Courses with bio-medical, elements such biostatistics and epidemiology were considered as clinical courses. Courses usually taught by computer science and/or information systems department, where technology was a core element, was considered 'technology courses.' Core knowledge courses provided the context for a health informatics program. It must be noted that some of core knowledge courses had some technology, but technology was not the major aspect of the course.

For the sake simplicity, for course content, we separated the institution into only two major categories. Table 3 shows that 390 of the courses included in four year degrees including undergraduate and graduate programs focus on other aspect of health informatics rather than technology or clinical issues, 313 courses focus on technology, and only 66 courses have clinical emphasis. Certificates emphasis on technology is greater than core knowledge, which makes sense since certificates are lighter offerings with less general information focus. Our findings are summarized in Table 3.

	Core Knowledge	Technology	Clinical	Total
Undergraduate and Masters	390	313	66	769
Certificates: Online and offline	132	147	35	314

Table 3. Number of Courses with Different Focus

Next attempt was to dig further to find different topics covered as core knowledge. Again two professors independently supervised the search in order to identify the six topics of interest; cost, quality, policy, research, security and privacy, and standards. Table 4 illustrates the number of times these topics appeared on course descriptions for either of four –year degree programs or certificates.

	Cost	Policy	Quality	Research	Security/ Privacy	Standards
Four year degree Undergraduate and Master	13	31	36	156	49/16 (7)	22
Certificates: Offline and online	9	10	30	42	30/11	26

Table 4. Frequency of Topics Appeared on Course Descriptions

According to these findings 'research' is the most frequently cited word and cost is the least for both four-year degree programs and certificates. At the undergraduate and master levels forty nine Courses addressed the issue of security and 16 the issue of privacy and seven covered both. Certificate programs (both online and offline) covered security issues in 30 courses, whereas privacy was mentioned in 11 courses.

We continued our cursory investigation to get a sense of offerings in PhD programs. In that spirit, Table 5 shows the breakdown of Ph.D. offerings, which is quite different from the undergraduate focus. Five Ph.D. programs are on health informatics, two are biomedical (clinical) and one is Health administration with five out of thirteen were not identified due to the lack of posted courses.

	Health Admin	Health Informatics	Clinical	Total	NA
Ph.D.	1	5	2	13	5

Table 5. Ph.D. Programs on Health Care Area

In order to determine the depth and breadth of the programs, we embarked on examining the number of courses for each type of programs. The results are shown in Table 6.

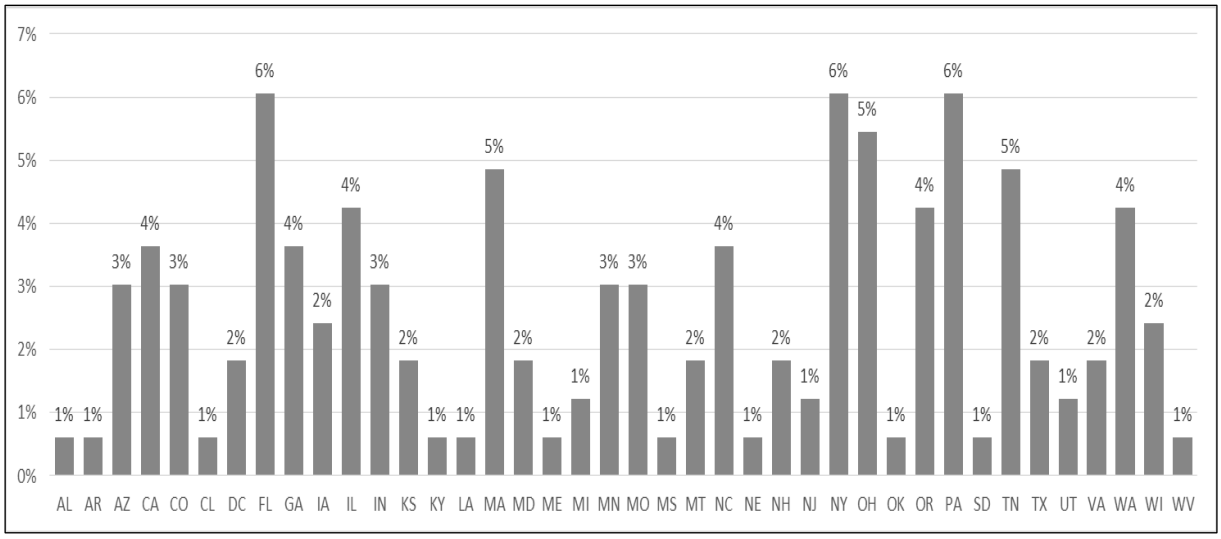

Figure 6. Percent of Institutions Offering Health Informatics in Different States

Category	Under-graduate	Masters and MBA	Under-graduate and Graduate Certificate	Other
1 to 3	13	57	41	2
4 to 6	3	14	6	2
7 to 9	0	5	7	1
More than 9	0	3	0	0
Total	16	73	54	5

Table 6: Number of Courses in HI Programs

Most of the programs offered 1-3 courses in health informatics, which falls short of providing enough knowledge in the field. Our assumption is that offerings are at the early stages of development with limited instructors qualified to teach. The large number of Master programs offering only three courses on health informatics indicates that other courses are required to complete the program, which is usually the case for any MBA degree. Undergraduate programs might be still in a development stage and not be able to offer more than three courses. Certificates are usually short term programs to equip students with a focus on one topic.

Since there have been different reactions from states to healthcare reform, we decided to see if there is a pattern for embracing higher education in health informatics by region. Figure 6 summarizes the concentration of the institutions offering health informatics in the USA.

According to this bar chart Florida, New York and Pennsylvania have the higher concentration (6%) of institutions with health informatics programs. Massachusetts, Ohio, and Tennessee come second with 5%, and California, Georgia, Illinois, North Carolina, Oregon, and Washington State come third with 4%.

Overall, these finding underscores the attempt to fill the gap in terms of supply and demand for healthcare informatics and educational institutions all over the state are responding to public interest in the field and responding to them by offering programs at all levels.

6. CONCLUSION AND LIMITATIONS

This study examines health informatics and its role to transform healthcare delivery. Health informatics constitutes data collection and processing with the goal of generating information and knowledge and providing solutions using the generated knowledge. For decades, hospitals, researchers, and government agencies have diligently collected a huge variety of health data including data from clinical trials, medical procedures, medical expenses, patient demographic information, and even the wait time in emergency rooms. Big data assembles all this information together from many different sources, stores them in one place, and eventually, use them to gain insights as how to improve our health care systems. Health informatics embraces big data and requires a new set of skills to process them. In this study we first examined the information technology skills needed for health informatics and discussed higher education's response to satisfy such needs.

The data collected on program offerings helps to have a cursory look and get a sense of the scope of tertiary education in HIT. It can also provide an initial understanding of competencies yet to be included in educational offerings. Based on our findings, there are courses that foster using technology to collect, manage, analyze big data in healthcare. But we could not find enough evidence to conclude the existing courses contain the needed content, the programs are cohesive, and the users are clearly identified.

The remaining questions include: what patient information needs to be collected and categorized, who would be the users of these information, what are specific goals of health information analysis, what are the appropriate technology to achieve the goals, what measures of quality control can be applied, what are the ethical issues

involved. To address these questions, future investigation with more scientific approach such as content analysis is needed to have an in depth examination. This study, however, is a good start for discussion on the topic that has not been explored before and the first step for more in-depth analysis.

7. REFERENCES

Barton, A. J. (2005). Cultivating Informatics Competencies in a Community of Practice. *Nursing Administration Quarterly*, 29(4), 323-328.

Bates, D., Cohen, M., Leape, L., Overhage, J. M., Shabot, M. M., & Sheridan, T. (2001). Reducing the Frequency of Errors in Medicine Using Information Technology. *Journal of the American Medical Informatics Association*, 8(4), 299-308.

Browman, G. P. (2000). Improving Clinical Practice Guidelines for the 21st Century. *International Journal of Technology Assessment in Health Care*, 16(4), 959-968.

Buntin, M. B., Burke, M. F., Hoaglin, M. C., & Blumenthal, D. (2011). The Benefits of Health Information Technology: A Review of the Recent Literature Shows Predominantly Positive Results. *Health Affairs*, 30(3), 464-471.

Burke, J. & Ingraham, R. (2008). Path to Insight. *Health Management Technology*, 29(9), 12-14.

Byrnes, J. (2012). Driving Value: Solving the Issue of Data Overload with an Executive Dashboard. *Healthcare Financial Management: Journal of the Healthcare Financial Management Association*, 66(10), 116-118.

Coddington, D. C. & Moore, K. D. (2012). Integrating Physician Perspectives into Business Intelligence. *Healthcare Financial Management: Journal of the Healthcare Financial Management Association*, 66(6), 158-160.

Diverseeducation (2013). Diverse Issues in Higher Education. Retrieved October 10, 2014, from http://diverseeducation.com/about-us/our-mission/#.

Figlioli, K. (2011). Closing the Healthcare Communication Gap. *Healthcare Financial Management, Inside IT*. Retrieved September 30, 2011, from http://www.hfma.org/Content.aspx?id=3082.

Frye, G.W. (2010). Using Business Intelligence to Build Optimal Decision Support. *Benefits & Compensation Digest*, 47(2), 17-21.

Garde, S., Harrison, D., & Hovenga, E. (2005). Skill Needs for Nurses in their Role as Health Informatics Professionals: A Survey in the Context of Global Health Informatics Education. *International Journal of Medical Informatics*, 74(11), 899-907.

Garde, S., Harrison, D., Huque, M., & Hovenga, E. J. (2006). Building health informatics skills for health professionals: results from the Australian Health Informatics Skill Needs Survey. *Australian Health Review*, *30*(1), 34-45.

Gardner, R. M., Overhage, J. M., Steen, E. B., Munger, B. S., Holmes, J. H., Williamson, J. J., & Detmer, D. E. (2009). Core Content for the Subspecialty of Clinical Informatics. *Journal of the American Medical Informatics Association*, 16(2), 153-157.

Gassert, C. A. (2008). Technology and Informatics Competencies. *Nursing Clinics of North America*, 43(4), 507-521.

Ghosh, B. & Scott, J. E. (2011). Antecedents and Catalysts for Developing a Healthcare Analytic Capability. *Communications of the Association for Information Systems*, 29(1), 395-410.

Giniat, E. J. (2011). Using Business Intelligence for Competitive Advantage. *Healthcare Financial Management: Journal of the Healthcare Financial Management Association*, 65(9), 142-144.

Glaser, J. & Stone, J. (2008). Effective Use of Business Intelligence. *Healthcare Financial Management: Journal of the Healthcare Financial Management Association*, 62(2), 68-72.

Greiner, A. C. & Knebel, E. (Eds.). (2003). *Health Professions Education: A Bridge to Quality*. National Academies Press.

Grimson, J. (2001). Delivering the Electronic Healthcare Record for the 21st Century. *International Journal of Medical Informatics*, 64(2), 111-127.

Groves, P., Kayyali, B., Knott, D., & Van Kuiken, S. (2013). The 'Big Data' Revolution in Healthcare. *McKinsey Quarterly*.

Hart, M. D. (2008). Informatics Competency and Development within the US Nursing Population Workforce: A Systematic Literature Review. *Computers Informatics Nursing*, 26(6), 320-329.

Hasman, A. (Ed.). (1995). *Education and Training in Health Informatics in Europe: State of the Art, Guidelines, Applications* (Vol. 25). IOS Press.

Hasman,A. & Albert, A. (1997). Education and Training in Health Informatics: Guidelines for European Curricula. *International Journal of Medical Informatics*, 45(1), 91-110.

Haux, R., Ammenwerth, E., Haber, A., Hubner-Bloder, G., Knaup-Gregori, P., Lechleitner, G., & Wolff, A. C. (2006). Medical Informatics Education Needs Information System Practicums in Health Care Settings - Experiences and Lessons Learned from 32 Practicums at Four Universities in Two Countries. *Methods of Information in Medicine*, 45(3), 294-299.

Hersh, W. (2008). Health and Biomedical Informatics: Opportunities and Challenges for a Twenty-First Century Profession and its Education. *Yearbook of Medical Informatics*, 157-164.

Hersh, W. (2009). A Stimulus to Define Informatics and Health Information Technology. *BMC Medical Informatics and Decision Making*, 9(1), 24-30.

Hersh, W. (2010). The Health Information Technology Workforce: Estimations of Demands and a Framework for Requirements. *Applied Clinical Informatics*, 1(2), 197-212.

Hoffmann, S. & Ash, J. (2001). A Survey of Academic and Industry Professionals Regarding the Preferred Skillset of Graduates of Medical Informatics Programs. *Studies in Health Technology and Informatics*, 2, 1028-1032.

Hovenga, E. J. & Mantas, J. (Eds.). (2004). *Global Health Informatics Education (Vol. 109)*. IOS Press.

Huang, Q. R. (2007). Competencies for Graduate Curricula in Health, Medical and Biomedical Informatics: A Framework. *Health Informatics Journal*, 13(2), 89-103.

Iakovidis, I. (1998). Towards Personal Health Record: Current Situation, Obstacles and Trends in Implementation of Electronic Healthcare Record in Europe. *International Journal of Medical Informatics*, 52(1), 105-115.

Mantas, J., Ammenwerth, E., Demiris, G., Hasman, A., Haux, R., Hersh, W., & Wright, G. (2010). Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics–1st Revision. *Methods of Information in Medicine*, 49, 105-120.

McNeil, B. J. & Odom, S. K. (2000). Nursing Informatics Education in the United States: Proposed Undergraduate Curriculum. *Health Informatics Journal*, 6(1), 32-38.

McNeil, B. J., Elfrink, V. L., Pierce, S. T., Beyea, S. C., Bickford, C. J., & Averill, C. (2005). Nursing Informatics Knowledge and Competencies: A National Survey of Nursing Education Programs in the United States. *International Journal of Medical Informatics*, 74(11), 1021-1030.

Mettler, T. & Vimarlund, V. (2009). Understanding Business Intelligence in the Context of Healthcare. *Health Informatics Journal*, 15(3), 254-264.

Moehr, J. R. (2006). Where to in the Next Ten Years of Health Informatics Education? *Methods of Information in Medicine*, 45(3), 283-287.

Morris, T. L. & Hancock, D. R. (2013). Institute of Medicine Core Competencies as a Foundation for Nursing Program Evaluation. *Nursing Education Perspectives*, 34(1), 29-33.

Murdoch, T. B. & Detsky, A. S. (2013). The Inevitable Application of Big Data to Health Care. *JAMA*, 309(13), 1351-1352.

Nagle, L. (2013). Making Informatics Competency Development Explicit. *Online Journal of Nursing Informatics (OJNI)*, 17(1), available at http://ojni.org/issues/?p=2382.

Norris, A. C. & Brittain, J. M. (2000). Education, Training and the Development of Healthcare Informatics. *Health Informatics Journal*, 6(4), 189-195.

Prideaux, D. (2003). ABC of Learning and Teaching in Medicine: Curriculum Design. *BMJ: British Medical Journal*, 326(7383), 268-270.

Procter, R. (2009). Definition of Health Informatics. Retrieved September 15, 2013, from http://www.nlm.nih.gov/hsrinfo/informatics.html.

Safran, C., Shabot, M. M., Munger, B. S., Holmes, J. H., Steen, E. B., Lumpkin, J. R., & Detmer, D. E. (2009). Program Requirements for Fellowship Education in the Subspecialty of Clinical Informatics. *Journal of the American Medical Informatics Association*, 16(2), 158-66.

Salon. (2013). Big Data Improves Health Care. Retrieved September 15, 2013, from http://www.salon.com/2013/09/09/big_data_improves_health_care/.

Staggers, N., Gassert, C. A., & Curran, C. (2002). A Delphi Study to Determine Informatics Competencies for Nurses at Four Levels of Practice. *Nursing Research*, 51(6), 383-390.

Stamouli, M. A., Balis, C., & Apostolakis, I. (2012). Integration of Informatics and Health Informatics into Health Educational Programs of Higher Education in Greece. *EJBI*, 8(1), 8-15.

Travis, L. & Brennan, P.F. (1998). Information Science for the Future: An Innovative Nursing Informatics Curriculum. *The Journal of Nursing Education*, 37(4), 162-168.

Westra, B. L. & Delaney, C. W. (2008). Informatics Competencies for Nursing and Healthcare Leaders. In *AMIA Annual Symposium Proceedings* (Vol. 2008, p. 804). American Medical Informatics Association.

Yasnoff, W. A., Overhage, J. M., Humphreys, B. L., & LaVenture, M. (2001). A National Agenda for Public Health Informatics Summarized Recommendations from the 2001 AMIA Spring Congress. *Journal of the American Medical Informatics Association*, 8(6), 535-545.

AUTHOR BIOGRAPHIES

Noushin Ashrafi is a professor of Management Information Systems at the University of Massachusetts-Boston. Her areas of expertise are in Business Intelligence, Object-Oriented System Analysis and Design, and health informatics. She has conducted seminars in agility and business intelligence in the U.S.A and abroad.

Jean-Pierre Kuilboer is an associate professor in the Management Science and Information Systems Department at the University of Massachusetts Boston. Dr. Kuilboer's research interests are in the area of business Intelligence, computer forensics, information security and privacy, database management.

Chaitanya Joshi is a graduate student at the University of Massachusetts Boston. He is currently working as a Financial Analyst with Partners Healthcare. His research interests include Healthcare Investment opportunities & Health Informatics.

Iris Ran is a research assistant at the University of Massachusetts Boston. She has dual master degrees of Finance and Management Information Systems Her research interests include International Finance, Portfolio Investment, Healthcare Informatics, and Data Analysis and Business Intelligence.

Priyanka Pande is a graduate student at the University of Massachusetts Boston. She works as the Programs Co-ordinator with Barakat, which is a non-profit organization working for literacy in Pakistan and Afghanistan. Her interests lie in the area of marketing and market research.