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The Landscape of Healthcare Informatics Programs in the United States: an Updated Survey

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Abstract

Healthcare informatics, also referred to as medical informatics, biomedical informatics, or healthcare information technology, is a field that lies at the intersection of medicine, information systems, and information technology. As a relatively new field, its exact scope has been difficult to pin down, complicating the task of designing educational programs. In 2010, the author conducted a survey of undergraduate healthcare informatics programs in the U.S., in an effort to determine the direction of a new healthcare informatics program at her university. The survey found that undergraduate programs fall into one of two types: accredited health information management programs rooted in management of medical records, and health/medical informatics programs related more closely to computer science, with the former type vastly outnumbering the latter. In 2014, the author collected the data again, looking to see if the landscape of healthcare informatics education had changed. The study was expanded to include master's programs. In this paper, the conclusions of the updated survey are presented.

Keywords: Healthcare informatics curriculum, healthcare information management curriculum, healthcare information technology, healthcare informatics competencies.

1. INTRODUCTION

Healthcare informatics (HCI) is a field attracting a great deal of interest within the computer science and information technology educational community. One of the main reasons is that, due to the adoption of electronic health records and other computer-based clinical systems, there is an increased need for trained IT professionals in healthcare settings. The fact that there is a shortage of such professionals has been noted in a number of reports (CHIME 2012)(Hersh 2010). The American Medical Informatics Association (AMIA) announced the AMIA 10x10 program in 2005, whose goal was to educate 10,000 clinicians in health care informatics by the year 2010 (Hersh & Williamson 2007). A report by the Computing Community Consortium on Information Technology Challenges for Healthcare mentions the need to train "fledgling" computer scientists in the biomedical domain as a critical need (Graham & Estrin 2010). For this reason, educational institutions are ramping up their offerings in the area of healthcare informatics.

A significant challenge is that there is no agreed-upon definition of the fields of health and medical informatics. The landscape of healthcare informatics falls into three subcategories: healthcare information management (HIM), healthcare information technology, (HIT), and healthcare/medical informatics (HCI), but the boundaries are very blurred. William Hersh, who writes extensively on healthcare informatics education, describes HIM as a field which historically focused on medical records but is now increasingly overlapping with healthcare informatics, HIT as the field in which computers and information systems are applied to the healthcare setting (Hersh 2006) and HCI as the field which is concerned with "the optimal use of information, often aided by the use of technology, to improve individual health, health

care, public health, and biomedical research." (Hersh 2009). The Commission on Accreditation for Health Informatics and Information Management (CAHIIM), which accredits HIM programs, defines HIM as focusing "on the skills and competencies in health data management, information policy, information systems, administrative and clinical work flow".(CAHIIM 2014b) They define HCI as focusing on "on information systems, informatics principles, and information technology as applied to the continuum of healthcare delivery." (CAHIIM 2014a).

2. THE ROLE OF THE PROFESSIONAL ORGANIZATIONS

As noted, existing educational programs tend to fall into either the HIM subfield or the HCI subfield. The two main professional organizations also follow this division: the American Health Information Management Association (AHIMA) which represents the interests of the HIM field, and the American Medical Informatics Association (AMIA), which is focused on HCI. AMIA often uses the term medical informatics (MI) instead of healthcare informatics when referring to educational programs (Kampov-Polevoi & Hemminger 2010).

The Commission on Accreditation for Health Informatics and Information Management Education (CAHIM) accredits associate's, bachelor's, and master's degree programs in HIM, and in HCI. The HIM accreditation standard uses knowledge standards developed by AHIMA, and requires that a HIM program have a fulltime director who is a Registered Health Information Administrator. A student who completes a bachelor's level accredited HIM program is eligible to take the exam to become a Registered Health Information Administrator. This is the primary focus of HIM programs. As a result, accredited HIM bachelors programs are all fairly similar in their course offerings. These programs will be analyzed in the next section. The graduate level CAHIIM HCI accreditation standards use knowledge standards developed by several organizations including AMIA, and the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics. There are currently 256 accredited associate's programs, 50 accredited undergraduate programs, 5 accredited HIM master's programs and 4 accredited HCI master's programs. Note, in the rest of this paper, the term CAHIIM accredited program will often be used as a synonym for undergraduate HIM programs, since they are all accredited or pending accreditation. We will use CAHIIM/HI to refer to accredited graduate HCI programs, and CAHIIM/HIM to refer to accredited graduate HIM programs.

The majority of programs at the undergraduate level are accredited HIM programs. While there are HCI bachelor's programs the overwhelming majority of them are at the graduate level. On AMIA's website, there are 61 schools listed that have health or biomedical informatics programs. Of these, 6 schools are listed as offering undergraduate degrees, 41 offer master's degrees, and 36 offer certificate programs (the numbers total more than 61 because some school offer more than one program). The curricula in these programs tends to vary widely, and to contain more computing and information technology content than the HIM programs, which typically have very little computer science content.

There have been a number of attempts to define competencies expected of students graduating from undergraduate healthcare and medical informatics programs. In 2010, the International Medical Informatics Association (IMIA) issued recommendations on healthcare and medical informatics programs which includes bachelor's degree programs (Mantas & Ammenwerth & Demiris & Hasman & Haux & Hersh & Wright 2010). The learning outcomes recommended were in the domains of:

1. **Biomedical and Health Informatics Core Knowledge and Skills**. This includes architectures of information systems in healthcare, regional networking, e-Health, and information processing tools to support healthcare professionals practice, vocabularies, electronic communication, health record design, and information literacy.
2. **Medicine, Bioscience, and Health System Organization,** which includes health system organization and health economics.
3. **Informatics/Computer Science**, which included basic informatics terminology, topics in programming, database systems, system modeling, and spreadsheets, among others.
4. **Optional Modules**, which contains items such as biomedical imaging, bioinformatics and computational

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biology, health-enabling technologies, ubiquitous health systems, health information science, medical chemoinformatics, medical nanoinformatics, medical robotics and public health informatics.

CAHIIM maintains a set of curriculum competencies and knowledge clusters for undergraduate HIM programs (CAHIIM 2012). These competencies fall into the following broad categories:

1. **Health Data Management**, which includes health data structure, content and standards, clinical classification systems, and reimbursement methodologies.
2. **Health Statistics, Biomedical Research, and Quality Management**.
3. **Health Services Organization and Delivery**
4. **Information Technology and Systems**, which includes explicit mention of database concepts and security.
5. **Organization and Management**, which includes human resources management, strategic planning and organizational development.

There is also a list in the document of biomedical science knowledge clusters, including Anatomy, Physiology, Medical Terminology, Pathophysiology, and Pharmacotherapy.

Comparing the two sets of standards, one can see many similarities. The CAHIIM standards include an entire category for management and organizational topics. The CAHIIM standards also emphasize medical coding and reimbursement methodologies, such as payment systems, chargemaster management, and electronic applications for clinical classification and coding. On the other hand, the IMIA competencies explicitly specify programming, which is not mentioned in the CAHIIM standards. As will be seen, these differences are reflected in the organization of the various types of undergraduate programs.

There are a number of career paths for people who are trained in one or more of the HCI areas. The Office of National Coordinator (ONC), which was established to provide a direction for the development of an integrated information infrastructure in healthcare, defines 6 professional roles in healthcare informatics that require training at the university level: a) Clinician/public health leader; b) Health information management and exchange specialists; c) health information privacy and security specialists; d) research and development specialists; e) programmers and software engineers; and f) health information technology sub-specialists (Jacko & Adam & Westra & Witrak & Berkeland & Nelson & LaTour 2010). It is not clear at all what the optimal educational background is for many of these roles and little research has been done on this question (Hersh 2010). The ONC provided funding to develop training for these roles via two types of programs: associates degree programs in community colleges and graduate certificate programs at universities aimed at clinical professionals (ONC). As a result, there has been more growth and interest in HCI programs at either the associate's level or the graduate level.

In the original study (MacKellar 2011), for which data was collected in 2010, 51 bachelors' level programs were identified, using lists on the CAHIIM website, the AMIA website, and by doing Google searches. These programs were analyzed on the following criteria:

- Accreditation status
- Computer Science content, determined by number of required courses in programming, databases, networking, and other computer science courses
- Healthcare information management content, determined by the number of required courses in medical terminologies and coding
- Type of department in which the program is housed.

For the current study, all of the 51 programs websites were revisited, the CAHIIM and AMIA websites were rechecked to identify new programs, and Google searches on keywords such as "healthcare informatics" were run. This time, master's programs were also included because it is clear that education in healthcare and biomedical informatics is largely taking place at this level. Only programs at nonprofit (both private and public) universities and colleges were included, largely because the educational model at for-profit schools can be quite different. In addition, programs in nursing informatics in nursing programs were not included.

3. RESULTS-UNDERGRADUATE PROGRAMS

For this study, 79 undergraduate programs were located and checked. While this would seem to indicate a lot of growth in undergraduate HCI programs, a number of these programs were ones included in the first study which have since closed or converted to master's programs. The programs were analyzed using information publically available on their websites. All of the programs posted curriculum information on their websites. The analysis was done in May 2014. Tables 1 and 2 in the appendix contain results. In cases where the number of programs does not add up to 79, the reason is because the information could not be determined from the source.

The 2010 survey found clear differences between the HIM programs and the other programs. The HIM programs are very standardized, because of accreditation requirements. This is still the case in the current survey results. In addition, HIM programs still do not contain much computing or IT content. In this survey, 4 out of 50 accredited programs had a programming requirement. In contrast, 20 out of 29 non-CAHIIM programs (69%) required at least one programming course. Other contrasts in IT content: only 12% of CAHIIM programs required a course in networking vs. 48% of non-CAHIIM programs, and 14% of CAHIIM programs required a course in security vs. 48% of non-CAHIIM programs. Cyber security is an area that has become critical in healthcare settings. In 2010, only 5 out of 40 programs (12%) required coursework in security; none of these were CAHIIM programs. In the current survey, 27% of all programs require security content, including 14% of CAHIIM programs (up from 0% in 2010) and 48% of non-CAHIIM programs. It is of interest that security is mentioned explicitly in the CAHIIM Information Technology and Systems competency but only 14% of programs require a full course in the area. CAHIIM and non-CAHIIM programs are closer to each other in two other technical areas: requiring coursework in databases (50% of CAHIIM programs compared to 90% of non-CAHIIM programs) and statistics, where 87% of all programs require a course. This likely reflects the centrality of both databases and statistical analysis in healthcare information systems.

The distinction can also be seen by looking at clinical content. Most CAHIIM programs (90%) require a course in medical terminology compared to 55% of non-CAHIIM programs. Anatomy and physiology is required by 92% of CAHIIM programs but only 41% of non-CAHIIM programs. And of course, the biggest difference is with the medical coding course work. All CAHIIM programs require one or more medical coding courses, since many graduates work in the field of medical coding. In contrast, only 21% of non-CAHIIM programs require medical coding.

Finally, another distinction can be seen in terms of the type of department that houses these programs. Most CAHIIM programs (84%) are housed in healthcare related departments, typically schools of allied health or health professions. On the other hand, only 31% of non CAHIIM programs are in healthcare related departments. Computer science and IT departments come in second in terms of housing healthcare informatics programs, with 40% of non-CAHIIM programs and 6% of CAHIIM programs. It is difficult to house a CAHIIM accredited program outside of a healthcare department because clinical content plays such an important role in these programs.

In terms of growth of healthcare informatics programs, there were 23 new programs in this year's survey, and 7 programs were discontinued. The majority of new programs were non-CAHIIM, possibly because it is easier to start such programs, but also because IT departments are increasingly interested in this area.

4. RESULTS-GRADUATE PROGRAMS

The landscape of graduate healthcare informatics programs is quite a bit different. CAHIIM accredits two types of programs at the graduate level: Health Information Management (HIM) and Healthcare Informatics (HCI). HIM graduate programs will focus on health data management, information policy, information systems, and administrative and clinical workflow. On the other hand, HCI graduate programs focus on information systems, informatics principles, and information technology. AMIA does not accredit at the graduate level, but lists many healthcare and medical informatics programs.

65 masters programs were located and checked, using the CAHIIM and AMIA websites again, as well as doing web searches. Interestingly, CAHIIM lists far more accredited associates and

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bachelors programs than graduate programs, whereas the situation is reversed on the AMIA site. This would seem to indicate that while undergraduate healthcare informatics programs are dominated by accredited HIM programs, HCI programs, which are stressed by AMIA, are dominated by graduate programs. Tables 3 and 4 in the appendix display the data.

Of note is the fact that only 9 programs are accredited through CAHIIM, which has separate standards for HIM and for HCI programs. Since the accreditation standards are relatively new (2009) and it takes several years to develop a program, this may well change in the coming years. Currently, though, graduate healthcare informatics programs are dominated by non-accredited HCI programs.

It is harder to spot overall trends in this group of programs because they are so diverse. However, some trends can be noted. First, programming plays a larger role than in the undergraduate programs. In particular, 32% of the non-CAHIIM programs require programming knowledge as a prerequisite, as do 2 of the CAHIIM programs. This is likely due to a greater emphasis on computer science topics at this level of program. Database coursework is required in the majority of programs, just as with the undergraduate programs, and is a prerequisite to a few of the programs. None of the programs, either CAHIIM or not, contain coursework in medical coding. And instead of a course in medical terminology, many of the programs require a course in vocabularies and data standards, which would encompass topics such as SNOMED, UMLS, and HL7. Again, this indicates a greater technical emphasis. There is a greater variety of computer science topics in these programs, and the topics are more advanced. Popular computer science topics include security (2 of 5 CAHIIM/HIM programs, and 37% of non CAHIIM programs), knowledge representation/artificial intelligence (27% of non CAHIIM programs), human computer interaction (21% of non CAHIIM programs), and data mining/information retrieval (34% of non CAHIIM programs). Interestingly, public health is only required in 12% of non CAHIIM programs, and none of the CAHIIM programs, despite public health informatics being a very important subarea of healthcare informatics.

Similarly to the undergraduate programs, the majority of graduate programs are housed within healthcare related departments. All of the CAHIIM accredited programs are within healthcare related departments and 73% of the non CAHIIM programs are in healthcare departments, often medical schools. Computing or information technology programs house 20% of the non-CAHIIM programs. Thus, it appears that healthcare related departments dominate graduate HCI programs even more than at the undergraduate level. This may well be because a number of the older and more established programs, such as Columbia University's, are within medical schools.

5. RELATED RESEARCH

There are very few surveys of healthcare informatics programs in the literature. William Hersh has done a number of analyses of the field of healthcare informatics education but has focused on the AMIA 10x10 program (Hersh and Williamson 2007), and workforce characteristics (Hersh 2010). Howard and Bishop-Clark (2013) discuss the design of a healthcare informatics program. Kane and Brewer (2006) surveyed a number of biomedical informatics programs in a paper discussing the design of a biomedical informatics program within an information technology department. Zheng, Zhang, and Li (2014) surveyed 8 healthcare IT programs to determine the data mining and predictive analytics content of each. Joshi and Perin (2012) surveyed 15 public health informatics programs, identifying them using methods similar to this study and then compared course titles and descriptions with the competencies for public health informatics determined by Centers for Disease Control and Prevention.

The most similar study to the current one is that done by Kampov-Polevoi and Hemminger (2010); this study also looked at curricula across 177 programs. However, the study included many types of programs not included in this paper, in particular bioinformatics, public health informatics, cheminformatics, pharmacy, and nursing informatics programs. In fact, the majority of programs surveyed in their study (91) were bioinformatics programs, which are sufficiently distinct from healthcare informatics programs to justify not including them in the current study. Also, Kampov-Polevoi's study included all levels of programs, the majority of which were at the graduate level. In fact, only 5 undergraduate HCI programs were included in their study; in contrast, the current study includes 79 HCI and HIM programs. However, a number of their conclusions agree with the ones

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reported in this paper: the fact that graduate education is dominant in this field, and that most programs are housed in healthcare related departments, with a minority in computer science or information technology departments. They also analyzed the programs in their dataset according to course content (Kampov-Poleroi and Hemminger 2011) and found that medical informatics and healthcare informatics programs contain more information technology content than other types of programs they studied.

6. SUMMARY

The 2010 study found that HIM programs are quite standardized because of the need for CAHIM accreditation and that non accredited programs contain more computer science/information technology content and are more likely to be housed in computer science or information technology departments. Since HCI programs seem to have a stronger foundation in computer science core areas than HIM programs, CS and IT departments considering adding a major or minor in a healthcare related field will probably consider going in that direction. This conclusion is still true based on the data in this study. In fact, there has been more growth in non CAHIIM undergraduate programs, though CAHIIM accredited HIM programs still dominate.

At the master's level, HCI dominates, and CAHIIM accredits very few programs. In general, there are many more graduate programs in HCI (60) than undergraduate (29). This could change but is unlikely to do so. Anecdotally, it appears that many potential HCI students are working professionals, often in clinical areas such as nursing. Undergraduate programs are not suitable for this population since they typically already have undergraduate degrees.

One issue that was noted in the previous study is the potential for confusion with accredited undergraduate HIM programs in the eyes of students and employers. In particular, we must be alert to the possibility that students might enroll in a program thinking that it is an accredited HIM program, discovering only later that they are not eligible to sit for the RHIA exams. Area hospitals who might wish to hire students may also be confused by a program that is nonstandard from their perspective. It is very important to communicate clearly the focus of the program. An example of this may be found on Oregon Institute of Technology's website (http://www.oit.edu/portland/programs/information-technology/health-informatics), which contains a document outlining the differences between HIM and healthcare informatics, in order to explain to potential students the focus of their health informatics degree.

Another issue for schools wishing to create an HCI major, either undergraduate or graduate, is that this is a fundamentally interdisciplinary field. Medical informatics in particular is a specialty that involves a hefty dose of computer science content, as can be seen from the tables in the appendix. At the same time, the expertise of clinical providers and researchers is also critical. Programs housed in clinical departments may struggle to teach the computer science material, and may need to collaborate with a computer science department for this expertise. For programs housed in computer science departments, it is essential that deep and meaningful collaborations with one or more clinical departments be established.

In order to understand better the breadth and content of existing education programs related to healthcare IT, we surveyed the content of 79 undergraduate programs. Programs fell strongly into one of two types: health information management (HIM) programs accredited by CAHIM, and non-accredited HCI programs. HIM programs are highly standardized, are usually housed in healthcare related departments, and have a great deal of content related to medical records. HCI programs are much less standardized, have more computing content, and may be easier for CS/IT departments to implement. In addition, 65 master's programs in HCI were surveyed in the same fashion. Graduate programs are more varied, and CAHIIM accreditation does not play a large role. These programs tend to have stronger computer science and IT content, but are even less likely to be housed in computer science or IT departments. This may change in the future as computer science and IT departments see the potential in these programs.

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Appendices and Annexures

Following are tables showing statistics for the various HCI programs.

	Number of programs	New	Discontinued	Requires programming	Requires DB	Requires medical coding	Requires medical terminology
CAHIIM	45 (5 pending)	9	5	4 (8%)	25 (50%)	50 (100%)	45 (90%)
Non-CAHIIM	29	23	2	20 (69%)	26 (90%)	6 (21%)	16 (55%)

	Requires anatomy and physiology	Networking course	Security course	Statistics course
CAHIIM	46 (92%)	6 (12%)	7 (14%)	46 (92%)
Non-CAHIIM	12 (41%)	14 (48%)	14 (48%)	23 (80%)

Table 1: Characteristics of undergraduate CAHIIM accredited and non-accredited programs.

	Healthcare-related department	Computer science, informatics or IT	Business	Engineering Technology	Other or unknown
CAHIIM	42 (84%)	3 (6%)	2 (4%)	0	2 (4%)
Non-CAHIIM	9(31%)	11 (40%)	3 (20%)	1	6 (21%)

Table 2: Types of hosting departments of undergraduate CAHIIM accredited and non-accredited programs.

	Number of programs	Requires programming	Programming prerequisite	Requires database	Database prerequisite	Medical coding required	Medical terminology, or vocabularies and data standards
CAHIIM/HI	4 (6%)	0	1 (25%)	3 (75%)	0	0	3 (75%)
CAHIIM/HIM	5 (7%)	1 (20%)	1 (20%)	3 (60%)	0	0	3 (60%)
Non CAHIIM	56 (86%)	8 (14%)	18 (32%)	36 (64%)	2 (3%)	0	11 (20%)

	Anatomy & Physiology	Networking	Security	Knowledge representations/AI	Human computer interaction	Data mining/information retrieval	Public health
CAHIIM/HI	4 (6%)	1 (25%)	0	0	0	0	0
CAHIIM/HIM	5 (7%)	0	2 (40%)	0	0	0	0
Non CAHIIM	56 (86%)	11 (20%)	21 (37%)	15 (27%)	12 (21%)	19 (34%)	7 (12%)

Table 3: Characteristics of graduate CAHIIM accredited and non-accredited programs.

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	Healthcare-related department	Computer science, informatics or IT	Business	Other or unknown
CAHIIM/HI	4 (100%)	0	0	0
CAHIIM/HIM	5 (100%)	0	0	0
Non-CAHIIM	41 (73%)	11 (20%)	2 (3%)	5 (8%)

Table 3: Types of hosting departments of graduate CAHIIM accredited and non-accredited programs.