Health Informatics Educational Offerings through ALA-Accredited LIS Programs

Rebecca Raszewski, MS, AHIP, University of Illinois at Chicago, Library of the Health Sciences Chicago, raszewr1@uic.edu

Jamie Dwyer, MLS, Salt Lake Community College, jamie.dwyer@slcc.edu

Tina Griffin, MLIS, University of Illinois at Chicago, Library of the Health Sciences Chicago, tmcg@uic.edu

Librarians who pursue a Health Sciences Librarianship career may need an understanding of Health Informatics for their work with health care professionals. Health sciences librarianship courses and degrees are available in most American Library Association-accredited Library and Information Science programs, but Health Informatics educational offerings within Library and Information Science programs have not been previously examined in the Library and Information Science literature. American Library Association-accredited programs' websites were examined to determine the availability of Health Sciences Librarianship and Health Informatics educational offerings (e.g. courses, degrees) because American Library Association accreditation is a globally recognized accreditation standard. The institutions' Carnegie Classifications and programs' iSchools statuses were also included in the analysis for benchmarking purposes. Library and Information Science programs may use the data from this study for benchmarking against other programs to compare their programs to peers, if there are gaps in their educational offerings, or to examine opportunities for expanding their current Health Informatics educational offerings and meet professional competencies.

Keywords: Health Informatics, Health Sciences Librarianship, Library and Information Science Education, Carnegie Classification, iSchools

Introduction

Library and information science (LIS) students who decide to pursue health sciences librarianship (HSL) will have opportunities to work with healthcare professionals in a variety of settings. To be successful in any area of librarianship, it is important to understand the context in which one functions and how that impacts their user groups' needs. "Understanding the health care environment" was identified in the competencies of HSL organizations in the United States, Ireland, the United Kingdom, Australia, and Canada (Lawton & Burns, 2015). One area that impacts nearly all healthcare professionals is the management of and engagement with heath information to improve healthcare outcomes, called Health Informatics (HI) (Hersh, 2009). This study explores whether there are visible HI educational opportunities within LIS programs.

The healthcare industry in the United States is expected to grow significantly by 2024, according to the United States Bureau of Labor Statistics' (2015) most recent projections. Additional HI professionals are needed in the United States due to the increase in electronic health records per the Meaningful Use mandates (Fridsma, 2016). Health Informatics positions are taking longer to fill, especially with newly created positions that are addressing emerging technologies in healthcare (Burning Glass Technologies, 2014). Developed countries such as Australia and the United Kingdom are working on expanding their healthcare technology infrastructure and further defining and increasing their HI workforces (Butler-Henderson et al., 2017; Department of Health, 2016; Health Workforce Australia, 2013; Kammermann, 2014-2015). The growth of HI in developing countries located within Africa, Asia, and Latin America has been curtailed due to lack of infrastructure within healthcare delivery systems and health information technology, educational opportunities, and a skilled workforce (Hersh, Margolis, Quiros, & Otero, 2010; Luna, Almerares, Mayan, Gonzalez Bernaldo de Quiros, & Otero, 2014; Oak, 2007; P. D. Otero et al., 2014). It has been suggested that "the sharing of experiences between developed countries and emerging regions" will be needed as those emerging areas develop HI practices (Luna, Otero, & Marcelo, 2013).

To address the rapid expansion of technology and information within the healthcare environment, competencies for many healthcare professionals are beginning to include aspects of HI. Health sciences librarians have become involved with HI initiatives and/or curricula at their institutions and some HI programs have explored international collaborations. It is unsurprising to see this overlap between HI and LIS as the two professions share certain competencies and backgrounds, but it is unknown how many educational opportunities are available to future health sciences librarians as part of their LIS programs that will prepare them to take on active roles in HI education and other initiatives upon entering the LIS profession.

This study examined the websites of institutions with ALA-accredited programs to identify HI educational offerings and if they were offered through LIS programs. The authors expected to find several HI opportunities through LIS programs due to the close connections between LIS and HI (Perry, Roderer & Assar, 2005; Cleveland & Cleveland, 2009; Dalrymple & Roderer, 2010; Murphy, 2010; Dalrymple & Varner, 2014). Health Sciences Librarianship offerings were also identified and compared to HI offerings through LIS programs. The authors anticipated a significant overlap between LIS programs that provided HSL and HI education. The Carnegie Classification Basic category for each institution and iSchools status for each LIS program were also examined to determine if there were any patterns in the type of institutions

involved in HI that could be used for benchmarking purposes, and to provide non-United States institutions a starting point for their own comparisons.

Literature Review

Health Informatics and LIS are disciplines that have a shared interest with how health information is organized, stored, transferred, and used within the healthcare enterprise (American Library Association, 2009; Cleveland & Cleveland, 2009; Murphy, 2010). Rising out of a concern that academic health sciences centers may not be equipped to handle the shift of information from paper to electronic format, the 1982 Matheson Report (1982) recommended that the library becomes the information management epicenter of academic health sciences centers. This is often considered to be the "seminal event" highlighting the convergence of HI and LIS (Dalrymple & Varner, 2014). Today there are overlapping competencies in both professions, in United States-based organizations like the American Medical Informatics Association (AMIA) (2017), American Library Association (ALA) (2009), and the Medical Library Association (MLA) (2017). Similarities in foundational knowledge are also seen in the International Medical Informatics Association (IMIA) (Mantas et al., 2010), Chartered Institute of Library and Information Professionals in the UK (2016), Australian Health Informatics Education Council (2011), Canada's Health Informatics Association (2012), and Certified Health Informatician Australasia (2013).

For many years, health sciences librarians have been aware of the importance of HI. The Medical Informatics Section (Medical Library Association, 2017b) of the Medical Library Association (MLA) started in 1991, demonstrating the need for a support system for health sciences librarians to learn more about HI and related disciplines with their colleagues as they encounter these opportunities in their field. Giuse et al. (1997) suggested that training in biomedical informatics, which includes HI, should be included in LIS training programs. Cleveland and Cleveland reiterated the importance of HI for librarians, noting that librarians who have a better understanding of "health informatics will have a powerful tool to use in their interactions with today's health informatics professionals and other health care professionals" (2009).

LIS educators and directors have identified an "understanding of informatics" to be a professional competency needed for entry level academic health sciences librarians (Philbrick, 2012). This foundational knowledge is becoming important in other health professions as well. Eldredge et al. (2012) developed a compendium identifying library and informatics skills in the competencies of 27 health sciences professions. Although not entirely focused on HI, this compendium highlighted the need for health sciences librarians to be aware of how library and informatics skills could be integrated into their health sciences programs based on various fields' professional competencies. The inclusion of HI skills in LIS and other healthcare professionals' competencies provides an impetus for health sciences librarians to be knowledgeable about HI.

Examples of librarians developing HI curriculum, teaching online HI courses, and related activities are easily discoverable in the literature (Hook, 2003; S. B. King & MacDonald, 2004; S. King, Murray, & MacDonald, 2010; S. King & Lapidus, 2015; Kumar, Wu, & Reynolds, 2014; Perry, Roderer, & Assar, 2005; Tmanova, Ancker, & Johnson, 2015; Turman, Self, & Calarco, 2004). Some health sciences librarians provide support in areas such as emerging

technologies, open web information, clinical decision making, and more (S. King & Lapidus, 2015). Other HI involvement remains more traditional. Kumar et al. (2014) described assisting students in an online HI course with tasks such as building references in a particular citation style format, literature searching, and evaluation of resources. In a more expanded role, health sciences librarians developed and delivered an online HI course "to introduce them [students] to concepts and issues, emphasizing that technology is pervasive throughout administrative, clinical and educational enterprises" in a PhD program in Health-Related Sciences (Turman et al., 2004). Turman, et al. (2004) noted that by teaching this course, the librarians were poised to develop future HI curriculum with other departments. Hook (2003) described the process of developing a HI course as a health sciences librarian while Dalrymple and Roderer (2010) encouraged LIS educators to become involved with HI education before aspects of LIS are removed from the HI curriculum. These activities demonstrate a need for health sciences librarians to be prepared to engage with HI activities.

Previous studies have examined HI programs to varying degrees. Ashrafi et al. (2014) looked at 128 institutions with HI programs and course descriptions that appeared to be from the United States and found that the most common offerings were Master's degrees (72) and graduate certificates (48). Kampov-Polevoi and Hemminger (2010) conducted research on 177 informatics programs' educational offerings, finding 32 programs, degrees, or specializations in HI or public health informatics. Arocha and Hoffman-Goetz (2012) examined 74 Canadian colleges' and universities' consumer health and public health informatics programs and courses. Thirty-one universities and four colleges had HI courses while nine universities and four colleges offered either HI certificates or degrees. Manifava, Kolokathi, and Mantas (2014) included university websites from countries which were members of the European Federation for Medical Informatics in their study of educational offerings with an HI specialization and other related areas. The majority of the programs were Master's degrees. Health Informatics represented 18% of the educational offerings.

Myers and Rodriguez (2016) reported that early career health sciences librarians most frequently identified formal LIS education as their method for achieving MLA professional competencies. However, several researchers have found gaps in LIS curricula around the world, particularly around HSL. Many LIS programs do not provide sufficient training for health sciences librarians (Petrinic & Urquhart, 2007; Ganaie, 2012; Ullah, Ameen, & Bakhtar, 2010). For example, Gavgani, Shokraneh, and Shiramin (2011) found all 10 LIS programs offering a Bachelor's and/or Master's degree in medical librarianship appeared to include some aspects of HSL in their syllabi, such as research methodology, but completely lacked medical informatics and other HSL concepts. Given that prospective students rely on online information when exploring potential programs (Moore & Berner, 2004; Noel-Levitz & National Association of Graduate Admissions Professionals, 2012; Ruffalo Noel Levitz, NRCCUA, OmniUpdate, & CollegeWeekLive, 2017; Saichaie & Morphew, 2014), this study explored whether future health sciences librarians had visible opportunities to become knowledgeable in HI as part of their formal ALA-accredited LIS education.

Methodology

Terminology

When reporting the results from this study, the terminology in Table 1 will be used to describe the institutions and the health sciences librarianship (HSL) and health informatics (HI) educational offerings in order to disambiguate academic entities and their internal unit levels. Data collected to elucidate the LIS program's involvement with HSL and HI education and the collaboration model may also be ambiguous; therefore, those terms are included here as well.

Table 1: Terminology

Term	Definition
Institution	A university or other, equivalent higher education entity with an ALA-accredited program.
College	The internal academic unit within an institution (as defined above) that provides an educational offering. College, as used here, is defined as a subject discipline subunit, regardless of whether it is called a college, faculty, or school. This term is separate from whether the institution as a whole is named "college."
LIS Program	A program offering the ALA-accredited degree, which represents library science, information science, library and information science, or an iSchools program. This may be an academic subunit (department or similar) or a College (as described above).
Educational Offering	Health Informatics (HI) or Health Sciences Librarianship (HSL) courses, certificates, specializations, and degrees.

Educational Offerings' Data Collection

The websites of the 60 ALA-accredited LIS programs from both the United States (including Puerto Rico) and Canada were reviewed between May-June 2017 (American Library Association, 2017). To identify HSL educational offerings, LIS programs' websites were searched with variations of the keywords, health and medicine. To identify HI educational offerings, LIS program websites were searched using the following keywords: health, healthcare, informatics. The use of these keywords was supported by Chen and Sarkar's (2015) findings that "healthcare informatics" was an appropriate alternative to "health informatics," and that "health informatics" was one of the most frequently used terms across the literature. Sub-disciplines of biomedical informatics or other informatics types (i.e. bioinformatics, clinical informatics, medical informatics, etc.) and health information management, which focuses on the management of medical records (The American Health Information Management Association, 2017), were not included in the scope of this paper. However, other types of biomedical informatics were included if they were offered in conjunction with HI, i.e. a course named Introduction to Nursing and Health Informatics.

After searching for HSL and HI educational offerings on the LIS programs' websites, the institutions' websites were searched, including institutional course catalogs when publicly available. Google Translate (2017) was used to assist in translating the University of Montreal and University of Puerto Rico LIS programs' websites. The following data were collected:

- Name of the institution with ALA-accredited program.
- Name of ALA-accredited LIS program.
- LIS program involvement (Yes/No).

LIS program involvement was determined by examining the LIS program's website or its institutional website to see if the educational offering originated from the LIS program or if there was an indication of LIS program involvement. If the educational offering originated outside of the LIS program, or there was no language about the LIS program's participation in the educational offering description or publicly available course listings, then the LIS program was listed as not involved.

The following information was recorded regarding both HSL and HI educational offerings at the institutions:

- No educational offerings (no courses, certificates, degrees etc.)
- Offers HSL or HI courses only.
- Certificates, fellowships, or other stand-alone non-degree programs.
- Bachelor's, Master's, or Doctoral degree. This also included HSL or HI as an area of study, concentration, minor, or specialization.
- Name(s) of course, degree, etc.
- URL with educational offering information.

It should be noted that most of the "courses only" category can be described as courses offered within an institution that did not have a certificate, specialization, or degree. The remainder were included as separate entities due to several factors such as LIS program involvement or different colleges of origin with no apparent collaboration. Also, it was assumed that if an institution offered education through a certificate or degree, then students probably have the opportunity to take classes at large or as electives. Therefore, if a certificate or degree and a class was listed as being from the same college or was somehow associated to one another, the class was regarded as part of the educational offering and not counted in the "courses only" category.

Two Microsoft Excel spreadsheets were used for collecting educational offering data; one for HSL, and one for HI. For each spreadsheet, each educational offering that was found was recorded as a separate entry and given a unique alpha-numeric identifier, including a single entry documenting if the institution did not offer HSL or HI education. Data on each educational offering were documented according to the categories listed above. In this way, when an institution had more than one educational offering, (e.g. offering both a certificate and a Master's degree), data could be analyzed according to each recorded variable. Because of multiple entries, there are more educational offerings than there are programs. The HSL subset data was then cross-referenced to the HI subset data during analysis. The dataset will be shared via the LIS Scholarship Archive and institutional repository.

Carnegie Classification data was downloaded from the 2015 public data file found at their website (The Carnegie Classification of Institutions of Higher Education, 2015). The Carnegie Classification® is a framework used in the study of United States higher education "for recognizing and describing institutional diversity." (The Carnegie Classification of Institutions of Higher Education, n.d.) Data used for analysis in May 2017 was the 2015 Carnegie basic

classification, which is mostly based on the number of doctoral or master's degrees offered at institutions. iSchools data was obtained from the iSchools membership directory in June 2017 (iSchools, 2017b). iSchools is an international consortium of information-focused schools that includes LIS programs. Data used for analysis was membership status. iSchools membership consists of three tiers and an associates category for schools that are new or have not met the membership requirements for the three tiers. Membership for each tier may be based on their doctoral programs and the extent of external funding (iSchools, 2017a).

Even though there were 60 ALA-accredited programs, 61 programs will be used in the Carnegie Classification and iSchools results section. One institution had two separate Carnegie Classifications due to where the educational offerings originated. The same institution also had two colleges listed on the iSchools directory but each college was under a different tier. A second institution had two colleges listed under two different tiers in the iSchools directory but it was decided to designate their results under the Tier 1 category because the LIS program was listed under the Tier 1 category.

Results

HI Educational Offerings Overall

Of the 60 institutions with ALA-accredited programs, 39 (65%) offered HI education while 21 (35%) did not. There were 78 total HI educational offerings from courses only through degrees breaking down as follows: 19 courses only, 15 certificates, 10 Bachelor's, 25 Master's, and nine PhDs. Within the institutions that offered HI, 20 institutions (51.3%) offered more than one option and, separately, in 24 (61.5%) the LIS program was involved. Within these 24, 12 were courses only, nine certificates, four Bachelor's, 18 Master's, and seven PhDs. Fifteen of these 24 institutions offered more than one option and there were 50 total offerings (Table 2).

Table 2: HI Offerings Overall

	HI Offerings	
	All	LIS involved
# Institutions	39	24
# Offerings	78	50
Courses Only	19	12
Certificates	15	9
Bachelor's	10	4
Master's	25	18
PhD	9	7

HSL Educational Offerings Overall

Of the 60 institutions, 46 (76.6%) LIS programs had HSL offerings while 14 did not. There were 54 total educational offerings breaking down as follows: 41 courses only, five certificates, six Master's, and two PhDs. No institutions offered Bachelor's and two institutions offered more than one option (Table 3).
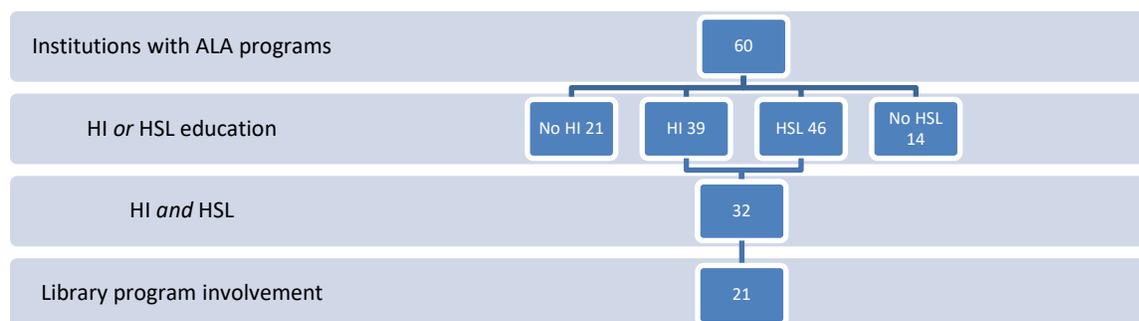
Table 3: HSL Offerings Overall

	HSL offerings
# Institutions	46
# Offerings	54
Courses Only	41
Certificates	5
Bachelor's	0
Master's	6
PhD	2

HI and HSL Status in LIS Programs

To answer the question of whether HI was being included within LIS programs that had HSL, HSL and HI educational offerings were cross referenced against each other. Overall, 32 institutions that had HSL offered HI education (Figure 1). There were 62 total educational offerings: 16 courses only, 11 certificates, nine Bachelor's, 19 Master's, and/or 17 PhDs. Sixteen institutions offered more than one HI option (Table 4).

Looking further, there were 21 institutions offering HSL and HI where the LIS program was involved in HI education specifically (Figure 1). There were 45 educational offerings: nine courses only, eight certificates, five Bachelor's, 16 Master's, and seven PhDs. Thirteen institutions offered more than one option (Table 4).

Figure 1: LIS Programs' Involvement in HSL and/or HI

Institutions with ALA programs				60			
HI *or* HSL education	No HI 21	HI 39	HSL 46	No HSL 14
HI *and* HSL				32			
Library program involvement				21			

Table 4: HI Offerings from LIS Programs with HSL Education

	HI and HSL	
	All	LIS involved
# Institutions	32	21
# Offerings	62	45
Courses Only	16	9
Certificates	11	8
Bachelor's	9	5

Master's	19	16
PhD	9	7

There were three institutions where the LIS program was offering HI education without offering HSL. Two of the three institutions offered more than one option. The HI option breakdown was three courses only, one certificate, and one Master's.

HI Offerings Outside of LIS Programs

Conversely, there were 15 institutions where the institution offered HI education, but the LIS program was not involved. There were 28 options overall: seven courses only, six certificates, six Bachelor's, seven Master's, and two PhDs. Six institutions offered more than one option (Table 5).

Additionally, there were 11 institutions that had HI and the LIS program had HSL, but the LIS program was not involved in HI education. There were 17 options: seven classes, three certificates, four Bachelor's, and three Master's. No institution offered a PhD. Three institutions offered more than one educational option (Table 5).

Table 5: HI Offerings without LIS Program Involvement

	HI Offerings – No LIS involvement	
	All	Has HSL
# Institutions	15	11
# Offerings	28	17
Courses Only	7	7
Certificates	6	3
Bachelor's	6	4
Master's	7	3
PhD	2	0

Benchmarking via Carnegie Classification and iSchools

When looking at the Carnegie Classification's Basic category for the 61 institutions with ALA-accredited programs, 43 classified as Research institutions, eight classified as Master's institutions, and 10 classified as other. Most (32) of the research institutions classified as R1, highest level of research activity, while the remaining classified as R2 (8) and R3 (3). All (8) of the Master's level institutions classified as M1, Larger programs. Other classifications included one institution as a Bachelor's of Arts/Sciences, one as a Special focus Arts/Music/Design, and eight were outside of the United States and not included in Carnegie Classification (Table 6).

Within these groups, in 25 institutions, the LIS program was involved in HI education. Separately, 47 institutions offered HSL education; and combined, 22 institutions offered HI, HSL, and the LIS program was involved in HI education.

Table 6: Institutions by Carnegie Classification Offering HI

	Carnegie Classifications				
	All	HI	HI +LIS	HSL	HI+LIS+HSL
# Institutions	61	40	25	47	22
R1	32	24	16	26	15
R2	8	6	3	7	3
R3	3	2	1	2	1
M1	8	4	4	6	2
Bachelor's A/S	1	0	0	0	0
Special Focus A/M/D	1	0	0	0	0
Non-United States	8	4	1	6	1

Of the 61 ALA-accredited programs' iSchools statuses, 28 were iSchools members, while 32 were not. Sixteen were Tier 1 members, six Tier 2, five Tier 3, and two were Associate members. Twenty of these schools listed HI offerings. Within these levels, 10 at Tier 1 had the LIS program involved, two each at Tier 2 and three had LIS program involved, and one Associate member had the LIS program involved. Separately, 19 institutions that offered HI also offered HSL. Twelve, four, and two were Tier 1 through 3, respectively. One was an Associate member. Combining both of these, 14 institutions offered HI and HSL, and the LIS program is involved. Of these, nine, two, and two were Tier 1 through 3, respectively. One was an Associate member.

Table 7: Institutions by iSchools Membership Offering HI

	iSchools				
	All	HI	HI + LIS	HSL	HI+LIS+HSL
# Institutions	28	20	15	19	14
Tier 1	16	13	10	12	9
Tier 2	6	5	2	4	2
Tier 3	5	2	2	2	2
Associate	2	1	1	1	1

Nineteen schools were not iSchools members but did list HI offerings. Collectively they offered 29 options: 11 courses only, three certificates, seven Bachelor's, six Master's, and two PhDs. Eight of these institutions had more than one educational offering.

Discussion

The data collected demonstrates that Health Informatics (HI) education was available at almost two-thirds of institutions with ALA-accredited LIS programs (39/60). Of these 39 HI opportunities, LIS programs were involved with 24 of them, or 61.5%. This suggests that LIS programs are being recognized as valuable to HI education at their institutions. The relationships between the two fields (HI and LIS) may explain some of this LIS involvement.

It was more common for LIS programs to offer HSL than HI, and not very common for them to offer both. While it is encouraging to see a majority (46/60, 76.6%) of ALA-accredited programs provide some formal education in HSL, there is room to expand and include HI opportunities as well. Just over one third of ALA-accredited programs were involved with both HI and HSL education (21/60, 35%). This represented fewer than half of the LIS programs that offered HSL (46 total HSL). Health sciences librarians rely on formal education to reach professional competencies, and there are some HI related competencies for health sciences librarians (Chartered Institute of Library and Information Professionals, 2016; Medical Library Association Task Force to Review MLA's Competencies for Lifelong Learning and Professional Success, 2017). Exposure to these during a formal LIS education would lessen the burden on librarians to pursue continuing education immediately out of LIS programs. The authors recognize that HI may be included in some of the HSL offerings and not visible through the data collection methodology used for this paper. While this study did not investigate the differences between HI and HSL curriculum or inclusion of one within the other, it might be worth further study to determine where specific overlaps and gaps exist in order to streamline program offerings and maximize their relevance to future HSL professionals.

Interestingly, three LIS programs involved with HI education at their institutions did not offer HSL through the LIS program. This might indicate a shift at those LIS programs to viewing health sciences librarians as informationists or some other confounding variable. Perhaps there is a stronger focus on HI than HSL at these institutions. On the other hand, there were 11 institutions where HI was available with no LIS program involvement, and the LIS programs listed HSL offerings. About half of the HI offerings at these institutions were certificates or courses only. If possible, these LIS programs could allow HI education to be considered as electives in their programs or otherwise collaborate to create a more thorough HSL/HI education experience. It may help their alumni be more competitive in the job market.

Although there were more HSL educational offerings than HI through LIS programs, there were more diverse educational offerings for HI. While the majority of HSL offerings were courses only, the majority of HI educational offerings were Master's degrees. This finding is consistent with HSL as a specialization of a larger LIS degree, while HI is a stand-alone discipline requiring its own degree program. There appears to be room for growth at the HI certificate level (only 15 offered at all 60 institutions, regardless of LIS involvement). Many professionals, LIS or other, may be interested in adding to their credentials without pursuing an additional degree. Continuing education or lifelong learning are emphasized in many professional competencies including those of ALA (2009), AMIA (Mantas et al., 2010), IFLA (Varlejs, 2016), and MLA (2017). Ullah, et al., (2010) and the IFLA Professional Development Guidelines (Varlejs, 2016) argue that LIS programs play a significant role in continuing education. Considering this, LIS programs may need to reexamine how they are offering continuing education to their alumni and other LIS professionals. Exploring existing continuing education opportunities offered through relevant organizations such as AMIA and MLA, and the National Library of Medicine (2017; 2017a; 2017) could reveal gaps that are not being addressed.

When considering whether an LIS program should offer HI education or evaluating its current offerings, it may be useful to benchmark against peer institutions. Using Carnegie Classification for this purpose, this study found that the majority of HI offerings came from the

highest level research activity, which is not surprising. Presumably, these institutions are equipped with faculty, technology, and other resources to properly train students for careers involving informatics. Despite this, there appears to be a general trend regarding LIS programs that have HSL being involved in HI education at research institutions, irrespective of total offering numbers. For example, of the R1 level institutions, 24 schools offered HI but only 16 LIS programs were involved (16/24, 66.6%). When considering HSL offerings as well, 15 of the 16 offered that option, meaning that almost all of the LIS programs that were involved in HI also offered HSL. This trend continues across most of the higher research classifications. For R2 and R3 institutions, 50% of the LIS programs were involved with HI, and all of those institutions offered HSL education. Master's institutions differed slightly in that while 50% of the LIS programs were involved HI, only 50% of them offer HSL as well.

However, when looking at the total availability of institutions offering HSL irrespective of LIS program involvement in HI, it is clear that ALA-accredited programs at research institutions that offer HSL are not taking advantage of potential opportunities for their students. Again, for the R1 institutions, the 15 LIS programs that offered HSL and were involved in HI represented only 57.7% (15/26) of the total programs that offered HSL. Similarly, R2, R3, and Master's LIS programs with both HSL and HI were only 30 to 50% of the programs that offered HSL overall. Institutions within these classifications might want to investigate what it would take to offer or be involved in HI education. Considering the overlap in foundational knowledge as discussed earlier, these programs would mostly likely be able to implement HI education and equip students interested in a HSL career. Since the data shows that the most common offerings overall are Master's or certificates, a dual degree track or electives that would fulfill a certificate might be practical first steps for an interested LIS program.

For other classifications reported, one each of Bachelor's and Special focus institutions, neither of these institutions were offering HI, nor were they offering HSL. It may be that their institutions do not have the capacity for this education; but it may be worth investigating whether there is institutional interest in HI education and be prepared to participate if this is the case. Offering HSL education in parallel, as shown by the research institutions' trend, or partnering in a stand-alone HI class would be an appropriate start for these levels. Literature indicates that collaboration is needed and desired to increase and distribute more HI education opportunities (Alkraiji & Househ, 2014; Bouhaddou, Bennani Othmani, & Diouny, 2013; Jaspers et al., 2004; Rienhoff, 1989; Weatherburn & Harvey, 2016). For the eight non-United States schools, four report having some HI education, but only one LIS program was involved and it also had an HSL offering. Considering that six of the eight schools offered HSL education but only one participated in HI, there would be significant opportunity for these institutions to develop or partner in HI education. Since so few ALA-accredited, non-United States LIS programs are engaging in this type of education, they could gain a significant advantage in attracting potential students as well as gain a reputation for preparing their LIS graduates to be on the leading edge in terms of competency for their geographic region. Examples of intra- and international partnership at varying institution levels already exist as models (Curioso, Fuller, Garcia, Holmes, & Kimball, 2010; Fossum, Fruhling, Moe, & Thompson, 2017; Gatewood et al., 2004; E. J. Hovenga, 2004; Marcelo, Adejumo, & Luna, 2011; P. Otero, Hersh, Luna, & Gonzalez Bernaldo de Quiros, 2010; Turner et al., 2017; Were, Siika, Ayuo, Atwoli, & Esamai, 2015).

It should be noted that international institutions sometimes have a different infrastructure for higher education than the United States. They were not included in this study because direct comparisons could not be made between offerings. For example, it is not always clear where whether a baccalaureate degree comes from a university, secondary education, or something similar to an institute. However, excluded institutions might want to review the Carnegie Classification definitions to determine what their nearest equivalent designation might be in order to draw their own parallels and/or perform their own benchmarking.

Since some LIS programs may be seeking iSchools membership, the authors also investigated whether iSchool members were more likely to be involved in HI education. While the numbers were too small to definitively state that they are, the data indicates a trend in that direction. Parallel to Carnegie Classification, the higher tier member institutions overall had more HI offerings. Within individual tiers, 13 Tier 1 institutions were involved in HI and of those 76% LIS programs were involved in HI education. Ninety percent of those programs also offered HSL in some form. This was repeated with Tier 3 and Associate members with all of them offering HI education and also HSL. Unlike what was seen in Carnegie Classification, between 75 - 100% of iSchools that offered HSL were also involved in HI. The outlier of this comparison was Tier 2. Only 40% of LIS programs were involved in HI, but all of them offered HSL. This was out of the 50% of institutions of this tier that offered HSL. The largest potential for growth in HI involvement would be by institutions at the Tier 2 membership level. iSchool tier designation is determined by a combination of scope of their PhD programs, amount of research funding, and willingness or ability to pay the annual membership (iSchools, 2017a). As Tier 2 schools have "reasonable degrees of similarity" to Tier 1, none of these differences immediately suggest a reason for the difference in Tier 2 involvement in HI education. This could be an opportunity for future research.

Irrespective of membership level, iSchools members were more likely to be involved with HI offerings than other LIS programs (50% of iSchools were LIS-HI vs. 31.3% of non-iSchools). Percentage-wise, this appeared to be significant, but again the small sample size may be incorrectly stressing the importance of being an iSchools member. Of the 32 institutions with ALA-accredited programs that were not iSchools, 19 had HI educational offerings compared to the 20 of 28 iSchools with ALA-accredited programs that had HI. These 20 iSchools also listed 49 unique educational offerings compared to 29 from the non-iSchools. The data showed that HI educational offerings may be found at iSchools and non-iSchools programs, yet iSchools may offer a wider variety of choices. The correlation between iSchools and HI education would benefit from additional research. If participation in iSchools membership increases, it will be interesting to see if this data manifests into a clear trend. If so, institutions may want to benchmark against their iSchools Tier to determine if they are being competitive, especially if the iSchools designation is important to them.

This study focused on the names of HI educational offerings rather than analyses of course and degree descriptions or course syllabi. This likely resulted in some issues related to the naming of HI areas of study, as there continues to be debate in the field regarding how various terminology is defined (Bernstam, Tenenbaum, & Kuperman, 2014; Chen & Sarkar, 2015; Dalrymple & Roderer, 2010; Hersh, 2009; Milsum & Laszlo, 1984). Course listings at some institutions were only accessible to current students or faculty. Websites and educational

offerings change frequently, which may have impacted the HSL and HI educational offerings' visibility, depending on how often a website was updated, or if HSL or HI course was listed in course catalogs at the time of data collection. This data provides a snapshot of offerings during the collection period that can be used for reference in future studies.

Studies examining HI curricula that have been published may provide guidance for those who wish to conduct a more in-depth analysis. Kampov-Polevoi and Hemminger (2011) examined similarities between biomedical informatics and health informatics curricula using a course classification scheme they developed. Some researchers have also mapped and identified gaps between various informatics associations' competencies and program curricula (Berner, Dorsey, Garrie, & Qu, 2016; Huang, 2007; Moore & Berner, 2004; Ritko & Odlum, 2013). Within HSL, Kasalu and Ojiambo (2015) used the previous version of MLA competencies as a basis for a questionnaire on both "broad and specific competencies and skills applicable to all working environments in health science" in Kenya. Perhaps conducting similar studies by examining HI content in LIS curricula using HI competencies could reveal additional insights. Studies that use professional competencies to determine existing or needed skills for the HI profession could be another approach for future research (Garde, Harrison, Huque, & Hovenga, 2006; E. Hovenga & Grain, 2013).

For future research, the authors will be exploring which programs LIS is partnering with on HI education, if LIS is the only college involved, or which colleges are offering HI without LIS involvement to shed light on interdisciplinary partnerships. The authors have collected additional data on biomedical informatics offerings in LIS programs through ALA-accredited programs in areas such as bioinformatics, clinical, medical, nursing, and public health informatics which will be reported in a future paper.

Conclusion

With the increasing demand for HI education, the growing workforce gap in providing HI service, and the overlap in HI and HSL competencies, LIS programs are well positioned to be part of a larger solution in providing HI education and addressing these issues for the long term. This paper shows that while that LIS programs are participating in HI education, there are more opportunities that are not currently being utilized.

LIS programs must examine their HSL educational offerings for how HI is being integrated into their curricula. Exposure to HI during formal LIS education would lessen the burden on librarians to pursue continuing education immediately after graduation. Since LIS programs are involved in HI educational offerings that are mostly courses only or Master's, they should consider expanding or diversifying their current offerings to post-master's certificates or PhD programs. It is also suggested they review HI or HSL competencies for new skills that may not be included within their existing curricula.

LIS programs that are not being included in HI education at their institutions should use the LIS programs involved with HI as exemplars. If the exemplars are partnering with other colleges, LIS programs who do not have HI should seek partnerships with other colleges on campus. LIS programs should approach the colleges offering HI and see if there are any opportunities for them to collaborate on courses or other educational offerings. There are also many models for international, intercollegiate partnerships in HI education as well. Global

partnerships have the added benefit of increasing cultural awareness and diversity, which are needed in healthcare currently.

Large research institutions lead in educating the HI workforce. American Library Association-accredited programs may use the numbers reported in this study for benchmarking to see how their programs compare to their peers. Since the majority of institutions have HSL offerings, LIS programs may need to see where HI exists at their institution for integrating HI into their curricula. Non-iSchools may examine iSchools' HI educational offerings to see how they can expand their curricula. This study may also be useful to LIS programs outside of North America to compare their programs with others within their countries or geographic regions.

HI is an important area related to HSL education that should be included within LIS curricula. Both current and future health sciences librarians will need an understanding of HI to work with healthcare professionals. Having LIS programs collaborate in HI education will also demonstrate how LIS is a valuable asset in the healthcare field. Further research is needed in this area to extract unseen HI educational opportunities and expand the scope beyond institutions with ALA-accredited LIS programs.

Acknowledgments

References

Alkraiji, A. I., & Househ, M. (2014). Evaluating the role of health informatics professionals in

Saudi Arabia: the need for collaboration. *Studies in Health Technology and Informatics,*

202, 123-126.

American Library Association. (2009). *ALA's core competencies of librarianship*. Retrieved

from http://www.ala.org/educationcareers/careers/corecomp/corecompetences

American Library Association. (2017). *Directory of ALA-accredited and candidate programs in*

library and information science. Retrieved from http://www.ala.org/accreditedprograms/

directory

American Medical Informatics Association. (2017). 10x10 virtual courses: Training health care

professionals to serve as informatics leaders. Retrieved from https://www.amia.org/

education/10x10-courses

AMIA Accreditation Committee. (2017). *AMIA 2017 competencies for health informatics*

education at the master's degree level. Bethesda, MD. Retrieved from

https://www.cahiim.org/documents/FINAL%20AMIA%20Health%20Informatics%20Core

%20Competencies%20for%20CAHIIM.pdf

Arocha, J. F., & Hoffman-Goetz, L. (2012). A survey of public health and consumer health

informatics programmes and courses in Canadian universities and colleges. *Informatics for*

Health & Social Care, 37(4), 242-252. http://doi.org/10.3109/17538157.2011.647937

Ashrafi, N., Kuilboer, J., Joshi, C., Ran, I., & Pande, P. (2014). Health informatics in the

    classroom: An empirical study to investigate higher education's response to healthcare

    transformation. *Journal of Information Systems Education, 25*(4), 305-315.

Australian Health Informatics Education Council. (2011). *Health informatics scope careers and*

    competencies. (No. Version 1.9). Retrieved from http://www.ahiec.org.au/docs/

    AHIEC_HI_Scope_Careers_and_Competencies_V1-9.pdf

Berner, E. S., Dorsey, A. D., Garrie, R. L., & Qu, H. (2016). Assessment-based health

    informatics curriculum improvement. *Journal of the American Medical Informatics*

    Association: JAMIA, 23(4), 813-818. http://doi.org/10.1093/jamia/ocw073

Bernstam, E. V., Tenenbaum, J. D., & Kuperman, G. J. (2014). Preserving an integrated view of

    informatics. *Journal of the American Medical Informatics Association: JAMIA, 21*(e1),

    e178-e179. http://doi.org/10.1136/amiajnl-2013-002262

Bouhaddou, O., Bennani Othmani, M., & Diouny, S. (2013). Medical informatics in Morocco.

    Yearbook of Medical Informatics, 8, 190-196.

Bureau of Labor Statistics. (2015). *Employment projections: 2014-24 Summary*. Retrieved from

    https://www.bls.gov/news.release/ecopro.nr0.htm

Burning Glass Technologies. (2014). *Missed opportunities: the labor market in health*

    informatics, 2014. Boston, MA. Retrieved from http://burning-glass.com/wp-

    content/uploads/BG-Health_Informatics_2014.pdf

Butler-Henderson, K., Gray, K., Greenfield, D., Low, S., Gilbert, C., Ritchie, A., . . . Schaper, L.
K. (2017). The development of a national census of the health information workforce:
Expert panel recommendations. *Studies in Health Technology and Informatics, 239*, 8-13.

Canada's Health Informatics Association. (2012). *Health informatics professional core
competencies.* Toronto, ON. Retrieved from https://www.coachorg.com/en/
resourcecentre/resources/Health-Informatics-Core-Competencies.pdf

Certified Health Informatician Australasia. (2013). *Health informatics competencies framework.*
(No. 1.0). North Melbourne, VIC. Retrieved from http://www.healthinformaticscertification.
com/wp-content/uploads/2016/02/CHIA-competencies-Framework_FINAL.pdf

Chartered Institute of Library and Information Professionals. (2016). *The professional knowledge
and skills base for health.* London, UK.

Chen, E., & Sarkar, I. (2015). *informatics: Identifying and tracking informatics sub-discipline
terms in the literature. *Methods of Information in Medicine, 54*(6), 530-539.
http://doi.org/10.3414/ME14-01-0088

Cleveland, A. D., & Cleveland, D. B. (2009). Health sciences librarians and health informatics.
Health informatics for medical librarians (pp. 85-108). New York, NY: Neal-Schuman
Publishers.

Curioso, W. H., Fuller, S., Garcia, P. J., Holmes, K. K., & Kimball, A. M. (2010). Ten years of
international collaboration in biomedical informatics and beyond: the AMAUTA program in

Peru. *Journal of the American Medical Informatics Association: JAMIA, 17*(4), 477-480. https://doi.org/10.1136/jamia.2009.002196

Dalrymple, P. W., & Varner, D. L. (2014). Health and biomedical informatics. In J. T. Huber, & F. Tu-Keefner (Eds.), *Health librarianship: an introduction* (pp. 263-275). Santa Barbara, CA: Libraries Unlimited.

Dalrymple, P. W., & Roderer, N. K. (2010). Education for health information professionals: Perspectives from health informatics in the U.S. *Education for Information, 28*(1), 45-55.

Department of Health. (2016). *Making IT work: harnessing the power of health information technology to improve care in England.* London, UK. Retrieved from https://www.gov.uk/government/publications/using-information-technology-to-improve-the-nhs/making-it-work-harnessing-the-power-of-health-information-technology-to-improve-care-in-england

Eldredge, J. D., Morley, S. K., Hendrix, I. C., Carr, R. D., & Bengtson, J. (2012). Library and informatics skills competencies statements from major health professional associations. *Medical Reference Services Quarterly, 31*(1), 34-44. http://doi.org/10.1080/02763869.2012.641839

Fossum, M., Fruhling, A., Moe, C. E., & Thompson, C. B. (2017). Crossing borders: An online Interdisciplinary course in health informatics for students from two countries. *Computers, Informatics, Nursing: CIN, 35*(4), 186-193. https://doi.org/10.1097/cin.0000000000000323

Fridsma, D. B. (2016). Health informatics: our domain, our challenge. *Journal of the American Medical Informatics Association: JAMIA, 23*(6), 1202-1202. https://doi.org/10.1093/jamia/ocw146

Ganaie, S. A. (2012). Curriculum of graduate courses in library and information science schools of Northern India: An analysis. *Trends in Information Management, 8*(1), 32-42.

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: A Publication of the Australian Hospital Association, 30*(1), 34-45.

Gatewood, L., Limburg, M., Gardner, R., Haux, R., Jaspers, M., Schmidt, D., & Wetter, T. (2004). International Master Classes in health informatics. *International Journal of Medical Informatics, 73*(2), 111-116. https://doi.org/10.1016/j.ijmedinf.2003.11.019

Gavgani, V. Z., Shokraneh, F., & Shiramin, A. R. (2011). Need for content reengineering of the medical library and information science curriculum in Iran. *Library Philosophy & Practice,* 166-178.

Giuse, N. B., Huber, J. T., Kafantaris, S. R., Giuse, D. A., Miller, M. D., Giles, J.,Dwight E., . . . Stead, W. W. (1997). Preparing librarians to meet the challenges of today's health care environment. *Journal of the American Medical Informatics Association: JAMIA, 4*(1), 57-67. https://doi.org/10.1136/jamia.1997.0040057

Google. (2017). Google Translate. Retrieved from https://translate.google.com/

Health Workforce Australia. (2013). *Health information workforce report.* Adelaide, SA. Retrieved from https://www.aims.org.au/documents/item/401

Hersh, W. (2009). A stimulus to define informatics and health information technology. *BMC Medical Informatics and Decision Making, 9*, 24. http://doi.org/10.1186/1472-6947-9-24

Hersh, W., Margolis, A., Quiros, F., & Otero, P. (2010). Building a health informatics workforce in developing countries. *Health Affairs, 29*(2), 274-277. https://doi.org/10.1377/hlthaff.2009.0883

Hook, S. A. (2003). Teaching health informatics: Designing a course for a new graduate informatics program. *Journal of the Medical Library Association: JMLA, 91*(4), 490-492.

Hovenga, E., & Grain, H. (2013). Developing a common reference model for the health informatics discipline. *Studies in Health Technology and Informatics, 192*, 122-126.

Hovenga, E. J. (2004). Globalisation of health and medical informatics education--what are the issues? *International Journal of Medical Informatics, 73*(2), 101-109. http://doi.org/10.1016/j.ijmedinf.2003.11.004

Huang, Q. R. (2007). Competencies for graduate curricula in health, medical and biomedical informatics: a framework. *Health Informatics Journal, 13*(2), 89-103. https://doi.org/10.1177/1460458207076465

iSchools. (2017a). Apply to join. Retrieved from https://ischools.org/members/apply-to-join/

iSchools. (2017b). Directory. Retrieved from http://ischools.org/members/directory/

Jaspers, M. W., Gardner, R. M., Gatewood, L. C., Haux, R., Schmidt, D., & Wetter, T. (2004). The international partnership in health informatics education. *Studies in Health Technology and Informatics, 107*(Pt 2), 884-888. https://doi.org/10.1016/j.ijmedinf.2006.02.008

Kammermann, M. (2014-2015). *The census of Australian health libraries and health librarians working outside the traditional library setting: the final report of the 2012 Anne Harrison award project.* Canberra, ACT. Retrieved from https://www.alia.org.au/sites/default/files/ CENSUS%20of%20Aus%20Hlth%20Libs%202012-14_Final%20Report_2016.pdf

Kampov-Polevoi, J., & Hemminger, B. M. (2011). A curricula-based comparison of biomedical and health informatics programs in the USA. *Journal of the American Medical Informatics Association: JAMIA, 18*(2), 195-202. http://doi.org/10.1136/jamia.2010.004259

Kampov-Polevoi, J., & Hemminger, B. M. (2010). Survey of biomedical and health care informatics programs in the United States. *Journal of the Medical Library Association: JMLA, 98*(2), 178-181. http://doi.org/10.3163/1536-5050.98.2.014

Kasulu, J. S., & Ojiambo, J. B. (2015). Educating the health librarians in Africa today: Competencies, skills and attitudes required in a changing health environment. Paper presented at IFLA World Library and Information Congress, Cape Town, South Africa. *81* 1-10. http://library.ifla.org/1104/

King, S., Murray, H., & MacDonald, K. (2010). Evolving a collaborative matrix for teaching informatics online to health sciences students at the Massachusetts College of Pharmacy and Health Sciences. *Journal of the Canadian Health Libraries Association: JCHLA, 31*(3), 109-114.

King, S. B., & MacDonald, K. (2004). Metropolis redux: The unique importance of library skills in informatics. *Journal of the Medical Library Association: JMLA, 92*(2), 209-217.

King, S., & Lapidus, M. (2015). Metropolis revisited: the evolving role of librarians in informatics education for the health professions. *Journal of the Medical Library Association: JMLA, 103*(1), 14-18. http://doi.org/10.3163/1536-5050.103.1.003

Kumar, S., Wu, L., & Reynolds, R. (2014). Embedded librarian within an online health informatics graduate research course: a case study. *Medical Reference Services Quarterly, 33*(1), 51-59. http://doi.org/10.1080/02763869.2014.866485

Lawton, A., & Burns, J. (2015). A review of competencies needed for health librarians - a comparison of Irish and international practice. *Health Information & Libraries Journal, 32*(2), 84-94. https://doi.org/10.1111/hir.12093

Luna, D., Almerares, A., Mayan, J. C.,3rd, Gonzalez Bernaldo de Quiros, F., & Otero, C. (2014). Health informatics in developing countries: Going beyond pilot practices to sustainable implementations: A review of the current challenges. *Healthcare Informatics Research, 20*(1), 3-10. https://doi.org/10.4258/hir.2014.20.1.3

Luna, D., Otero, C., & Marcelo, A. (2013). Health informatics in developing countries: Systematic review of reviews. Contribution of the IMIA Working Group Health Informatics for Development. *Yearbook of Medical Informatics, 8*, 28-33.

Manifava, E., Kolokathi, A., & Mantas, J. (2014). Exploring the biomedical and health informatics educational programs in Europe. *Studies in Health Technology and Informatics, 202*, 67-70.

Mantas, J., Ammenwerth, E., Demiris, G., Hasman, A., Haux, R., Hersh, W., . . . IMIA Recommendations on Education Task Force. (2010). Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics First Revision. *Methods of Information in Medicine, 49*(2), 105-120. http://doi.org/10.3414/ME5119

Marcelo, A., Adejumo, A., & Luna, D. (2011). Health informatics for development: a three-pronged strategy of partnerships, standards, and mobile health. Contribution of the IMIA Working Group on Health Informatics for Development. *Yearbook of Medical Informatics, 6*, 96-101.

Matheson, N. W., & Cooper, J. A. (1982). Academic information in the academic health sciences center. Roles for the library in information management. *Journal of Medical Education, 57*(10 Pt 2), 1-93.

Medical Library Association. (2017a). Academy of Health Information Professionals (AHIP). Retrieved from http://www.mlanet.org/p/cm/ld/fid=41

Medical Library Association. (2017b). Medical Informatics Section. Retrieved from https://mla.socious.com/p/cm/ld/fid=532

Medical Library Association Task Force to Review MLA's Competencies for Lifelong Learning and Professional Success. (2017). *Medical Library Association competencies for lifelong learning and professional success 2017.* Chicago, IL. Retrieved from http://www.mlanet.org/p/cm/ld/fid=1217

Milsum, J. H., & Laszlo, C. A. (1984). From medical to health informatics. *Methods of Information in Medicine, 23*(2), 61-62.

Moore, R. A., & Berner, E. S. (2004). Comparing health/medical informatics graduate program curricula against two sets of professional criteria. *Journal of Healthcare Information Management: JHIM, 18*(3), 44-50.

Murphy, J. (2010). Health science librarianship's legacy to health informatics. *Health Information & Libraries Journal, 27*(1), 75-79. http://doi.org/10.1111/j.1471-1842.2010.00882.x

Myers, B. A., & Rodriguez, B. (2016). How do early career health sciences information professionals gain competencies? *Journal of the Medical Library Association: JMLA, 104*(3), 215-220. http://doi.org/10.3163/1536-5050.104.3.006

National Library of Medicine. (2017). NLM's university-based biomedical informatics and data science research training programs. Retrieved from https://www.nlm.nih.gov/ep/GrantTrainInstitute.html

Noel-Levitz, I., & National Association of Graduate Admissions Professionals. (2012). *Marketing and student recruitment practices for master's-level graduate programs, 2012.*

Trends in enrollment management. Coralville, IA: Noel-Levitz, Inc. Retrieved from https://www.ruffalonl.com/papers-research-higher-education-fundraising/2012/2012-marketing-student-recruitment-practices-master-level

Oak, M. R. (2007). A review on barriers to implementing health informatics in developing countries. *Journal of Health Informatics in Developing Countries, 1*(1), 19-22.

Otero, P. D., Perrin, C., Geissbuhler, A., Cheung, N., Theera-Ampornpunt, N., & Lun, K. C. (2014). Informatics education in low-resource settings. In E. S. Berner (Ed.), *Informatics Education in Healthcare Lessons Learned* (pp. 197-222). London: Springer London. https://doi.org/10.1007/978-1-4471-4078-8_14

Otero, P., Hersh, W., Luna, D., & Gonzalez Bernaldo de Quiros, F. (2010). A medical informatics distance-learning course for Latin America. Translation, implementation and evaluation. *Methods of Information in Medicine, 49*(3), 310-315.

Perry, G. J., Roderer, N. K., & Assar, S. (2005). A current perspective on medical informatics and health sciences librarianship. *Journal of the Medical Library Association: JMLA, 93*(2), 199-205.

Petrinic, T., & Urquhart, C. (2007). The education and training needs of health librarians—the generalist versus specialist dilemma. *Health Information & Libraries Journal, 24*(3), 167-176. https://doi.org/10.1111/j.1471-1842.2007.00717.x

Philbrick, J. L. (2012). *A study of the competencies needed of entry-level academic health sciences librarians.* (Doctoral dissertation, University of North Texas) Retrieved from https://digital.library.unt.edu/ark:/67531/metadc115139/

Rienhoff, O. (1989). Health informatics education in the Third World. *Methods of Information in Medicine, 28*(4), 270-272.

Ritko, A. L., & Odlum, M. (2013). Gap analysis of biomedical informatics graduate education competencies. *AMIA ...Annual Symposium Proceedings. AMIA Symposium, 2013*, 1214-1223.

Ruffalo Noel Levitz, NRCCUA, OmniUpdate, & CollegeWeekLive. (2017). *2017 e-expectations trend report: discover the keys to greater engagement with high school students and parents.* Cedar Rapids, IA: Ruffalo Noel Levitz. Retrieved from https://www.ruffalonl.com/papers-research-higher-education-fundraising/recruitment-marketing-and-financial-aid/e-expectations-research-reports

Saichaie, K., & Morphew, C. C. (2014). What college and university websites reveal about the purposes of higher education. *The Journal of Higher Education, 85*(4), 499-530. http://dx.doi.org/10.1353/jhe.2014.0024

The American Health Information Management Association. (2017). What is health information? Retrieved from http://www.ahima.org/careers/healthinfo?tabid=what

The Carnegie Classification of Institutions of Higher Education. (2015). 2015 update public file [data set]. Retrieved from http://carnegieclassifications.iu.edu/downloads.php

The Carnegie Classification of Institutions of Higher Education (n.d.). About Carnegie

   Classification. Retrieved from http://carnegieclassifications.iu.edu/

Tmanova, L., Ancker, J., & Johnson, S. (2015). Integrating an informationist into graduate

   education: Case study with preliminary results. *Medical Reference Services Quarterly,*

   34(3), 296-310. http://doi.org/10.1080/02763869.2015.1052692

Turman, L. U., Self, P. C., & Calarco, P. V. (2004). Teaching a Web-based course in health

   informatics. *Reference Services Review, 32*(1), 21-25. http://doi.org/10.1108/

   009907320410519324

Turner, A. M., Facelli, J. C., Jaspers, M., Wetter, T., Pfeifer, D., Gatewood, L. C., . . . Sohih, H.

   (2017). Solving interoperability in translational health. Perspectives of students from the

   International Partnership in Health Informatics Education (IPHIE) 2016 master class.

   Applied Clinical Informatics, 8(2), 651-659.

Ullah, M., Ameen, K., & Bakhtar, S. (2010). Professional activities, needed competencies and

   training needs of medical librarians in Pakistan. *Education for Information, 28*(2-4), 115-

   123.

Varlejs, J. (2016). *IFLA guidelines for continuing professional development: principles and best*

   practices--2016 update. Retrieved from https://www.ifla.org/publications/node/11885

Weatherburn, J., & Harvey, R. (2016). Finding and forming the bold and the fearless: the future

   of LIS education in Australia. *Australian Library Journal, 65*(4), 251-261.

   https://doi.org/10.1080/08164649.2016.1237946

Were, M. C., Siika, A., Ayuo, P. O., Atwoli, L., & Esamai, F. (2015). Building comprehensive

and sustainable health informatics institutions in developing countries: Moi University

experience. *Studies in Health Technology and Informatics, 216*, 520-524.