

# Health Informatics Educational Offerings through ALA-Accredited LIS Programs

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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 (ALA)-accredited library and information science (LIS) programs, but health informatics educational offerings within LIS programs have not been previously examined in the LIS literature. ALA-accredited programs' websites were examined to determine the availability of health sciences librarianship and health informatics educational offerings (e.g., courses, degrees) because ALA accreditation is a globally recognized accreditation standard. The institutions' Carnegie Classifications and their programs' iSchools statuses were also included in the analysis for benchmarking purposes. LIS 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:** Carnegie Classification, health informatics, health sciences librarianship, iSchools, library and information science education

Library and information science (LIS) students who decide to pursue health sciences librarianship (HSL) will have opportunities to work with health-care 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 affects 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 affects nearly all health-care professionals is the management of and engagement with health information

to improve health-care outcomes, called health informatics (HI) (Hersh, 2009). This study explores whether there are visible HI educational opportunities within LIS programs.

The health-care industry in the United States is expected to grow significantly by 2024, according to the most recent projections of the US Bureau of Labor Statistics (2017). Additional HI professionals are needed in the United States due to the increase in electronic health records through the Meaningful Use mandates (Fridsma, 2016). HI positions are taking longer to fill, especially with newly created positions that are addressing emerging technologies in health care (Burning Glass Technologies, 2014). Developed countries such as Australia and the United Kingdom are working on expanding their health-care technology infrastructure and further defining and increasing their HI workforces (Butler-Henderson et al., 2017; Department of Health & Social Care, 2016; Health Workforce Australia, 2013; Kammermann, 2014–2015). The growth of HI in developing countries in Africa, Asia, and Latin America has been curtailed due to a lack of infrastructure within health-care delivery systems and health-information technology, a shortage of educational opportunities, and a dearth of skilled workers (Hersh, Margolis, Quirós, & Otero, 2010; Luna, Almerares, Mayan, González Bernaldo de Quirós, & Otero, 2014; Oak, 2007; Otero, Perrin, Geissbuhler, Cheung, Theera-Ampornpunt, & Lun, 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, p. 5).

To address the rapid expansion of technology and information within the health-care environment, competencies for many health-care 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.

### KEY POINTS

- Management and utilization of health-care information via health informatics is a recognized competency in health professions, including health sciences librarianship.
- It is more common for LIS programs to offer HSL than HI, and not common for them to offer both.
- LIS programs should consider collaborating with their institutions' HI programs or adding HI education to their programs to lessen the burden on alumni to pursue continuing education immediately after beginning a HSL career.

This study examined the websites of institutions with American Library Association (ALA)-accredited programs to identify HI educational offerings and determine whether 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 (Cleveland & Cleveland, 2009; Dalrymple & Roderer, 2010; Dalrymple & Varner, 2014; Murphy, 2010; Perry, Roderer, & Assar, 2005). HSL 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-US institutions a starting point for their own comparisons.

### Literature review

Health informatics and LIS are disciplines that have a shared interest in how health information is organized, stored, transferred, and used within the health-care 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 (Matheson & Cooper, 1982) recommended that the library become 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 US-based organizations such as the ALA, the American Medical Informatics Association (AMIA Accreditation Committee, 2017), and the Medical Library Association (MLA) (2017a). Similarities in foundational knowledge are also seen in the International Medical Informatics Association (IMIA) (Mantas et al., 2010), the Chartered Institute of Library and Information Professionals (2016) in the UK, the 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 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 (2009, p. 94) 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.”

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, p. 143). This foundational knowledge is becoming important in other health professions as well. Eldredge, Morley, Hendrix, Carr, and Bengtson (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 the professional competencies of various fields. The inclusion of HI skills in LIS and other health-care 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; King & MacDonald, 2004; King, Murray, & MacDonald, 2010; King & Lapidus, 2015; Kumar, Wu, & Reynolds, 2014; Perry et al., 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 (King & Lapidus). Other HI involvement remains more traditional. Kumar et al. describe assisting students in an online HI course with tasks such as creating 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 Ph.D. program in health-related sciences (Turman et al., p. 22). Turman, et al. note that by teaching this course, the librarians were poised to develop future HI curriculum with other departments. Hook describes the process of developing an HI course as a health sciences librarian, while Dalrymple and Roderer (2010) encourage 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, Kuilboer, Joshi, Ran, & Pande (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 the educational offerings of 177 informatics programs, finding 32 programs, degrees, or specializations in HI or public health informatics. Arocha and Hoffman-Goetz (2012) examined the consumer health and public health informatics programs and courses of 74 Canadian colleges and universities. 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 that 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. HI represented 18% of the educational offerings.

Myers and Rodriguez (2016) report 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 (Ganaie, 2012; Petrinic & Urquhart, 2007; Ullah, Ameen, & Bakhtar, 2010). For example, Gavvani, 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, & CollegeWeek-Live, 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 sub-unit, 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 an ALA-accredited degree, which represents library science, information science, library and information science, or an iSchools program. This may be an academic sub-unit (department or similar) or a college (as described above).
Educational offering	Health informatics (HI) or health sciences librarianship (HSL) courses, certificates, specializations, and degrees.

### Data collection on educational offerings

The websites of the 60 ALA-accredited LIS programs from both the United States (including Puerto Rico) and Canada were reviewed between May and June 2017 ([American Library Association, 2017](#)). To identify HSL educational offerings, LIS programs' websites were searched using variations of the keywords "health" and "medicine." To identify HI educational offerings, LIS program websites were searched using the following keywords: "health," "healthcare," and "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 ([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, for example, 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 \(Google, 2017\)](#) was used to assist in translating the University of Montreal and University of Puerto Rico LIS programs' websites. The following data were collected:

- the name of the institution with an ALA-accredited program;
- the name of the ALA-accredited LIS program; and
- 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;
- the name(s) of course, degree, etc.; and
- 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 offers 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 were listed as being from the same college or were 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 alphanumeric 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 were then cross-referenced to the HI subset data during analysis. The datasets will be shared via the LIS Scholarship Archive (HSL DOI: 10.31229/osf.io/6aqv7; HI DOI 10.31229/osf.io/a69qk) and Figshare repository (DOI: 10.6084/m9.figshare.7265636).

Carnegie Classification data were downloaded from the 2015 public data file found at their website ([Carnegie Classification of Institutions of Higher Education, 2015](#)). The Carnegie Classification is a framework used in the study of US higher education “for recognizing and describing institutional diversity” ([Carnegie Classification of Institutions of Higher Education, n.d.](#)). Data used for analysis in May 2017 were from the 2015 Carnegie basic classification, which is based mostly on the number of doctoral or master’s degrees offered at institutions. iSchools data were obtained from the iSchools membership directory in June 2017 ([iSchools, 2017b](#)). iSchools is an international consortium of information-focused schools that includes LIS programs. The data used for analysis concerned 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 schools’ 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 we decided to put 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 ranging from courses only through degrees, breaking down as follows: 19 courses only, 15 certificates, 10 bachelor’s, 25 master’s, and nine doctoral. 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, the breakdown was as follows: 12 courses only, nine certificates, four bachelor’s, 18 master’s, and seven doctoral. Fifteen of these 24 institutions offered more than one option, and there were 50 total offerings (Table 2).

### 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 doctoral. No institutions offered courses at the bachelor’s level, and two institutions offered more than one option (Table 3).

**Table 2: HI offerings overall**

	All	LIS involved
# Institutions	39	24
# Offerings	78	50
Courses only	19	12
Certificates	15	9
Bachelor’s	10	4
Master’s	25	18
Doctoral	9	7

**Table 3: HSL offerings overall**

	HSL offerings
# Institutions	46
# Offerings	54
Courses only	41
Certificates	5
Bachelor’s	0
Master’s	6
Doctoral	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). A total of 62 educational offerings were found: 16 courses only, 11 certificates, nine bachelor’s, 19 master’s, and 7 doctoral. 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 doctoral. Thirteen institutions offered more than one option (Table 4).

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 LIS programs

Conversely, there were 15 institutions where the institution offered HI education but the LIS program was not involved. There were 28 options

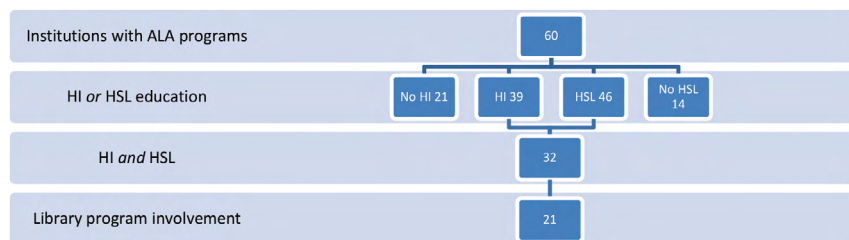


Figure 1: LIS Programs’ Involvement in HSL and/or HI.

Table 4: HI offerings from LIS programs with HSL education

	All	LIS involved
# Institutions	32	21
# Offerings	62	45
Courses only	16	9
Certificates	11	8
Bachelor’s	9	5
Master’s	19	16
Doctoral	7	7

**Table 5: HI offerings without LIS program 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
Doctoral	2	0

overall: seven courses only, six certificates, six bachelor's, seven master's, and two doctoral. 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 courses only, three certificates, four bachelor's, and three master's. No institution offered a PhD. Three institutions offered more than one educational option (Table 5).

#### **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, the highest level of research activity, while the remaining classified as R2 (8) and R3 (3). All eight of the master's-level institutions classified as M1, that is, 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 Carnegie Classification groups, in 25 institutions the LIS program was involved in HI education. Separately, 47 institutions offered HSL education, and combined, 22 institutions offered HI and HSL and the LIS program was involved in HI education.

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 Tiers 2 and 3 had LIS program involved, and one Associate member had the LIS program involved. Separately, 19 institutions that offered HI also offered HSL: twelve in Tier 1, four in Tier 2, and two in Tier 3, and one was an Associate member. Combining both of these, 14 institutions offered HI and HSL and the LIS program was involved. Of these, nine were in Tier 1, two each were in Tiers 2 and 3, and one was an Associate member (see Table 7).

**Table 6: Institutions by Carnegie Classification offering HI**

	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

**Table 7: Institutions by iSchools membership offering HI**

	All	HI	HI + LIS	HI + 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 doctoral. Eight of these institutions had more than one educational offering.

## Discussion

The data collected demonstrate 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 represents 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, 2017c](#)). 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 curricula or the 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 the [ALA \(2009\)](#), the [AMIA \(Mantas et al., 2010\)](#), the [IFLA \(Varlejs, 2016\)](#), and the [MLA \(2017a, 2017b\)](#). [Ullah et al. \(2010\)](#) and the [IFLA Professional Development Guidelines \(Varlejs\)](#) argue that LIS programs play a significant role in continuing education. Considering this, LIS programs may need to re-examine how they are offering continuing education to their alumni and other LIS professionals. Exploring existing continuing education opportunities offered through relevant organizations such as the [AMIA](#) and the [MLA](#), and the [National Library of Medicine \(2017\)](#) could reveal gaps that are not being addressed.

When considering whether an LIS program should offer HI education or when 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 institutions with 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 with HI, only 50% of them offered 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-level LIS programs with both HSL and HI comprised 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 an HSL career. Since the data show 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 whether they would 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 (Alkrajji & Househ, 2014; Bouhaddou, Bennani Othmani, & Diouny, 2013; Jaspers, Gardner, Gatewood, Haux, Schmidt, & Wetter, 2004; Rienhoff, 1989; Weatherburn & Harvey, 2016). For the eight non-US schools, four reported 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-US 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; Hovenga, 2004; Marcelo, Adejumo, & Luna, 2011; Otero, Hersh, Luna, & González Bernaldo de Quirós, 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 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 indicate a trend in that direction. Parallel to the 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% of 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 with the Carnegie Classification, between 75 and 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 doctoral 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 suggests 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 appears 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 show that HI educational offerings may be found in both 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 these data manifest 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 accessible only to current students or faculty. Websites and educational offerings change frequently, which may have affected the visibility of the HSL and HI educational offerings, depending on how often a website was updated, or if HSL or HI courses were listed in course catalogs at the time of data collection. These data provide 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; 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, in order 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 at the master's level, they should consider expanding or diversifying their current offerings to post-master's certificates or doctoral programs. It is also suggested that 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 health care currently.

Large research institutions lead in educating the HI workforce. ALA-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 before 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 health-care 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.

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