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RESEARCH ARTICLE

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Digital humanities in the iSchool

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Abstract

The interdisciplinary field known as digital humanities (DH) is represented in various forms in the teaching and research practiced in iSchools. Building on the work of an iSchools organization committee charged with exploring digital humanities curricula, we present findings from a series of related studies exploring aspects of DH teaching, education, and research in iSchools, often in collaboration with other units and disciplines. Through a survey of iSchool programs and an online DH course registry, we investigate the various education models for DH training found in iSchools, followed by a detailed look at DH courses and curricula, explored through analysis of course syllabi and course descriptions. We take a brief look at collaborative disciplines with which iSchools cooperate on DH research projects or in offering DH education. Next, we explore DH careers through an analysis of relevant job advertisements. Finally, we offer some observations about the management and administrative challenges and opportunities

related to offering a new iSchool DH program. Our results provide a snapshot of the current state of digital humanities in iSchools which may usefully inform the design and evolution of new DH programs, degrees, and related initiatives.

1 | INTRODUCTION

Digital humanities (DH), a broad interdisciplinary field concerned with the theory and practice of digital and computational methods in humanities research and pedagogy, has long been present in iSchools and information and library science programs. As we describe in more detail below, there are currently many digital humanities courses and programs at iSchools around the globe.

The field now known as digital humanities emerged out of the earlier field of humanities computing and involves both the application of computational and digital methods in humanities research as well as the application of humanities methods, theories, and frameworks in the study of digital media and digital culture. A key moment in the increasing profile of digital humanities within iSchools was in 2003, when John Unsworth, a leading DH scholar (and co-editor of *A Companion to Digital Humanities* published by Blackwell in 2004), was appointed Dean of the University of Illinois' Graduate School of Library and Information Science (now School of Information Sciences) (Schreibman et al., 2004). Unsworth had an English Ph.D., with no formal training in information science or library science, but with a decade of experience (1993–2003) as the Director of the University of Virginia's Institute for Advanced Technology and the Humanities (IATH), a leading digital humanities research center. Since then, we find that many iSchools have hired, tenured, and promoted other faculty with Ph.D. degrees in the humanities and varying degrees of technical, digital, and computational expertise that may be applied to humanities research (Wiggins & Sawyer, 2012).

The research for this article emerged from the work of an iSchool committee on Digital Humanities Curricula (iDHCC). This committee was formed in early 2019 by Professor Sam Oh, Chair of the iSchools organization from 2018 to 2019, and charged with the following tasks:

- Define digital humanities as a field of study in the context of iSchool research and pedagogy.
- Provide a list and general description of the types of DH-specific courses offered in iSchools and iSchool-affiliated DH programs.
- Provide a list of broader topics and methodologies relevant to DH.
- Provide a list of links, literature, and existing curricula/recommendations that the committee has reviewed.
- Publish a report on opportunities for DH curricula in iSchools and possible models for DH curricula and programs in iSchools.

What follows is not the final report to the iSchools, which has a more pragmatic, programmatic, and administrative focus, but the results of our research on the current state of digital humanities teaching and research in the iSchool context.

In the sections below, we apply multiple methods to explore many aspects of digital humanities as practiced and taught within iSchools, often in collaboration with other units and disciplines. Through a survey of iSchool programs and analysis of the CLARIN-DARIAH[1] Digital Humanities Course Registry (CLARIN-ERIC & DARIAH-EU, 2021), we investigate the various education models for digital humanities training found in iSchools, followed by a detailed look at DH courses and curricula, explored through analysis of course syllabi and course descriptions. We then take a brief look at collaborative disciplines, the disciplines and units with which iSchools collaborate on DH research projects or in offering DH education. Next, we explore DH careers through an analysis of relevant job advertisements. Finally based on our own professional experiences of implementing DH programs in iSchools, we offer some observations about the management and administrative challenges and opportunities related to offering a new iSchool DH program. We conclude with some general recommendations based on our findings.

2 | EDUCATION MODELS

Our investigation into digital humanities in iSchools began by examining the educational models used to deliver DH knowledge and credentials to students. We define an *educational model* as a type and level of degree offered by an official intra-university organization. Thus, an educational model might involve the iSchool itself offering a graduate certificate in DH for all master's and Ph.D. students at the university. A DH *program* brings together the people, processes, and courses in a structure that would offer multiple educational models in addition to other activities, such as supporting research or hosting workshops and colloquia.

In order to develop a rough picture of the educational models for DH within iSchools or the wider university,

we collected data about existing programs in multiple ways. First, we conducted a manual review of pan-university program websites to get a general sense of what types of DH degrees are being offered. Members of the iDHCC explored websites in their own regions through a nonsystematic survey of select websites. We augmented this in Europe (only) through the collection of data from the European-focused CLARIN-DARIAH online registry of DH educational offerings. In addition, we used self-reported data from an online questionnaire, which focused exclusively on universities with iSchools. This online questionnaire was built by the iDHCC and sent out to leaders at iSchools around the world, with about a 40% response rate. These data sources taken together are not fully comprehensive, but we do derive a general sense of the diverse range of DH education models and programs that currently exist at universities across the world.

First, we aimed to achieve a general understanding of the way in which DH models are structured at universities, regardless of the administering unit. Through an ad hoc survey of public websites identified through standard internet search engines, we cataloged 31 Asian and Australian DH credentials at 15 universities, 44 North American DH credentials at 39 universities, and 47 European DH credentials at 38 universities. Other areas of the world (particularly Africa and South America) were outside the scope of this investigation as they host few iSchools. In Asia and Australia, we identified 18 credentials at the bachelor's level (6 majors, 9 minors, and 3 other minor-like credentials), 11 credentials at the master's level (5 full master's, 3 graduate certificates, and 3 other certificate-like credentials), and 2 Ph.D. degree programs. Across North American universities, we found 15 credentials at the bachelor's level (3 full bachelors, 7 minors, and 5 additional minor-like credentials) and 29 credentials at the master's level (7 full master's degrees, 20 certificates, and 2 certificate-like credentials), but no Ph. D. degree programs. In Europe, we cataloged 7 credentials at the bachelor's level (6 full bachelor's and 1 minor), 37 credentials at the master's level (29 full master's degrees, and 8 minors/specializations), as well as 3 Ph.D. degree programs. The CLARIN-DARIAH Digital Humanities Course Registry listed 83 bachelor's, 162 master's, and 16 Ph.D. credentials, mostly in Europe. For this study, we selected a subset of models from the DH Course Registry that focused on the broader digital humanities or closely related fields (e.g., humanities computing, informatics for humanities) while excluding narrower discipline-specific fields like computational linguistics.

This detailed survey revealed great diversity in the types of DH educational models, including Ph.D., master of arts or sciences, graduate certificate/specialization/track/pathway, and bachelor's major and minor/certificate/specialization/honors credentials (Cobb & Golub, 2021). Worldwide, master's degrees are the most common type of model, followed by master's certificates, minors, and the like. After master's degrees, the most common type of models are bachelor's minors and other undergraduate minor-like credentials, followed by full bachelor's DH degrees. Ph.D. degree programs in DH are quite rare. There is also a wide variety of names for credentials that will provide some level of DH training to students secondary to their main program of study. Although the most frequent names for these are *undergraduate minor* or *graduate certificate*, there are several other titles used on a more limited basis, which indicate variance that may be either regional or reflect different academic traditions. Furthermore, there appears to be a definite divide among the continents as to the types of credentials that are commonly offered. In Asia and Australia, undergraduate DH credentials are slightly more common. In North America and Europe graduate-level DH degrees are much more common; however, many European universities offer a full master's degree program whereas North American universities generally offer graduate certificates. Similarly, at the undergraduate level, European institutions are more likely to offer a full DH degree program, while in North America, DH is most often offered as a minor, or some other add-on to a full degree in another discipline.

We also circulated a survey to iSchool leaders requesting basic information about the DH programs in their schools (Table 1). Among the respondents, 18 universities with iSchools offer DH credentials (in some cases offered through academic units outside the iSchool), 10 additional iSchools offer courses in DH, and 4 are in the advanced stages of planning digital humanities curricular offerings. Our comprehensive survey of iSchool websites in North America, together with our questionnaire results, shows that few iSchools there currently offer DH credentials wholly within the iSchool; only 8 out of the 51 iSchools offer a DH credential themselves. However, 32 North American universities which have iSchools have some form of collaborative DH program offered by different departments or faculties, and among those, the iSchool is engaged as a partner in 11 of those joint efforts. Furthermore, according to the responses to our questionnaire, several more iSchools have already begun or are planning to embark on innovative approaches to offer DH credentials (such as certificates) that leverage their interdisciplinary knowledge and specializations; this ongoing planning demonstrates the continuing and emerging opportunities for iSchools to offer DH content as part of their curricula.

TABLE 1 Results of survey of iSchool leaders

Region	Bachelor's	Master's	Ph.D.
Asia and Australia	18 (6 majors, 9 minors, 3 minor-like credentials)	11 (5 master's, 3 certificates, 3 certificate-like credentials)	2
Europe	7 (6 majors, 1 minor)	34 (28 master's, 6 minors or specializations)	4
North America	15 (3 majors, 7 minors, 5 minor-like credentials)	29 (7 master's, 20 certificates, 2 certificate-like credentials)	0

3 | COURSES AND CURRICULA

In this section, we describe two studies of DH curricula from the perspective of the iSchools. First, we explore the presence and content of DH courses within iSchools themselves, using recent syllabi. Second, we apply structural topic modeling to 426 DH course descriptions drawn from the DH program registry as well as known DH programs. Together, these two studies indicate the state of DH curriculum within our field, as well as relevant topics and methodologies which the iSchools might contribute to DH.

Existing studies of DH curricula have surveyed programs (Sula et al., 2017), course syllabi (Spiro, 2011; Terras, 2006), instructors (Croxall & Jakacki, 2019), and practitioners (Clement & Carter, 2017), and numerous articles have discussed the development of DH programs and courses in specific locations, such as community colleges (McGrail, 2016), colleges of liberal arts and science (Alexander & Davis, 2012; Buurma & Levine, 2016), graduate education (Selisker, 2016), and libraries (Rosenblum et al., 2016; Varner, 2016; Vedantham & Porter, 2016). While several of these have addressed how librarians learn and then teach DH, none has systematically examined DH courses within iSchools as a whole, despite these being responsible for training information professionals for work in libraries, archives, museums, and other environments that have been identified as key sites of DH work and partners for collaboration.

Data on DH courses were collected by manually inspecting course catalogs and program websites for all 109 schools listed in the iSchools Directory and identifying courses which explicitly include the phrase *digital humanities* in the title or description. (It should be noted that several schools allow students to take courses offered outside of the iSchool; courses in these other disciplines were not included here, though they may merit further study.) A total of 34 courses were identified across 26 institutions, and syllabi for 24 courses were obtained through web searches or through direct requests to the instructors. Course titles, course descriptions, syllabus topics, learning outcomes, sources cited, assignments, and technologies were analyzed using frequency and text analysis. Additional details on methods are available (Sula et al., 2020; Sula & Berger, 2020).

TABLE 2 Selected titles of digital humanities courses offered in iSchools

Introductory course titles	Advanced course titles
Digital Humanities	Advanced Projects in Digital Humanities
Introduction to Digital Humanities	Data Science in the Humanities
Survey of Digital Humanities	Technologies and Tools of Digital Humanities
Humanities Information	Programming for Digital Humanities
History and Theory of Digital Humanities	Digital Humanities Capstone
Digital Humanities Librarianship	Digital Humanities Practicum

Around one-quarter of iSchools offer DH courses, and most of those have only a single course in digital humanities. In schools with two or more DH courses, the first one is routinely an introduction to theory and methods, followed by those on projects or specialized methods and technologies, such as text mining (see Table 2). Notably, the iSchool courses cover concepts such as data, research, libraries, and cultural heritage (in distinction to DH courses offered in other settings), and critical evaluation and reflection (see Figure 1) appear frequently in the learning outcomes (in common with DH courses offered elsewhere). The iSchool courses generally cover technologies for text analysis (Voyant, TEI, AntConc, Mallet), programming (Python, Jupyter Notebooks), content management (Omeka), and data visualization (mapping, networks, timelines) (Anthony, 2020; McCallum, 2002; Project Jupyter, 2021; Roy Rosenzweig Center for History and New Media, 2020; Sinclair & Rockwell, 2021; TEI Consortium, 2020).

To identify the main topics covered in DH courses, we used computational techniques of structural topic modeling to analyze the course descriptions in programs

FIGURE 1 Word tree visualization of learning outcomes in iSchool digital humanities courses. The size of the word reflects its frequency of occurrence in course learning outcomes. Stopwords have been removed

from any school, department, or discipline, not just from iSchools. For this study, a total of 426 DH course descriptions (comprising a corpus of 1,694 terms and 19,096 tokens) were collected and analyzed, using a snowball sampling method of the DH program registry as well as known DH programs in December 2020. The data—extracted from extensive searching and browsing of the DH program websites—consists of the country, level of study (e.g., undergraduate and graduate), type of program (e.g., Bachelor of Arts, Master of Science, certificate and major/minor), university, course title, field of study, and course description.

We used structural topic modeling (STM) to identify a topic model that includes the document-level metadata (Roberts et al., 2016, 2019). Similar to other topic models, the framework captures the document topics through Latent Dirichlet Allocation (LDA). The STM model is able to estimate the prevalence of topics and topical content by the document-level metadata. Specifically, we built a model that estimates the relationship between

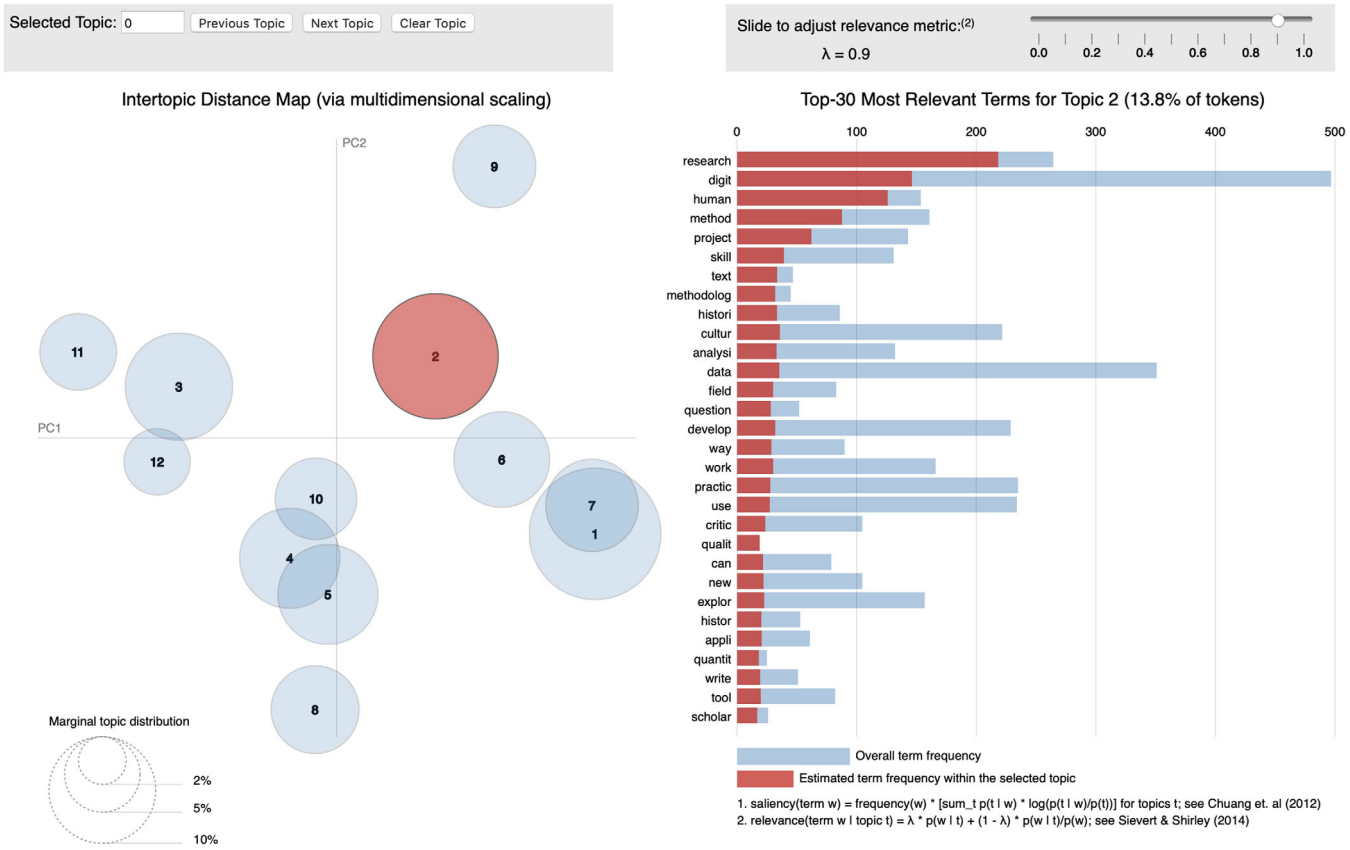

FIGURE 2 Interactive topic model visualization showing intertopic distance [Color figure can be viewed at wileyonlinelibrary.com]

document-level metadata (i.e., course description and field of study) as well as topical content. Topic prevalence was a function of the "field of study" variable, which was coded as being humanities or digital-oriented. In other words, we specified the field of study as a covariate in topic prevalence for the course description.

Our analysis has identified a total of 12 topics across DH programs by a data-driven approach to select the number of topics as well as a qualitative analysis of the topics, aided by an interactive visualization of the topic model (Sievert & Shirley, 2014) (see Figure 2). The descriptive labels we assigned to the 12 identified topics are:

Topic 1. Socio-political theory and concepts.
Topic 2. Software programming and development.
Topic 3. Management of language resources.
Topic 4. Critical digital media and socio-cultural impact.
Topic 5. Statistical data analysis.
Topic 6. Contemporary digital art and production.
Topic 7. Text, geospatial data analysis, and modeling.
Topic 8. Design and evaluation of human computer interfaces.
Topic 9. Critical history of cultural heritage issues.
Topic 10. Web applications, architecture, and metadata.
Topic 11. Public communication and production.
Topic 12. Interactive data visualization.

Further analysis reveals the topic proportions and their correlations in the model. Specifically, topics of 12, 8, 7, 10, 4, and 5 had a larger topic proportion than other topics. Figure 3 illustrates the correlations among the topics and their relationships, with particular references to two main clusters of topics: (2, 5, 7, 8, 10) and (1, 4, 6, 9, 11), representing the digital-oriented and humanities-oriented course topics, respectively. These topics can also be hierarchically organized, resulting in five clusters of topics: (3, 12), (5, 7), (2, 10), (9, 11), and (1, 4) (Figure 4). Overall, our results reveal the core components of DH courses and their relationships by structural topic modeling and visualization techniques.

4 | COLLABORATIVE DISCIPLINES

As noted above, many iSchool DH programs are offered in collaboration with other academic units at a given institution. To get a broad picture of the collaborative relationships that shape DH curricula in iSchools, we

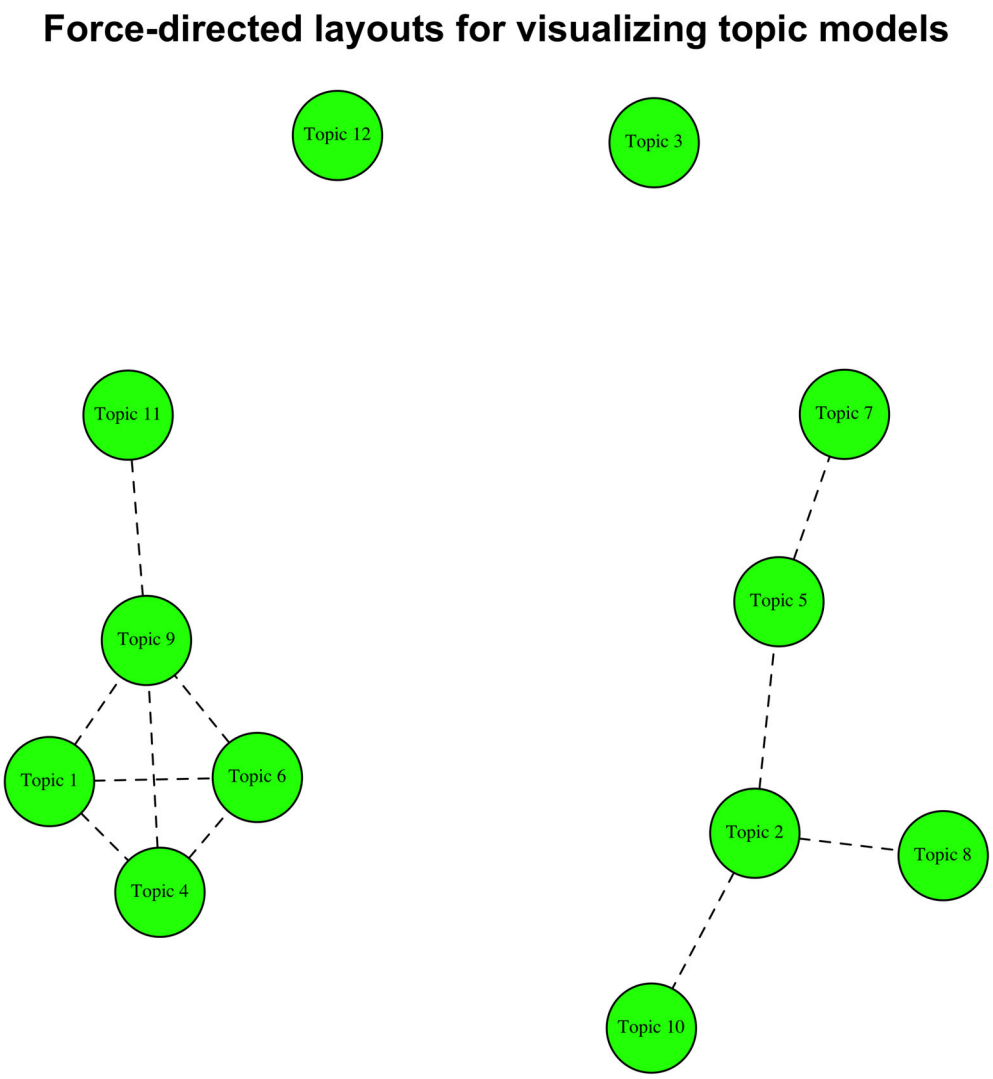

FIGURE 3 Network visualization of topic model showing topic correlations [Color figure can be viewed at wileyonlinelibrary.com]

surveyed the members of our committee, many of whom are active participants in such collaborations. In general, we found that iSchools interact mostly with humanities and computer science departments.

These collaborations fall into four paradigms along a spectrum of engagement. First, some iSchools have no DH program, or a DH curriculum which is only offered to students within their school. In a second, the iSchool may engage informally with DH, and students both within and without the iSchool are able to develop DH expertise by taking iSchool classes. Third, the university may have a DH center that offers formal DH programs and credentials, but iSchool courses, alongside courses from other schools and departments, are components of those programs. Finally, some universities have or are planning to establish formal DH programs and credentials within the iSchool that include a broad and organized collaboration with external departments.

One such broad and organized collaboration is currently being planned at Sungkyunkwan University (SKKU) in South Korea. SKKU intends to create a new College of Computing and Informatics (iCollege) that can equip humanities and social science students with the ability to enhance their domain knowledge by gaining a solid foundation in data-analytics and interpretation. Humanities and social science students at SKKU will be strongly encouraged to pursue a second major in digital humanities or social informatics, majors that will be offered by the iCollege. The iCollege will also be responsible for offering foundational courses to serve both iCollege students and students from the College of Humanities and the College of Social Science. The collaborative model at SKKU includes encouraging faculty from Humanities and Social Sciences to have joint appointments with the iCollege.

Many survey respondents felt that DH represents an opportunity for iSchools, since connections with other

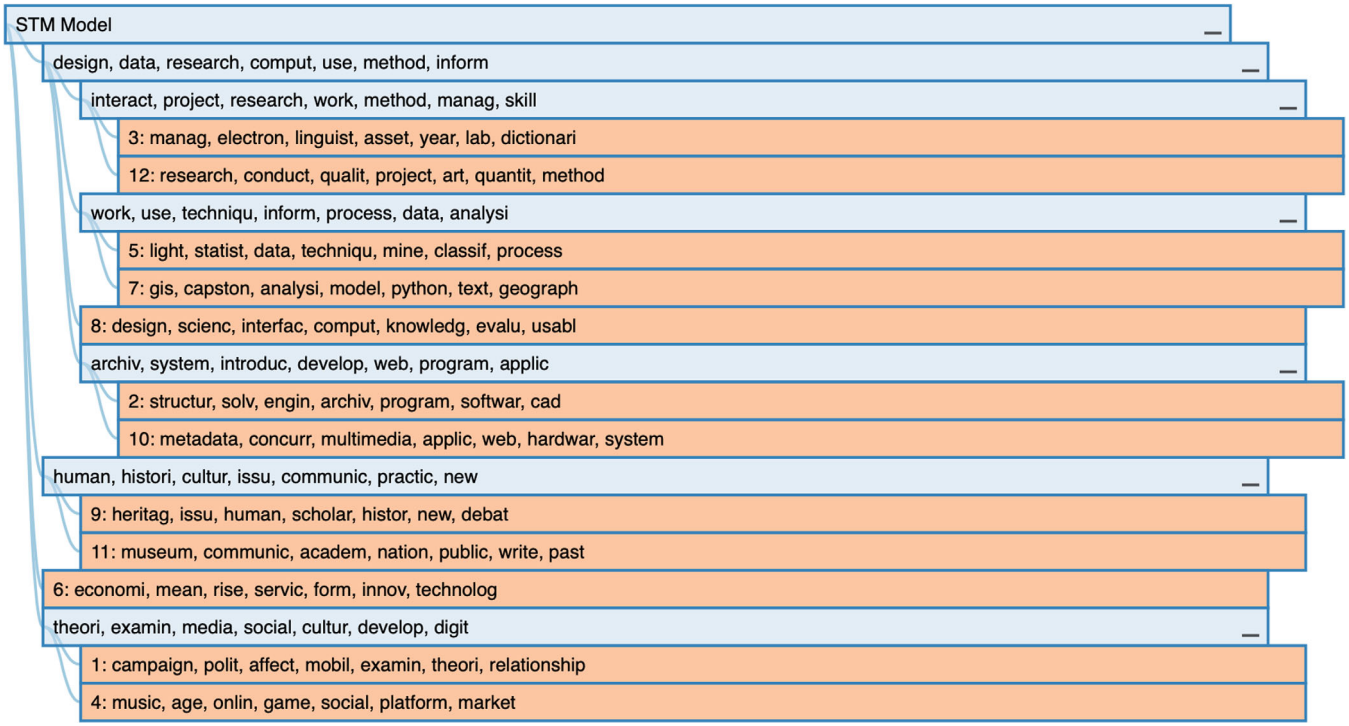

FIGURE 4 Hierarchical display of structural topic model (STM) [Color figure can be viewed at wileyonlinelibrary.com]

disciplines may enhance collaboration, broaden diversity of perspective, and provide "opportunities to illustrate the breadth and reach [of] iSchool research." Two respondents expressed a sense that DH represents an opportunity especially for emerging bachelor's degrees. Alternatively, several respondents also suggested that collaborations with other disciplines could encourage a misleading division of labor, if "colleagues outside the iSchool think that iSchool faculty bring technical expertise and the humanities faculty bring content and theoretical/critical expertise." On this issue, however, our survey revealed persistent differences of opinion. Some respondents were happy for the iSchool to be seen as contributing technical expertise, while others suggested that their institution was outgrowing this division of labor. It seems in any case to be a model that many people have encountered.

Looking more closely at a particular region, we examined the status of organizational, physical, technical, and social infrastructures and how these influence DH programs in Library and Information Studies (LIS) schools drawn from 22 selected universities in Africa. The study further examined the strategies, collaborations, and partnerships that exist in LIS Schools delivering DH instruction. University websites were used to identify the 22 universities with programs in information science and humanities. An online questionnaire was emailed to the deans and heads of departments in the respective universities. Responses were received from 15 universities.

The study was informed by the wider scientific domain in modeling interdisciplinary relationships between information sciences and humanities and research units (Rosenbloom, 2009). In terms of organizational infrastructure, 79% of these LIS schools offer the following programs: Library and Information Studies; Archives and Records Management; Publishing and Media Studies; Information Technology; Computing and Informatics. Only 33% of the institutions surveyed are actively engaged in DH research and scholarship. Although 91% of LIS Schools in Africa have dedicated computer laboratories that support teaching, learning and research, our questionnaire established that the physical and technical infrastructure was inadequate. On a more positive note, digital libraries (72.7%), digital archiving (54%), and institutional repositories (90.9%) are widely used to support DH activities in the universities. Eighty-two per cent of the respondents anticipate the integration of DH in their curricula. A significant number of respondents (91%) are collaborating with humanities departments in teaching and curricula design as well as in research.

This focused regional study concludes that DH initiatives are slowly taking root in universities in Africa. There is a need to create more awareness of DH through workshops and conferences tailored to DH thematic

areas. More ambassadors of DH are required in all the regions of Africa.

5 | CAREERS

After analyzing DH in the iSchools, we turned our attention to DH jobs available to the graduates of iSchool programs. The goal of this employment analysis is to determine—by examining required or preferred qualifications in job advertisements—the technical competencies sought in DH professionals. A detailed analysis of the technical skills, expertise, and other competencies required for DH positions can be used by iSchool programs in tailoring their curricula to better serve the needs of students and employers; this will better equip graduates with the skills and real-world experiences needed for leadership in the DH field or the workplace.

The job advertisements were drawn selectively from position announcements listed in Digital Humanities Now (2021), an online news source that distributes digital humanities scholarship and resources, published between January 2010 and December 2019. *Digital Humanities Now* was chosen as it has a wide appeal and aggregates position announcements from various sites, including HASTAC (https://www.hastac.org), dh + lib (https://dhandlib.org), and DigitalKoans (https://digital-scholarship.org/digitalkoans). The study harvested job advertisements for positions based in the United States that included keywords such as "digital humanities" or "DH" in the job description. The study excluded faculty positions that primarily involved research, teaching DH courses, or advising students. Reopened position announcements were not examined. Institutional websites were consulted for the complete ad if only a partial description was provided in the original advertisements.

A total of 194 unique advertisements were identified for inclusion in this study. They were ingested into QDA Miner, qualitative data analysis software (Provalis Research, 2021). Position announcements were analyzed for employer types, position titles, and required/desired technical competencies. A coding scheme was developed and used to categorize the data for further analysis, with codes assigned to label specific sections of the job advertisements. The frequency with which coding category occurred was calculated and represented as a percentage.

5.1 | Employer types

DH positions are centered in higher education institutions ($n = 188$, 96%). Of those institutions, more than two-thirds of the job advertisements represented institutions classified as "Doctoral Universities – Very High Research Activity" ($n = 153$). The others include "Baccalaureate Colleges: Arts & Sciences Focus" ($n = 18$) and "Master's Colleges & Universities: Larger Programs" ($n = 7$). The larger percentage of institutions in the research university category may reflect the fact that the research institutions have increased staffing to support DH research.

Of those job advertisements for higher education institutions, the type of academic unit responsible for the largest number was the academic library ($n = 127$), which accounted for 65% of those sampled for this study. This confirms that academic libraries have played a crucial role in supporting and promoting digital humanities scholarship in their communities (Kasten-Mutkus et al., 2019; Sula, 2013; Zhang et al., 2021). The next largest employer in this sample was university DH centers ($n = 56$), which often take the form of joint ventures among a few academic departments, or partnerships between academic departments and other academic or service units—such as a library or information technology services—to serve as an interdisciplinary research hub (Anne et al., 2017). The remaining institution types represented here were other cultural heritage institutions ($n = 9$), including museums and public libraries, and private sector employers, such as publishers ($n = 2$).

5.2 | Position title

Because of the variety of employer types and library departments employing DH personnel, we expected the job titles to be diverse. The most commonly occurring words in the position titles were "digital humanities" ($n = 57$) and "digital scholarship" ($n = 42$), which appeared in 51% of the job advertisements. The variation of words and phrases that we found in the job titles indicated that DH is combined with activities such as research, instruction, digital project management, digital publishing, digital collection services, and scholarly communication. Commonly occurring words in the job titles that suggested the position's role were "librarian" ($n = 64$), followed by "specialist," "developer," and "manager."

Chi-square tests were run to determine the association between words used in the job titles and employer types. The words "digital scholarship" ($\chi = 21.86$, $p < .01$) and "librarian" ($\chi = 45.16$, $p < .01$) appeared more frequently in academic library positions; this finding suggests that a digital scholarship service model is common among libraries developing support for DH and that DH librarians are expected to engage with the development, implementation, and support of DH research and pedagogy. Titles with "manager" ($\chi = 20.16$, $p < .01$), "director" ($\chi = 9.37$, $p < .05$), or "project"

TABLE 3 Technical competencies for DH

Category	Competency	No. (%)
Digital stewardship	Digital content platform	69 (35.6)
	Metadata	57 (29.4)
	Copyright	26 (13.4)
	Digital collection/exhibit	21 (10.8)
	Digitization	20 (10.3)
	Digital media production	19 (9.8)
	Digital preservation practice	18 (9.3)
	Data management	18 (9.3)
	Digital file formats	6 (3.1)
DH research methods and tools	Text analysis/mining	63 (31.8)
	Data visualization	62 (31.2)
	GIS/mapping	49 (20.3)
	Text encoding	28 (14.4)
	Network analysis	23 (11.6)
	Image analysis	13 (6.6)
	Data analysis (quantitative/qualitative)	12 (6.1)
	AR/VR/3D modeling	12 (6.1)
	Web scraping	4 (2.0)
	Data cleaning/manipulation	4 (2.0)
System administration and software development	Scripting language	64 (33.0)
	Website development	59 (30.4)
	Relational database	45 (23.2)
	XML and related standards	20 (10.3)
	Web application framework	18 (9.3)
	Operating system (Unix, Linux, OS)	17 (8.8)
	Version control system	16 (8.2)
	Linked data and semantic web	14 (7.2)
	Usability testing	12 (6.2)

($\chi = 12.02$, $p < .01$) were favored in DH centers. This implies that university DH centers are seeking managerial and project management expertise.

Although the number is small, museums used some unique phrases, such as "digital experience" ($\chi = 43.10$, $p < .01$) and "digital conversion" ($\chi = 19.50$, $p < .01$).

5.3 | Technical competencies for DH

Technical competencies for DH professionals were categorized by the following three broad categories: Digital Stewardship Competency; DH Research Methods/Tools Competency; and System Administration and Software Development Competency. Table 3 presents a variety of areas of technical knowledge, skills, and abilities required or preferred for DH professionals.

DH professionals are expected to have an array of basic and specialized skills and knowledge to support activities related to the digital object lifecycle to be competitive in the job market. In our study, Digital Stewardship Competency was required in 63% of the job ads ($n = 122$).

Working knowledge of and demonstrated experience with digital content platforms appeared most frequently ($n = 69$). Digital content management systems and/or digital publishing platforms that were specifically mentioned by employers include Omeka (Roy Rosenzweig Center for History and New Media, 2020), WordPress (Wordpress, 2020), Scalar (Alliance for Networking Visual Culture, n.d.), CONTENTdm (OCLS, 2021), Fedora (Duraspace, 2020), and DSpace (Duraspace, 2021). Knowledge of metadata standards, such as Dublin Core (Dublin Core Metadata Initiative, 2021), MODS (Library of Congress, 2020a), and METS (Library of Congress, 2020b), and controlled vocabularies, in addition to experience creating metadata ($n = 57$), appeared next most frequently, followed by familiarity with copyright, licensing issues, and fair use practices for digital objects ($n = 26$).

As the DH field frequently involves the creation and analysis of digital content and media, it is not surprising that knowledge of digitization best practices ($n = 20$), along with digital media production skills ($n = 19$), which includes experience with graphic design, audio/video editing and streaming, and image processing applications, are also frequently listed as required or desired skills for DH professionals.

Nearly half of the job advertisements ($n = 89$) included a requirement for technical proficiency in DH research methods and tools. Text analysis/mining appeared most frequently ($n = 63$), followed by visualization ($n = 62$). Text analysis/mining, which involves the computational analysis of textual data, is often used as an umbrella term for a range of strategies, including the application of natural language processing and machine learning tools, topic modeling, sentiment analysis, and document classification. This is not unexpected as a range of text-mining strategies, as applied to large and diverse text corpora, have become a fundamental methodology in much DH research. Other technical competencies related to textual data include web scraping ($n = 4$) and text encoding ($n = 18$).

Visualization also has been used as a popular methodology to illustrate and make sense of text and other types of data, including quantitative, spatial, and temporal data. In the job advertisements collected in our study, visualization was frequently included as "experience or

familiarity with data visualization tools and techniques applied to humanities." Other job advertisements mentioned specific visualization tools, such as D3.js (Bostock, 2020), Plotly (2021), Tableau (2021), and Gephi (Gephi.org, 2017). Similarly, maps and GIS provide additional mechanisms to present data visually, as either an alternative or supplement to narrative text in DH research and projects. GIS and mapping were frequently mentioned in the job advertisements ($n = 49$). A number of positions requested experience with specific mapping tools, such as QGIS (2021), ArcGIS (Esri, n.d.), Google Earth (Google, n.d.), and Leaflet (Agafonkin, 2019), whereas others asked for demonstrated proficiency in geospatial analysis.

The data also reflected a moderate but growing need for other computational methods, including network analysis ($n = 23$) and image analysis ($n = 13$). Proficiency in data analysis ($n = 12$) was also often included as a required or preferred skill set, including knowledge of statistical models and experience with statistical analysis tools, such as SPSS (IBM, n.d.), Stata (StataCorp, 2021), SAS (SAS Institute, 2020), and R (R Foundation, n.d.), as well as qualitative data analysis software, such as ATLAS.ti (2021) and NVivo (QSR International, 2021).

System administration and software development competency was also mentioned in more than half the job advertisements ($n = 92$). The list under this competency confirms that skills in web and software development, web and project hosting, and custom application configuration are all in high demand.

The most frequently mentioned competency in the area of system administration and software development was familiarity or experience with less-formal, procedural scripting and programming languages ($n = 64$). Python, which seems the most popular programming language of choice in humanities research, especially for many text-analysis tasks, was frequently mentioned in the advertisements. Other languages like PHP or Ruby, which are often used for creating web-based interfaces to databases, were also included. Along with scripting language, other skills involving DH web applications were also regularly listed as required or preferred qualifications, including experience with relational databases in the creation of dynamic data-driven web applications ($n = 45$); web application frameworks, such as Django (Django Software Foundation, 2021), Flask (Pallets, 2010), and Ruby on Rails (n.d.) ($n = 18$); and linked data/semantic web technologies like RDF and JSON-LD ($n = 16$).

A significant number of employers ($n = 59$) prefer applicants to have front-end web development and design skills, which was often stated as "understanding of web design standards using HTML, CSS, and JavaScript, and web development platforms." Web design skills were often combined with knowledge of usability testing and user experience design ($n = 12$).

The ability to work in a Unix/Linux-based server environment ($n = 17$), which the vast majority of web-based projects run upon, also seems to be part of basic DH literacy. In addition, version control through Git and Github ($n = 16$) is becoming ubiquitous for DH developers.

Some differences were seen in technical competencies between academic libraries and university DH centers. Chi-square tests revealed that the following Digital Stewardship Competency areas were more frequently mentioned in academic library DH positions: metadata ($\chi = 12.05$, $p < .01$), copyright ($\chi = 9.45$, $p < .01$), data management ($\chi = 8.65$, $p < .01$), digital collection/exhibit ($\chi = 7.82$, $p < .01$), digitization ($\chi = 6.78$, $p < .01$), and digital preservation practice ($\chi = 5.27$, $p < .05$). There were no significant differences among employer types regarding requirements for the DH Research Methods/Tools Competency and System Administration and Software Development Competency. This implies that the call for technical expertise for the design and development of DH research and scholarship, which includes skills for computational research tools and approaches as well as skills for implementing and managing applications and systems, is common to all types of DH employers.

6 | MANAGEMENT AND ADMINISTRATIVE CHALLENGES AND OPPORTUNITIES

Rather than relying on a systematic survey of digital humanities centers, which would have raised ethical issues about confidentiality, this section is grounded on and draws evidence from the experiences of establishing and running DH master's programs in two different European iSchools. The discussion that follows is based on the experiences of implementing a campus-based DH program at University College London, UK (UCL) and an online program at Linnaeus University, Sweden. Here we pull together both the challenges and opportunities involved that we expect to be common to any institution.

Any new program needs to be justified with regard to demand and resources with a business case that sets expectations of student numbers as well as how the program would fit into existing infrastructure and provisions. Senior management needs to be convinced of the value as well as the necessity for a new program (or indeed a new center that would take responsibility for the program) before being willing to divert limited resources from already stretched budgets (Golub &

Milrad, 2020; Warwick, 2012). Those designing and requesting resources for a new program must develop a narrative about the program's importance, how it moves scholarship forward, and how it supports research to better understand the human condition.

Demand for a new program is difficult to quantify, but analysis of the job market and the skills that give graduates an advantage there (as in our job advertisement analysis above; see also Billore & Golub, 2017) can create a strong argument, together with increasing graduate student numbers, particularly as a feeder for doctoral studies (Mahony & Pierazzo, 2013). One can also tap into competitive instincts by drawing attention to peer institutions—with a similar ethos and/or institutional and demographic ranking—that are demonstrating success with digital humanities programs. The new program presents an opportunity for developing new interdisciplinary courses and establishing teaching relationships where materials and expertise can be shared (Mahony et al., 2016). A typical DH program requires a core curriculum, sometimes based in an iSchool, supplemented by a range of optional/elective courses drawing on expertise across the institution, and possibly beyond with external partners and collaborating institutions (as seen in the section on education models above). Collaborators across the institution may also participate in capstone and dissertation project supervision. Student mobility across departments has advantages in support of interdisciplinary collaboration and broadening the curriculum, but it also comes at a cost with institutional models for cross-charging where the money (for tuition and other fees) follows the student; this mobility within the institution could mean that part of the home unit's income from student tuition fees would be diverted to other departments. Nevertheless, for the university as a whole, this would be an advantage if more students overall are attracted as a result.

For those considering designing and implementing a DH program, an additional question is the extent to which the program is wholly new or rather a reconfiguration of existing and perhaps newly designed courses that have been brought in line with the overall program aims. The former has significant implications for staffing and infrastructure, including library and other resources for teaching. The latter model may prove more desirable to senior management as it necessarily relies more on existing staffing and infrastructure and may be achievable with minimal new investment; it would also enhance interdisciplinarity across the university, a goal toward which many institutions are striving.

As discussed above, many different educational models exist for iSchool DH education, ranging from the individual undergraduate or graduate course, to minors, tracks, and specializations, to full undergraduate and graduate degree programs. Introductory DH courses, offered by the iSchool but that may be deployed across, for example, the arts and humanities, social sciences and/or computer science, may serve to stimulate interest in the iSchool programs more broadly and attract students who may not otherwise be aware of the relevance of these offerings to their own interests and career goals. Similarly, programs offered in collaboration with units from the arts and humanities, social sciences, and computer science may introduce new students to iSchool research and teaching. All these collaborations could contribute to interdisciplinary research addressing complex societal challenges, which is often a key element of a modern university's vision and strategy.

Any model requires approval from the decision-making bodies and individuals from the department that will host the program as well as from others higher up the institutional hierarchy. To support the approval process, program designers should anticipate questions about student enrollment numbers, conduct preliminary market research to establish demand (see, e.g., Billore & Golub, 2017), and write a persuasive and evidence-based business plan that may be presented to the decision-makers (such as, e.g., the SWAT analysis presented by Golub & Milrad, 2016). Other topics that should be addressed in a business plan include publicity and marketing, facility and space requirements, and additional staffing needs.

Expected student numbers are always going to be speculative for a graduate program and can never be confirmed until enrollment is completed. The current pandemic seems to indicate that, despite the difficulties and campus restrictions with much face-to-face contact being lost, students are still willing to attend in person. Figures from the UK Universities and Colleges Admissions Service (UCAS, 2020) show an increase of 12% in students from outside the EU holding a firm offer for a place in the 2020 cycle compared to the previous year. It should be noted that this is for undergraduate rather than postgraduate students, and the same document shows a 6% fall in the number of EU students, which was to be expected with the uncertainty over BREXIT. Further, these figures are from June 2020 for firm offer holders rather than the actual numbers that have enrolled. In *The Guardian*, Adams reports that in 2020 there has been almost no increase in the expected deferrals to the next year because of anticipated campus restrictions (5.7% compared with 5.4% in 2019) although they do not give the source of those data (Adams, 2020). The data for 2019/2020 UK enrolments available at HESA, *Higher Education Student Statistics: UK, 2019/2020* show a continued decline in undergraduates ("6% each year from 2017/2018 to 2019/2020") and increase in postgraduate

students, particularly for 2019/2020, with the rise "largely due to an increase in enrolments from non-European students (HESA, 2021) ." In the UK, certainly, despite BREXIT and the global pandemic, overall student numbers have seen an increase. Publicly available figures for graduate students at UCL for the current session are not available (UCL, Student and Registry Services, 2021). There has, however, been an overall growth in the number of UK postgraduate students over the last decade: "[T]he number of postgraduate starters increased by 16% between 2008/2009 and 2017/2018, with growth particularly marked among the 'non-EU' cohort (+33%)" (House, 2020, p. 2). Notwithstanding this, the issues over campus restrictions imposed following the pandemic have clearly demonstrated the logistical advantage of deploying an online distance delivered program although, judging by the numbers above, a significant number of applicants still want the campus experience. Either way, a variety of pedagogy and assessment types are needed as well as an agile approach to enable a quick response to changing circumstances. In addition, the experience of Linnaeus University demonstrates that opening up the program courses to non-program students proved an effective way to address sustainability issues and to counter decreasing retention rates of (especially online) students.

The most crucial element to the successful launch of a new program is the support from senior management; institutional support is essential to any new venture whether that be a new DH program or a center to host it. The advantage to the institution needs to be made clear and presented in such a way as to ensure that support is forthcoming and, importantly, sustained.

7 | CONCLUSION

The purpose of this study was to investigate DH education as practiced in iSchool contexts around the world. As our study demonstrates, a significant number of iSchools are engaged in DH research and instruction, with around a quarter of iSchools offering at least one digital humanities course. Our study also reveals a diversity in the models for DH education, from individual courses, certificates, minors and specializations, to full degree programs.

The diversity of iSchools makes it difficult to recommend a common curriculum for digital humanities programs in iSchools. Some iSchools are rooted in library and information science while others offer full-blown computer science and engineering programs. On the other hand, the disciplinary and methodological diversity of DH means that virtually all iSchools may offer a credible digital humanities program, even if the DH curriculum varies a great deal from one iSchool to the next. As noted above, our analysis of DH courses and curricula found that iSchools that are engaged in digital humanities teaching typically offer one or two dedicated DH courses. A single course can introduce students to common definitions, concepts, and research methods for DH research, emphasizing those definitions, concepts, and methods best supported by a particular iSchool's expertise and orientation. A second, advanced course may provide opportunities for applied, project-based DH work. A dedicated course or two may then provide the foundation or core of a DH program, supplemented by the many other courses typically offered in an iSchool. Our analysis of DH careers—as represented in job advertisements that list the skills and expertise that employers seek in applicants for DH positions—likewise reveals great diversity, ranging from highly technical systems administration and software development skills, to digital research methods, to digital stewardship expertise. These topics are commonly covered in iSchool curricula in courses that may not be explicitly about digital humanities but are nonetheless extremely relevant. Future research on DH curriculum design might attempt detailed mapping and tracking of the curriculum to the specific competencies identified in our analysis of DH job advertisements and may seek to identify gaps in programs by mapping existing iSchool courses to key DH topics.

An important takeaway from our study is that iSchools are a vitally important component of the DH intellectual landscape and larger organizational ecosystem. For instance, our analysis of job advertisements shows a number of required or desired competencies, such as metadata, copyright, digital collections/exhibits, digitization, digital preservation, and more, that fall clearly within the disciplinary domains claimed by information science, library science, and the wider iSchool community. The broad purview of iSchools includes many, if not all, of the other competencies identified by our study. iSchools then clearly have a great deal to contribute to the *digital* and methodological aspects of the digital humanities. The historical and ongoing connections between the iSchool community and the information and library science community bring strengths in cultural heritage, documentation, and the ongoing stewardship of the record of human knowledge and creativity. These latter strengths—along with well-defined research areas such as knowledge organization and ontology; history and philosophy of information; science, technology, and society; intellectual freedom; and critical information studies—allow for significant contributions from the iSchool community to the *humanities* aspects of digital humanities. Building on these many strengths in the field

of DH, iSchools should proactively aim to host and lead digital humanities programs, while also collaborating with other units and disciplines. Through collaborative DH programs, iSchools may strengthen relationships with relevant units and disciplines outside the iSchool and expose new audiences to iSchool teaching and research. iSchools should clearly articulate their interdisciplinary expertise (technical, scientific, humanistic, critical, theoretical) and their relevance to digital humanities.

Both independently and in collaboration with partners from other disciplines, iSchools are playing an important role in delivering digital humanities training and education to new generations of information professionals, librarians, and researchers. This snapshot of DH in the iSchool should provide useful guidance to iSchools in developing new or revising and evolving existing digital humanities programs.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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ENDNOTE

[1] Common Language Resources and Technology Infrastructure (CLARIN) and Digital Research Infrastructure for the Arts and Humanities (DARIAH) are each a European Research Infrastructure Consortium (ERIC) (European Commission, 2009).

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