

Information Technology and the Humanities Scholar: Documenting Digital Research Practices

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Digital tools offer new affordances and methodologies to humanities scholars' research. This study used a constructivist grounded theory approach to examine humanities scholars' research practices, including their use of a wide range of resources and digital technologies. Using in-depth study, several themes emerged from the research relating to the role of technology in shaping humanities scholars' research practices. The themes include: (a) humanities scholars' research approaches and technology tools; (b) the humanities scholar as tool developer; (c) the role of data preparation as a meta-level research practice; (d) data visualization versus numeric outputs—one size does not fit all; (e) the importance of flexibility and agency; (f) technology tools in support of the researcher as writer; and (g) working alone/working together—technology tools and collaborative practice. The heterogeneous nature of humanities scholars' research practices are explored and the resulting implications for digital tool design. Two new research practices—tool development and data preparation—are proposed. The diverse digital technologies humanities scholars use support the traditional ways of working within their discipline, as well as creating potential for new scholarly practices.

Introduction

Scholars are influenced by historic, disciplinary work practices, by personal preferences, and by social, cultural, and environmental contexts affecting research practice. Traditionally, humanities scholars' work is depicted as independent, where scholars conduct research and publish alone

(e.g., Stone, 1982; Watson-Boone, 1994). This image of the “solo” scholar continues to be reflected in studies about humanities research (Bronstein, 2007; Toms & O'Brien, 2008) and influences the institutional supports scholars are offered, including information literacy instruction and computing infrastructure. However, for many humanities scholars, particularly those working with large datasets or who conduct research in digital spaces, daily practices are changing. Although humanities scholars continue to value and use physical resources (e.g., Baruchson-Arbib & Bronstein, 2007; Martin & Quan-Haase, 2016; Rimmer, Warwick, Blandford, Gow, & Buchanan, 2008) and some scholars may prefer reading in print (e.g., Kachaluba, Brady, & Critten, 2014), e-books are used by many humanities scholars (e.g., Chrzastowski & Wiley, 2015) and digital texts are an increasingly integral part of their scholarship (e.g., Borgman, 2009; Kachaluba et al., 2014). Despite their increasing importance, problems with digital texts may remain, such as issues with authority (Sinn & Soares, 2014). Technology tools and innovative practices play a significant role in humanities scholars' research. Few studies, to date, explore how humanities scholars integrate information technologies into daily research practices.

This study presents empirical data of humanities scholars' experiences, documenting their approaches to information technology use as a core element of research practice. The primary objective of this study was to operationalize the concept of “digital research as practice” for humanities scholars, examining how they use technology to accomplish various research activities. The study explored the following research questions: (a) What are the research practices in which humanities scholars engage in conducting digital research? and (b) What are humanities scholars' perceptions of the technology tools they use in their research? The results provide a glimpse into the complex ways that

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humanities scholars have integrated historic, individualized research practices with new, digital research environments.

Humanities Scholars' Ways of Working: A Brief Overview

Many studies have examined humanities scholars' information needs, seeking, and use (e.g., Baruchson-Arbib & Bronstein, 2007; Ellis & Oldman, 2005; Pilerot, 2014; Stone, 1982; Sukovic, 2008; Watson-Boone, 1994). However, little research explores the range of information activities in which humanities scholars engage or focus on research practice in digital environments. Chu (1999) produced a five-stage model of literary critics' research process, which was later amended and used by Toms and O'Brien (2008) to understand the technology needs of e-humanists. The categories of work outlined by Toms and O'Brien include: idea generation (creating ideas and starting projects); preparation (locating and synthesizing materials); elaboration (focusing on the project); analysis and writing (drafting and revising); and dissemination (distributing the work; p. 105). Although this framework was used with e-humanists in the context of their research, it is limited in two significant ways. First, it combined analysis and writing as a single category of research work, despite the unique and varied tasks that comprise these activities; and second, it did not include the management of data gathered, as a research practice. There may be an increasing acknowledgment of the importance of managing collected resources, including activities such as "clean-up or preprocessing" and creating file structures and category hierarchies (Trace and Karadkar, 2017, p. 501).

Traditionally, humanities scholarship has involved researchers engaging with and reflecting on texts, broadly defined as that which can be "read," regardless of format (e.g., written, audio, visual). This scholarship requires little specialized equipment or infrastructure. Although the natural and health sciences disciplines build and maintain substantial research infrastructure (e.g., wet labs, server rooms, clinical practice rooms), humanities researchers have typically relied on personal collections, public archives, academic libraries, and other sources of data requiring small-scale computing power. The increase in the use of technology tools to conduct humanities research over the past decade, as well as the development of technological innovation as a particular focus of humanities scholarship, has changed these scholars' ways of working (e.g., Baruchson-Arbib & Bronstein, 2007; Brown, 2002; Dalbello, 2011; Toms & O'Brien, 2008). Researchers in the discipline of digital humanities, for example, focus on the use and development of technologies to understand and interpret texts; this discipline is inherently collaborative in its research design, where humanities scholars work alongside computing scientists, information scientists, and scholars from other disciplines in large teams. This new research focus in the humanities influences the technological resources and supports humanities scholars require. Yet few studies have explored the impact

of technology on humanities scholars' views of their day-to-day work. This article presents research findings exploring humanities scholars' views of technology use in the context of their overall research practices.

Humanities Scholars and Technology Use: A Review of the Literature

Humanities scholars' positive attitudes toward technology use is often tempered by a focus on practicality; many scholars are skeptical about whether technology can adequately meet their research needs and will only adopt tools if a benefit can be seen (Barrett, 2005; Baruchson-Arbib & Bronstein, 2007). If technology proves useful, it is incorporated into a researcher's workflow; some tools become indispensable for everyone (such as e-mail and word processing), with other tools' usefulness is dictated by researchers' individual project management needs (Palmer & Neumann, 2002). If tools cannot be found to suit their purposes, scholars will "cobble together ad-hoc solutions" by using a variety of preexisting digital tools (Trace & Karadkar, 2017, p. 505).

Although many technology uses apply to all scholars, the use of large corpora of texts is a defining feature of humanities scholars' research (Ge, 2010). The use of digital documents is notable, as this alters aspects of traditional humanities scholarship, including the use of what Buchanan (2010) calls "document triage" (p. 126; i.e., scanning great numbers of texts and saving them for further examination), and the building of data archives (Dalbello, 2011). These activities spur new information management practices, including searching large digital collections (Dalbello, 2011). The accessibility of digital texts allows scholars in the early years of their careers (i.e., those with less content knowledge) to ask questions of the texts directly (Ruhleder, 1995). Where, traditionally, scholars spent many years engaged in close reading of a single collection to interrogate its content, digital texts are widely accessible and analysis is undertaken in new ways. When new methods (e.g., data mining) are applied the results can provoke new analytic insights; similarly, when texts are represented abstractly using statistics, patterns in the data emerge over time (Kirschenbaum, 2007). The last decade has seen a major shift in the design and application of humanities scholarship to account for—and benefit from—a wide array of new digital landscapes.

Digitized texts provide improved or easy access, including the ability to work remotely (Rimmer et al., 2008), and specialized analysis tools offer unique affordances that are not possible with physical texts. However, digital sources cannot always serve as substitutes for physical items (Palmer & Neumann, 2002; Sinn & Soares, 2014). For example, digitized documents may have poor image quality or be uniform in output, making documents less engaging (Rimmer et al., 2008). Locating and storing documents can also be challenging; although search engines and databases can enhance ease of access, the quality of the source data is the

deciding factor in whether scholars use a particular item (Bronstein & Baruchson-Arbib, 2007). This can result in lengthy searches or the use of creative search tactics to locate the ideal source. Typical information literacy sessions (e.g., database searching workshops) or general advice on data management (e.g., storing digital files) may not provide the appropriate type or degree of help if these are not designed to suit humanities scholars' needs. Generally, the "if we build it they will come" approach to resource access is not a guiding maxim for this group of scholars (Rimmer et al., 2008, p. 1389).

Traditional text collections, such as those found in libraries and archives, remain important for humanities scholars' research (Trace & Karadkar, 2017; Warwick, Terras, Galina, Huntington, & Pappa, 2008). However, humanities scholars frequently use search engines to find materials, to locate text excerpts, or to check facts (Rieger, 2010; Sinn & Soares, 2014). Toms and O'Brien (2008) found the majority of survey respondents used specialized text analysis tools; those who did not use these tools attributed this to technical issues, lack of compatibility with texts and systems, or lack of available tools for their specific purpose. Toms and O'Brien also found that although most scholars require text analysis tools for their work, few are satisfied with what is available; most scholars do not adapt existing tools or make their own, and many are not aware of what tools can meet their needs. Although technology makes digital texts available, problems with navigation, searching, and annotation, if left unaddressed in system design, will limit humanities scholarship (Buchanan, 2010).

Some digital humanities scholars, to meet their needs, take to developing their own tools. However, development work is hindered in two ways. First, the creation of new tools has not always been accepted within humanities scholarship. Ruhleder (1995) describes tool development as a form of "scholarly production," but notes that it is "traditionally ranked low" (p. 50) in academic status, which has adversely affected tenure and promotion reviews. Although Marchionini (2000) raised this issue more than a decade ago, this continues in disciplines or departments where development methodologies are untested as markers of academic performance. Second, development work requires technical expertise, which in turn requires consistent support from institutions. Often, technical skills were "acquired in a sporadic manner" and institutional support was "haphazard" (Ruhleder, 1995, p. 52).

New studies on digital tools developed for humanities scholars examine the functionality of specific tools or tool collections (e.g., Kornbluh, 2008) and the broader digital research infrastructure (also called cyberinfrastructure or e-research) designed to support humanities scholars' work (e.g., Blanke & Hedges, 2013; de la Flor, Jirotko, Luff, Pybus, & Kirkham, 2010). There are calls for digital infrastructure to be designed for large projects within the digital humanities, particularly to enable collaboration (e.g., Borgman, 2009; Simeone, Guiliano, Kooper, & Bajcsy, 2011). However, these projects have not explored the impact of

new technologies—that is, new tools being developed, such as text analysis tools, and everyday digital resources, such as Google Docs and Skype—within the context of humanities scholars' views of their everyday research practices.

Research Design

This article presents findings from in-depth qualitative interviews with 20 humanities scholars during a session that also included real-time, guided interactions with online text analysis tools. This study is a part of a larger research project, with members of the research team developing text analysis tools and investigating both the development of tools and the use of online text analysis tool portals. The purpose of the study reported in this article was to explore scholars' use of some of the text analysis tools within the larger context of their digital tool use. This study used interviews conducted over Skype to explore humanities scholars' day-to-day use and experiences with the various information technologies they use in their research, including everything from word processing to programming languages. In addition to discussions of scholars' typical technology use, they were also asked to use a series of four text analysis tools developed by members of the research team. This tool use was captured using Camtasia screen recording software. Rather than user experience testing on these specific tools, the real-time engagement with specific text analysis tools prompted discussion of general technology features that scholars found particularly useful, or that inhibited their work. This approach was used to gain feedback from participants about the text analysis tools presented, as well as to discuss the role technology plays in their scholarly work. The project used constructivist grounded theory (Charmaz, 2006) as a framework for the project design and for data analysis. Constructivist grounded theory is both a way to collect data and the result of the data analysis. Data collection is systematic and flexible; iterative data collection and analysis allows constant comparison. The theory that results emerges from the data rather than coming from a priori assumptions (Charmaz, 2008). This methodological approach was used to gain a rich view of scholars' experiences.

Participants

Participants included 15 faculty members and 5 graduate students, recruited from various disciplines; most participants ($n = 11$) worked in the discipline of English, with the rest ($n = 9$) drawn from humanities computing, languages and literature, linguistics, philosophy, visual design, and information studies. To explore a range of perspectives, some participants were familiar with text analysis tools, including the specific tools that were used in the protocol, whereas other participants had no experience with these types of tools. Purposive, maximum variation sampling was used to identify individuals conducting humanities research with a significant focus on digital research practices; participants were identified via postings to listservs, through the researchers' online networks, and using snowball sampling

(Morgan, 2008). Eleven women and nine men were recruited from Canada, the United States, the United Kingdom, Ireland, and Germany, with ages ranging from 24 to 66 (with a median age of 43). Ethics approval for research involving human participants was obtained from research ethics boards at two universities for this study. Participants provided consent for the project and were assigned pseudonyms for use in publications.

Procedures

Semistructured, in-depth qualitative interviews explored participants' use of information technologies in their research, including the use of text analysis tools. Initially, participants were asked some general demographic questions, followed by questions about research, resources used in research, and the role of technology in humanities work. Participants were then asked to use four text analysis tools from two portals designed by members of the larger research team, who were not involved with the design or implementation of this study. The first portal was *Voyant*, a "web-based reading and analysis environment for digital texts" (<http://voyant-tools.org/>), which provides a space to upload a text and then uses a set of text analysis tools to present information on that text in various ways (e.g., word frequencies, visualizations). The second portal was TAPoR, "a gateway to the tools used in sophisticated text analysis and retrieval" (<http://tapor.ca/>), which acts as a curated repository of stand-alone text analysis tools. Tool use involved a guided exploration of features for research tasks, from the participants' perspectives, with the following tools:

1. *Cirrus* (<http://voyeurtools.org/tool/Cirrus/>), a word cloud tool that presents the words in a text in a cluster and represents their relative frequency through font size;
2. *List Words* (<http://taporware.ualberta.ca/~taporware/textTools/listword.shtml>), a word frequency tool that presents the words used in a text and their numerical frequency in a table;
3. *Find Text* (<http://taporware.ualberta.ca/htmlTools/find-text.shtml>), a concordance tool that lists the words used in a text within its immediate context; and
4. *Bubbles* (<http://voyant-tools.org/tool/Bubbles/>), a dynamic word frequency tool that "reads" through a text with accompanying visual and auditory representations, depicting the relative frequency of words through font size and playing a unique tone applied to each word.

Using a digital text of their choice (e.g., a Shakespearean play), participants interacted with the tools using a verbal analysis protocol (e.g., Guha & Saraf, 2005). After engaging with each tool through free exploration, participants were asked a series of questions about the tool—that is, how it worked, what they liked or did not like about the tool's features, whether it fulfilled their research needs, their views on the overall design, and how (if at all) they would improve the tool to support their research. The protocol, which explored scholars' digital tool use in their research and their

feelings about text analysis tools designed for humanities scholars, provided a context-rich exploration of participants' experiences and opinions of their digital research practices.

Analysis

The interview transcripts were analyzed with a grounded theory approach using "guidelines for conducting inductive qualitative inquiry aimed toward theory construction" (Charmaz & Bryant, 2008, p. 375). ATLAS.ti qualitative data analysis software was used to code data in the interview transcripts, iteratively, for emergent themes. A first round of coding applied initial, descriptive terms to the data, using short analytic labels (Charmaz, 2001; Charmaz & Bryant, 2008). Numerous codes were used to describe the activities in which participants engaged. A second round of focused coding was used to sort and synthesize the data (Charmaz, 2001), in which the codes were then examined for patterns and relationships. The second round of coding resulted in the emergence of key themes.

Findings and Discussion

The emergent findings point to a rich and complex digital landscape informing humanities scholars' research practices. The sections that follow explore the major themes that emerged during analysis: (a) humanities scholars' research approaches and technology tools, (b) the humanities scholar as tool developer, (c) the role of data preparation as a meta-level research practice, (d) data visualization versus numeric outputs—one size does not fit all, (e) the importance of flexibility and agency, (f) technology tools in support of the researcher as writer, and (g) working alone/working together—technology tools and collaborative practice.

Humanities Scholars' Research Approaches and Technology Tools

Participants were asked about the types of research in which they engaged to contextualize discussions of specific technology needs and research practices. Table 1 provides an overview of the broad categories of research undertaken by the scholars, along with specific tasks and project types.

These descriptions reflect a mix of traditional tasks (e.g., reading), digital work (e.g., text mining), and social science-style research with human participants (e.g., ethnography). This range of approaches reflects the contemporary life of humanities scholars, where the digital nature of the text and the integration of social sciences approaches are now reflected in scholars' work. Despite the variety of approaches, for these scholars "the text" still remains paramount as a data source, a finding borne out by other humanities research (e.g., Heuser & Le-Khac, 2011; Kirschbaum, 2007). Further, the textual focus of research practice has expanded to include metadata practices and computing (e.g., OCR correction; programming), and is complemented by other approaches (e.g., interviews). Within this broad set of research types, participants used

TABLE 1. Participants' descriptions of their research activities.

Categories of research	Research tasks and projects
Working with texts	OCR correction Digitizing documents Using archives
Analyzing texts	Computational analysis Metadata study Text mining
Creating tools	Building games/apps Creating collections, databases, digital objects Programming Tool development
Methodologies/Methods	Ethnographic research Field work Interviews
Traditional scholarly work	Reading Studying historic documents Thinking Writing

TABLE 2. Types of information technology participants used in research.

Inventory of Participants' Current Information Technology Tools
Communication Tools (<i>e.g., Skype, Email</i>)
Databases (<i>e.g., Project Muse, JSTOR, MLA</i>)
Digital Content Creation (<i>e.g., WordPress, Drupal, DreamWeaver</i>)
Digital Organization Tools (<i>e.g., Zotero, Evernote</i>)
Markup Languages/Editors (<i>e.g., XML, TEI, TextEdit, Oxygen</i>)
Online Storage (<i>e.g., Dropbox, Google Drive, GitHub</i>)
Programming and Script Languages (<i>e.g., Python, Ruby, Perl</i>)
Repositories (<i>e.g., Libraries, Rare Book Collections, Internet Archive, Google Books</i>)
Search Engines/Web Browsers (<i>e.g., Google, Google Chrome, Mandala</i>)
Spreadsheets (<i>e.g., Excel, Google Spreadsheet</i>)
Statistical Software (<i>e.g., R, Minitab, Excel</i>)
Text Analysis Tools (<i>e.g., Omeka, Many Eyes, Voyant</i>)
Word Processors (<i>e.g., Word, Google Docs, Scrivener</i>)

many tools in their research (see Table 2). This inventory is a diverse and comprehensive list, itemizing participants' use of quite varied information technology tools. Although some tools (e.g., Omeka, a text analysis tool) are designed for humanities research, others demonstrate the usefulness of ubiquitous tools (e.g., Word, Excel) in scholars' practice. This research contributes to the understanding of humanities scholars' research practices that consist of new and old techniques and unique and ubiquitous tools. Although universities may offer training and support for specialized tools, dedicated sessions exploring the usefulness of common tools (especially those already on hand, such as Microsoft Office), could enhance humanities scholars' research practices.

The Humanities Scholar as Tool Developer

Whether tools were generic or designed for humanities scholars, participants noted it was important for tools to foster thinking in unique or innovative ways. If existing tools

were limited for particular tasks, some participants created new tools to meet their needs. Matthew, a 42-year-old faculty member, built his own tools, but also felt pressured to do so as an academic:

I almost always write my own software to do [specific analyses]. Yeah, I mean . . . as an academic, there's pressure to do something new . . . especially in text analysis. And so I find myself rolling my own tools more often than not.

Tool development is one creative way to explore new ideas and play with data. Caroline, a 39-year-old faculty member, demonstrated a text analysis tool she codeveloped, which used colors to visualize data. She talked about this development work saying, "I'm excited. I don't know if [the tool is] going to be useful to people, but it's a fun idea." George, a 62-year-old faculty member, discussed using his own tools as part of his regular repertoire:

I use some of my own homemade tools. I use program archive tools from Newcastle called the Intelligent Archive. That does a lot of my work. I use Wordsmith tools; I use statistics program; I do a lot of work in Excel.

For some participants, being a tool developer is an important part of who they are as scholars. Wade, a 61-year-old faculty member talked about it as part of his identity, noting "Well. . . we're builders here. So of course the . . . computers are essential because we're building digital objects." Due to the new affordances offered by tools, and the ways these scholars interact with colleagues, development activities can foster understanding of what it means to be a humanities scholar. This research contributes to our understanding of what it means to be a humanities scholar working in the digital age. Tool building, either as a scholarly output or for analysis, is a common practice and, for some scholars, is central to their academic identity. Other research has demonstrated the importance of tools development for digital humanities scholars. Toms and O'Brien (2008) found nearly two-thirds of digital humanities scholars created their own tools. In surveying tool developers, Schreiber and Hanlon (2010) found that nearly all respondents (94%) considered tool development a scholarly activity, with others describing it as a service. Despite tool development being commonplace, little research literature discusses how tool creation affects humanities scholars' identities.

Data Preparation as a Meta-Level Research Practice

Once the relevant tools (and data) are in hand, humanities scholars engage in many meta-level tasks to prepare for analytic work and writing. These are significant aspects of research practice not often discussed in the literature—that is, the data preparation, cleaning, and management to ready materials for analysis. Data must be in a format that can be stored, accessed, analyzed, and used in the writing process, which is the dominant form of dissemination (often, in book

form) in the humanities. Participants discussed data preparation problems when relating their research practices. For example, Sarah, a 43-year-old faculty member, discussed having to process data to make them usable for analysis:

Most of the images I need have not [been] digitized, so for the most part I've had to work with originals, photocopying them, scanning them, turning them into digital images to use in presentations and in publications and so on. So most of the material that I need to work with hasn't been digitized.

When texts are not available digitally this either increases scholars' workloads (i.e., to digitize texts themselves) or lessens the chance a text will be used in research. Toms and O'Brien (2008) note that the availability of high-quality digitized texts is central to digital humanists' work.

All data use requires some preparatory work, but is imperative with digital documents and large corpora. Karen, a faculty member, described one problem with online texts—that is, that words in the “front matter” and “back matter” are included in searching, which are not part of the text being analyzed:

This [on the screen] is a text I've found. A lot of what they put in the text is making it a little irrelevant, you know, because they left in all the Project Gutenberg stuff. So at one level if this was something [I want to use in my work] I would like to be able to re-manipulate this text, I could get rid of the stuff that's . . . causing the distortion.

George, after describing his typical work with various text analysis tools, discussed data preparation,

Often the most time consuming part of the project is getting texts, both appropriate texts to compare with whatever I'm working on and then fixing them, correcting them, getting rid of garbage that's inside them and errors.

Luke, a 40-year-old faculty member, described this stage as “pre-analytic,” or the processing needed to prepare texts for analysis,

At this stage . . . this is almost like . . . sort of a pre-analytical stage. [There are] various standards for facilitating the editing and publication and search-ability, the accessibility of texts, so things like TEI or various data modeling standards that would enable the stuff to be easily linked to other projects, linked to other . . . data and to be easily searched and customized. That's mostly what I've sort of been focusing on. . . . I'm still building the body of text on which I would potentially use those kinds of [analytical] tools.

Humanities scholars also use visual and auditory files, which are now prevalent with the availability of digital multimedia. As most research data used by humanities scholars are in textual formats, multimedia must be processed to make them accessible textually. For example, images may

need descriptive metadata to be added or audio files may need to be converted into textual transcriptions. Barbara, a 59-year-old faculty member, described working with visual data:

I also (because I work with illustrations), do have to work quite a bit with image storage and digitization, archiving images, that kind of thing, from 19th century illustrated materials. And I do some work with user interface, site design. I've worked quite a bit in the markup of images for search functions so that images will be returned in the same search hit as verbal material, so an adaptation of TEI for that purpose.

In addition to cleaning data, scholars also described using metadata to retain context in large corpora. When a text analysis tool either did not have the ability to retain metadata, or the functionality to include that metadata in the dataset, participants noted this lack of functional affordance. If a tool was not useful in this “pre-analytic” work it was seen as either an impediment to using the tool or the reason for non-use. Sandra, a 48-year-old faculty member, mentioned one example:

[The] gap between the tool and the text is still a sort of major impediment for me and I think that that's probably the case for a lot of scholars. It's just hard to find the time to prepare the texts for use in *Voyant* without a kind of interface that's really geared towards helping you do that fairly easily. . . . I realize that from a development point of view this is asking for a lot, but I also think it's what the tools will need if they're going to achieve a higher level of uptake among more mainstream humanities community.

As raw, digital texts are more prevalent, the onus is on individual scholars to bring expertise to foster an understanding of the text or to create the metadata to enable searches.

In the literature, the issue of text preparation has often been framed around digitization (e.g., Blanke & Hedges, 2013; Kirschenbaum, 2007; Toms & O'Brien, 2008), focusing on quality of scanning, digital surrogates, licensing, copyright, and access (Kirschenbaum, 2007; Toms & O'Brien, 2008). However, once texts have been digitized and access is gained, there is more preparatory work to be done. Texts must be cleaned and metadata must be created for storage, access, and analysis (Trace & Karadkar, 2017). Rather than viewing these as simple procedures, they are complex ways of working that require significant content and technical expertise. Preparing texts requires significant expertise and tools that enable that work; it is an area where humanities scholars now require additional support and technological infrastructure. As de la Flor et al. (2010) note,

“Despite the great potential of cyberinfrastructures and tools for e-Research, significant challenges remain when trying to deploy these technologies to support the everyday work practices of researchers. Not only do designers face the familiar

problems of developing technologies that match the requirements of users, that include considerations of the ways they work, but also the additional challenges of identifying the needs of researchers that may be very specific, relating to the distinctive nature of a particular research project or the particular materials they are work [sic] with.” (p. 332)

As a way to focus study and better understand humanities scholars’ work, this research proposes data preparation as a meta-level research practice.

Data Visualization Versus Numeric Outputs: One Size Does Not Fit All

Once data are prepared, humanities scholars focus on analysis and writing. Considering the design of data outputs, for example, shapes humanities scholars’ thinking about what is possible during analysis. When discussing the specific tools explored in the study, participants focused on functional affordances, particularly the tools’ outputs. One key finding was a preference for either data visualization or raw number outputs. There was a strong divide between those participants who wanted data visualized in new ways (or presented in auditory form) and those who wanted data only in numeric form. This preference depended on the preferred type of analysis, as well as the desired outcome. Some participants valued what data visualizations could offer; as Marissa, a 40-year-old graduate student, noted,

[A visualization] is really appealing and probably it conveys information [in a] more effective way than just word frequency list, which has to go in a horizontal, in a vertical way from top to down basically, scrolling the list. In particular if the list is long ... a [visualized] summary could be like, putting thinking into a nutshell and showing immediately what is most and what is least frequent.

Sandra discussed the unique affordances offered by visualization compared to reading physical texts. “Any kind of electronic environment will [provide] the ability to move quickly through the text and, and check things in a way that’s harder to do with a printed copy.” For Sandra, a tool like *Bubbles* could provide new and distinctive ways to experience the text. *Bubbles*, a dynamic, interactive tool, reads the text in auditory and visual ways, showing both uniqueness and frequency of words used (see Figure 1, a sample *Bubbles* output).

Bubbles assigns a unique tone to each word, reading through the text dynamically, playing assigned tones, and showing frequency through the relative size of each bubble. The primary purpose of *Bubbles* is to guide readers through the text in unique ways, allowing for audio and visual representations, rather than providing outputs for use in publications.

Other participants did not share Marissa and Sandra’s views that data visualization could more effectively convey

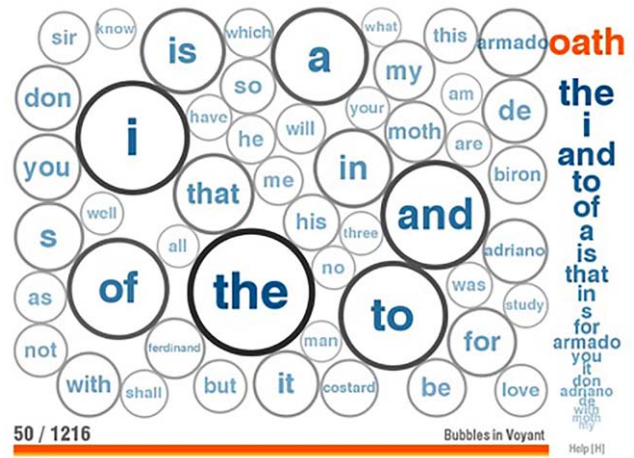


FIG. 1. Series of *Bubbles* output. [Color figure can be viewed at wileyonlinelibrary.com]

important information about texts. James, a 63-year-old faculty member, for example, noted:

Well, [visualization tools are] a bit indirect for me because a couple of things. You’ve given me a result here but it’s not a result that is frequencies, it’s a result that’s some visualization of frequencies. But I want the frequencies. I’d like to take the numbers and do more with the numbers.

For James, a tool like *List Words* best suited his needs, because the word frequency counts are visible (see Figure 2, a screenshot of *List Words* output).

This research demonstrates the variety of the ways in which humanities scholars work with digital texts and how this influences their research requirements. Humanities scholars—and digital humanities scholars—cannot be viewed as homogenous. In particular, this research contributes to the recognition of the split between scholars who use tools to general visual outputs that provide new insights into texts and those who use tools to generate numeric outputs for further quantitative analysis. Looking at the literature, the difference between scholars’ desire for either visualization or numbers may relate to Jessop’s (2008) finding that humanities scholars often emphasize written language, showing an “apparent mistrust of images” (p. 283). He states that humanists have low levels of visual literacy due to the lack of focus on visuals in humanities’ education, something that could be addressed to better “exploit digital visualization” (p. 289). Similarly, Heuser and Le-Khac (2011) note that using quantitative methods in the humanities raises methodological anxieties, as humanities scholars require (but do not typically receive) quantitative analysis training. Toms and O’Brien (2008) also found that more than one-third of survey respondents had not received any formal computer training. Work in the digital humanities pushes the traditional boundaries of humanities scholarship and the methods it employs, requiring new thinking about education and ways of working.

Summary: There are 2748 unique words other than those in the stop list, there are 5020 words other than those in the stop list. There are 12266 words in total including the stop words.

Words	Distribution Counts
life	28
man	21
mind	21
father	20
shall	20
years	17
story	17
became	16
time	16
friend	15
spirit	14
said	13
nature	13
tale	12
day	12
ira	12

FIG. 2. *List Words* output. [Color figure can be viewed at wileyonlinelibrary.com]

The Importance of Flexibility and Agency

The preference for particular outputs is one example of participants' general desire for agency in using tools. Participants wanted flexibility and choice in inputs, outputs, and operations, including filtering and uploading data, adjusting data displays, and manipulating outputs. Having online access was important, but only if speed was not sacrificed for access and if tools were bug-free and remained consistent in design. Caroline expressed a common concern about the *Cirrus* word cloud tool, saying "That's boring. To be honest, if I was going to do word cloud I would do *Wordle* because this word cloud you can't manipulate the way it's constructed." Figure 3 shows a screenshot of options available within *Cirrus*, including a stop word list and search function.

Manipulability was a key feature for Caroline: "And what I like about those tools is that they're iterative and you can update, you can use your own data and you can sort of modify as you go to make your results match your discoveries." The importance of flexibility in the outputs means that a tool such as *Cirrus* would not meet most researchers' needs. With *Cirrus*, the output is visual and word counts are only available in a rollover feature (see Figure 4 for a sample *Cirrus* output). Similarly, neither color nor word placement can be manipulated in the output, reducing the tool's utility.

In discussing the value of the tools used in their research, participants repeatedly articulated expectations that tools should work cohesively to afford multiple ways of working



FIG. 3. *Cirrus* options. [Color figure can be viewed at wileyonlinelibrary.com]



FIG. 4. *Cirrus* output with a callout documenting the frequency (3585) of the word "shall" in the text being analyzed. [Color figure can be viewed at wileyonlinelibrary.com]

with texts and to provide more (and easier) ways to analyze. Although different tools offered the range of desired affordances, the lack of integration between tools limited overall utility. Some participants, for example, mentioned the need to see the tool output alongside (or within) the context of the full source. Matthew highlighted this point in exploring the concordance tool *Find Text*:

I mean with [data analysis] it's all about context, right? I mean I want to be able to move back and forth between different views. I think it's probably in the nature of the way [*Find Text*] is set up that it's just showing me particular things at a time. Though ideally you'd want all of these things to be combined in a way that lets you move easily back and forth between them.

The desire to see broader context than what concordance tools provide was a key issue for participants. Figure 5 provides a view of the *Find Text* tool that shows the limited amount of context provided by the system. For Matthew, and other participants, the ability to integrate one tool with another, or to enhance the functionality of a tool like *Find Text* to provide context, would increase utility for data analysis.

Sandra also discussed the importance of the tool's output (or ability to manipulate that output) to meet her needs:



FIG. 5. *Find Text* output. [Color figure can be viewed at wileyonlinelibrary.com]

I think [*Cirrus* is] quite limited as a tool for the kind of analysis of literary texts that I'd want to do, I mean some of the things that have come up for me in some of my studies I'm looking at just the fact that you'd want to combine certain words, you want to be able to exclude certain words. [*Cirrus* is] just not flexible enough in terms of what it allows you to do in manipulating the visualization to look at what you particularly want to explore.

George expressed a desire not only to manipulate the output but also to better understand how the tool works.

I prefer [tools] to be as flexible as possible. And I prefer them to be as un-black-box-like as possible. In other words, I want to be able to see the intermediate steps. I want to be able to get hold of the data and manipulate it in ways that the tool itself doesn't predict or use.

Flexibility is also important for accessibility. Marissa discussed this both in terms of personal workflow and to enhance accessibility for others,

I can use *Dropbox* where I can put my text and then access from wherever I am. That gives a lot of flexibility and I can upload here from wherever I am and then, actually have different outputs for displaying it, for example, as a link on the internet . . . I thought maybe at a later stage, whatever I produce in my search I would like to make it a browsable object, so XML or HTML output would make it easy, actually, to make it a browsable, accessible object for others too.

The format of the output has a potential impact on information-sharing practices among scholars and their colleagues.

This finding contributes to the understanding of humanities scholars' heterogeneous ways of working and the value they place on their own agency over the tool; that is, being able to flexibly work with tools, manipulate their outputs, and share the results. This also aligns with other research into the importance of flexibility to the working of humanities scholars (Toms & O'Brien, 2008; Trace & Karadkar, 2017). This is particularly true of sharing practices, which have been described as a scholarly primitive (i.e., a fundamental scholarly task) of the digital humanities (Blanke &

Hedges, 2013). These sharing practices go beyond online publication of resources to include "the interim sharing of temporary research results within a particular research community" (Blanke & Hedges, 2013, p. 658). Sharing can be between project collaborators or between other colleagues and are supported by digital technologies (e.g., Markauskaite, Kennan, Richardson, & Hellmers, 2012; Niu et al., 2010). Therefore, digital tools need to be created with academics' sharing practices in mind, to maximize utility. These findings are key to understanding how to build tools for humanities scholars.

Technology Tools in Support of the Researcher as Writer

Most humanities scholars' research activities—even in digital work—are textual in nature, including data sources and ways to communicate results. The act of writing is a key element of humanities scholars' research practice, and one that has received attention in the literature (e.g., Chu, 1999; Palmer & Neumann, 2002; Toms & O'Brien, 2008). In this study, participants discussed repurposing tools for dissemination that were designed with a particular affordance unrelated to writing practice. Oliver, for example, a 34-year-old faculty member, used a text analysis tool to assess his own writing practices:

It allows me to see tendencies in my own writing that I might be unconscious of. I think that one's pretty key. . . . I take my writing quite seriously. [Also] I've used it actually for an article I've submitted recently, it's under review, for showing the ways in which text can be granulated and treated in various ways using these mechanisms including *Voyant* but also other tools, such as *Juxta* and the like.

Text analysis tools were developed for analyzing large numbers of texts in very detailed ways, providing digital tools to help with labor-intensive activities. Yet Oliver uses these tools to get a sense of his own writing, gaining a better picture of what his writing entails at a higher level of abstraction. *Voyant*, which Oliver refers to in this quote, provides a suite of tools that analyze text in multiple modes at once (see Figure 6 for a sample output from the *Voyant* suite). For Oliver, *Voyant* provides a new way to explore his own writing practices. However, tools that provide dynamic and/or multimodal perspectives of texts, such as *Bubbles*, could also be used in the writing process to provide researchers with different views of their own writing.

For other participants, the conscious decision *not* to use a tool was an important part of the writing process. Although scholars may not always understand a tool's potential usefulness or functionality, they may decide not to use it because they have a clear understanding of the time and effort needed to learn to use something new. This time investment can take time away from other tasks. Kim, a 27-year-old graduate student, expressed her reluctance to use new tools, preferring a clunky yet familiar way of writing,

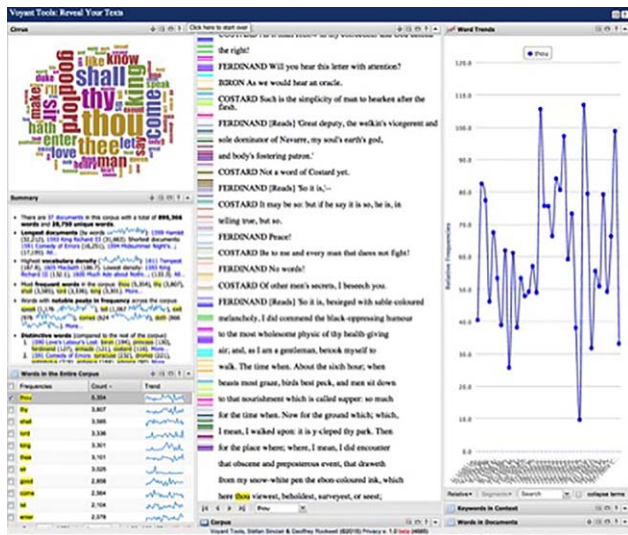


FIG. 6. Voyant output, including the *Cirrus* word cloud tool. [Color figure can be viewed at wileyonlinelibrary.com]

And I know programs like RefWorks and Endnote are intuitive to use, but because it is still not intuitive to me to use it immediately, I still don't . . . I still find myself copying and pasting bibliographies on a separate Word document and then cleaning it up when I'm done, which I know for everyone who are wizards at RefWorks and Endnote that's such a timewaster, that's not an efficient way to do things, but I still haven't you know found a way that you can sort of seamlessly introduce those things into your daily working that isn't frustrating really.

As with Kim, a large number of participants referred to word processors as important tools for writing. The specific tool used to write could depend on the situation, particularly when writing collaboratively. Trevor, a 24-year-old graduate student discussed the tools he likes to use, and the tools he uses when working with others. "Google Docs is my most indispensable tool probably so I use Microsoft Word if I need to prepare an article as a Word document or if I'm editing with other people but usually I do things in Google Docs." Even when tools were not expressly designed for collaboration, affordances such as communicating and remote access could aid scholars in working with others. Sarah discussed using various tools to take on a large project with a colleague,

I just edited a 500-page book on Skype because my collaborator is in Utah, so we had 2-hour meetings on Skype . . . and Dropbox. Constant use of Dropbox! All my teaching notes, all my research stuff, the entire book manuscript is on Dropbox so we edited it being on Skype and using Dropbox and shared files and submitted articles through Dropbox. We submitted a whole book manuscript through Dropbox. So those are really important, those are . . . becoming incredibly important tools in my day-to-day life.

As Skype can be installed on a local computer and opened while other programs (such as Word files or Excel)

are in use, it has the potential to be useful during collaborative writing processes. Although Skype was not designed as a collaborative writing tool, it provides the affordance of real-time communication and facilitates humanities scholars' work. In the next section, the degree to which these scholars worked alone or together is discussed.

Working Alone / Working Together: Technology Tools and Collaborative Practice

Humanities scholars' collaborative research practices are understudied, complex spaces (Given & Willson, 2015). In this study, Trevor's experience with Google Docs highlights that technology tools can provide new affordances to humanities scholars to enable collaboration, providing in-built features for communication and sharing. Oliver also discussed how tools designed for sharing facilitate remote collaboration:

And the things that I find actually helpful for real collaborative work would be stuff like Google Forms. So for example I've had a group of students or colleagues that are all working on the same project and what they're gathering related materials to, I'll submit them to a form, they would then be aggregated into a spreadsheet for easy reference and exporting.

Humanities scholars take note of tool affordances and decide to use (or not) based on those affordances. However, familiarity, ease of use, and situational factors remain important in determining what tools scholars will choose, in the end.

Large datasets, new technology, and complex tool development also encourage scholars to work in teams. This teamwork has not had a long tradition in some of the humanities fields, although the digital humanities (a relatively new discipline with a computer-based focus) tend toward larger project work. Wade discussed the types of projects he works on, collaboratively,

So I'm using software development tools where I'm building these prosopographies, for example, or the other sorts of things that we build. They have databases in them because I'm comparing to structured data. They're very much involved in getting stuff off from the browsers, and we have to deal with browsers and all that kind of thing. But we're doing that as people who build software ourselves.

Trevor discussed being a research assistant on a large project, as part of a subgroup with a particular task; the sheer size of the project prohibited "solo" scholars from tackling the work:

For the last year and a half I've been a research assistant on a project [involving] a large aggregation of library metadata. So what we have is content from various library digitization projects from across the US and then we put it together in one place. And my specific work is in a subgroup where we do topic modeling so we try to find coherence across the

entire collection of over a million items and how can we find themes and topics over that.

Despite the number of participants involved in collaborative projects, others talked about working alone. Often, personal work was denoted by such terms as “my work,” “my personal work,” or “my own work,” explicitly. George, for example, said “Most days, if I’m working on my own research, I’m using [these particular] tools.” Carol also drew clear lines between her own research and that of her teammates: “So then finally, my own personal research is more in visualizations and how they affect understanding of literature.” Sandra classified her collaborative work as very different from her individual work; when asked to show examples of her tool use, she responded,

I have not shown you things like the experimental interfaces that I myself have been involved in developing and designing because I think [of] those as somehow separate from tools that I would use for my research that are not so closely connected to the development work I’m doing.

This distinction of “my research” as opposed to collaborative work or work in teams indicates that both types of work are a part of these scholars’ research practices.

When working by themselves, participants chose tools—and used them—in ways that suited their personal working styles. William, for example, only wanted tools to be located on his hard drive. “Every time that happens [an error in loading an online text analysis tool] it reinforces my desire to have everything on my own machine.” Whereas Kim preferred online tools, wanting to keep her hard drive clear; she stated, “So if it is something that I have to install, I usually shy away from it, because I guess for my own purposes I don’t like a lot of clutter in my hard drive.” Technologies are both adapted by humanities scholars and require adaptation. Adapting tools and digital environments to suit specific needs is important for scholars who work regularly with technologies as an integrated part of their work. However, personal adaptation to suit technology is also, at times, necessary; large and complex digital projects, for example, may require scholars who might otherwise work alone to work together to accomplish this work.

Conclusion

Humanities scholars’ discussion of their research demonstrated the wide range of research activities in which they regularly engage, as well as the wide range of digital resources and tools that are a part of their work. The digital technologies they use support traditional ways of working, but also create potential for new scholarly practices, including tool development and data preparation. Many humanities scholars are tool developers or part of tool development teams. Rather than viewing tool development as an outcome of research, tool development can be research in and of itself. This is a shifting role for scholarly identity. Data preparation and writing, two of the research phases in the model

proposed by Chu (1999), were identified as important aspects of humanities scholars’ research practices, although ones that typically receive little attention in the research literature. Particularly important when dealing with raw texts, data preparation is key to making texts usable with digital tools. This work, often time- and labor-intensive, requires an in-depth understanding of the information technologies and analysis processes to make compatible decisions about how to prepare the data. Data preparation becomes a meta-level process, fundamental to both analysis and writing.

Important to humanities scholars throughout the research process is the ability to work in ways that suit their individual research needs and work patterns, regardless of the tools use or whether working in print or with digital texts. However, information technologies play an important part in these ways of working, enabling and constraining ways of carrying out work. Although multimedia provides options in presenting scholarly work, writing remains a central aspect of researchers’ practice and the main way of conveying ideas. Ways of working that are both flexible and able to be molded into practiced workflows continue to be important to scholars. Scholars tend to adopt/adapt less specialized information technologies, those not developed specifically for academics and/or digital humanists, preferring to use tools already mastered and those close at hand for themselves and their collaborators.

Overall, humanities scholars are not satisfied with stand-alone, single-purpose tools; they want tools that can be integrated, working together in a cohesive environment. These types of tools require coordination, adherence to standards, and forward planning to gauge how others might use the tools (Warwick et al., 2009). The affordances of digital tools have created new methodologies, not only requiring new training and institutional support, but also choices to be made about what types of outputs are most useful for analysis and writing. However, use of visualizations or numeric outputs may require new digital literacies for analytic work. In addition, although collaboration is possible without digital technology, teamwork can be facilitated through the affordances made available by digital tools. Collaboration itself may require development for humanities scholars who are trained as “solo” scholars or who typically work in isolation. The development of new tools to enhance traditional work, and support new ways of working, continues to be an emerging area for future research in humanities disciplines.

Although this research looked at a range of humanities scholars’ use of information technology in research practice, the study is limited in its reliance on a small group of scholars mainly in the discipline of English. The size of the sample reduces some of the transferability of the findings. For some of these scholars, tool development is an important part of their work; how tool development fits into their scholarly work and how it is valued (or not) by their departments requires further exploration. The discussions of tools and practices used regularly in scholarly practice were insightful; however, observation of scholarly work would have provided a more comprehensive picture of the various ways scholars work. Future studies would benefit from using

observational methods to examine a wide section of humanities scholars' digital research practices, paying particular attention to the variety of technologies used in everyday scholarly work, such as data preparation.

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