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K Martin
University of Guelph

Anabel Quan-Haase
The University of Western Ontario, aquan@uwo.ca

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“A Process of Controlled Serendipity”: An Exploratory Study of Historians’ and Digital Historians’ Experiences of Serendipity in Digital Environments

Kim Martin

School of English and Theatre Studies
University of Guelph
kmarti20@uoguelph.ca

Anabel Quan-Haase

Faculty of Information and Media Studies
University of Western Ontario
aquan@uwo.ca

ABSTRACT

We investigate historians’ experiences with serendipity in both physical and digital environments through an online survey. Through a combination of qualitative and quantitative data analyses, our preliminary findings show that many digital historians select a specific digital environment because of the expectation that it may elicit a serendipitous experience. Historians also create heuristic methods of using digital tools to integrate elements of serendipity into their research practice. Four features of digital environments were identified by participants as supporting serendipity: exploration, highlighted triggers, allowed for keyword searching, and connected them to other people.

Keywords

Historians, serendipity, digital environments.

INTRODUCTION

A digital environment is a platform or tool used to access and manipulate information; for example, digital libraries, databases, social media, and journals. However, not all disciplines have embraced these digital environments to the same extent and even within a single discipline scholars have made use of digital tools to different degrees. This paper takes historians as its focus, including the subsection of historians that self-identify as digital historians. Historians have become increasingly digital over the past decade, using and designing different tools to aid their own research (Fyfe, 2015; Leary, 2015). Often the designation digital historian is used to describe those history scholars who integrate various digital sources and tools into their work practice. While distinctions between historians and digital historians have been questioned, the label of digital historian is used in the context of this paper to describe

those historians that self-define as ‘digital’ in the context of our survey. To date, information scholars have tended to focus on humanities scholars as a group without paying much attention to the unique information needs and scholarly practices of historians (some exceptions include: I. Anderson, 2010; W. M. Duff & Johnson, 2002; Tibbo, 2003). Historians, however, have attributes that stand out from other humanities scholars, including extensive use of the library and archives (Case, 1991; Delgadillo & Lynch, 1999), the importance of primary sources to their research (Rutner & Schonfeld, 2012), and the common experience of serendipity while researching (Anderson, 2010; Duff & Johnson, 2002; Martin & Quan-Haase, 2013). It is important to study digital historians to understand how the use of digital sources and tools is influencing the unique attributes of historical research.

The present paper examines historians’ perceptions of how digital environments have affected their experiences of serendipity. Much research has looked at the role of serendipity in historical scholarship. Anderson (2010) lists serendipity as an information-seeking method used by historians in his examination of their work with primary resources. Kirsch and Rohan (2008) in the introduction to their collection *Beyond the Archives*, argue that their work teaches historians to attend to the facets of their research that “seem merely intuitive, coincidental, or serendipitous” (p. 4) in order to identify areas of scholarly research. Fyfe (2015) sees the recognition of a serendipitous connection as a skill in which historians can be, and should be, trained. Despite the attention that serendipity has received in the literature on historians’ scholarly practices, little is known about what specific environments are perceived as most conducive for serendipity and few attempts have been made to isolate the effect of specific features for serendipitous experiences. The present paper investigates the following two research questions:

1. What digital environments are historians using to encourage serendipity in their research?
2. Which features of digital environments do historians see as supporting serendipity?

LITERATURE REVIEW: SERENDIPITY IN THE DIGITAL ENVIRONMENT

Several recent studies investigate the role of serendipity in the digital environment, and lay the groundwork for our own examination of this experience by historians. In an attempt to trigger a serendipitous encounter in a digital environment Toms and McCay-Peet (2009) set up an observational laboratory study that saw 96 participants complete three tasks using a Wikipedia-based tool developed for the study, called “Suggested Pages”. Forty percent of their participants used the tool, reporting that the links they found through “Suggested Pages” were relevant to their assigned tasks, and were surprising, but some also deemed them as a distraction from the task at hand. The authors concluded that the lab setting did not replicate typical behaviour, and that there was much left to understand about how to trigger in a digital environment a serendipitous encounter with information.

Race (2012) examined the serendipitous features associated with web-scale, user-friendly discovery tools such as WorldCat and EBSCO. She noted the importance of personalizing the search process, and demonstrated that interactivity between the user and the computer system could help users better realize interconnections. The main strength in Race's article lies in her summary of web-scale discovery tools that support serendipity. Here Race managed to break down the various tenets of serendipity (browsability, hypertext links, visualization of results, etc.) and determine whether each of the aforementioned tools supports these features or not.

McCay-Peet, Toms, and Kelloway (2014) conducted a series of studies with the aim of developing robust measures of serendipity that were specifically geared to the unique context of digital environments. They identified five features of a serendipitous digital environment or SDE:

1. *Trigger-rich*: The digital environment is filled with a variety of information, ideas, or resources interesting and useful to the user.
2. *Enables connections*: The digital environment exposes users to combinations of information, ideas, or resources that make relationships between topics apparent.
3. *Highlights triggers*: The digital environment actively points to or alerts users to interesting and useful information, ideas, or resources using visual, auditory, or tactile cues.
4. *Enables exploration*: The digital environment supports the unimpeded examination of its information, ideas, or resources.
5. *Leads to the unexpected*: The digital environment provides fertile ground for unanticipated or surprising interactions with information, ideas, or resources.

Other studies of serendipity in digital environments focus on how best to capture these experiences, which are most often collected in the form of self-reports (Makri et al., 2015). Makri et al. (2014) interviewed 14 creative professionals about their personal strategies for influencing serendipity, and then discussed the various ways in which digital environments support these personal strategies. For example, a creative professional mentioned “varying their routines” as a personal strategy. Makri et al. (2014) suggested that designers of digital environments could support serendipity by recommending material tangentially related to the users’ work, or by encouraging users who have similar interests to share links to web sites. For the authors digital environments that support these personal serendipity strategies would be more beneficial to both creative professionals and general users because they support elements of serendipity rather than attempting to offer “serendipity on a plate” (Makri et al., 2014, p. 2181).

The literature review shows various approaches in which digital environments can be designed to promote serendipity. The literature so far has not focused on historians and how digital environments may be designed to aid in their scholarly work. As serendipity is central to their practice, designing digital environments with their information needs in mind could help support their work.

METHODS

The survey was developed by building on previous findings based on interviews with historians about their scholarly practice (Martin, 2016; Martin & Quan-Haase, 2013, 2016). The online survey was chosen as a method to reach a diverse set of historians, after attempts to recruit members of this population for interviews proved challenging.

Sample

A total of 142 participants started the survey, of which 90 participants provided answers to all questions ($N=90$). We did not require that participants answer all questions, as only those who could recall a specific serendipitous experience were able to answer the survey in full. Also, several of our questions were open-ended, and required more time and effort than simply clicking a button, which may have influenced question non-response (Reja, Manfreda, Hlebec, & Vehovar, 2003). As the number of respondents to each question differed due to how the survey was set up in Qualtrics, we will report the number of participants – n – who provided responses to each question.

Demographics were collected at the end of the survey, and were completed by 88 participants. We had 55% women, 42% men, and 1% who identified as “other”, with 2% preferring not to provide an answer. The ages of participants were well spread out, with 9% between 18–24, 33% between 25–34, 23% between 35–44, 17% between 45–54, 11% between 55–64, and 7% aged 65 or older. Most participants held a PhD (49%), while 36% held a Master’s

Degree, 9% held an undergraduate degree, and 5% completed high school (1% preferred not to answer).

Online Survey

Data were collected via an online survey that took about 15 minutes to complete (Martin, 2016). There were four sections to the survey: Section A: background on participants' historical research, Section B: serendipitous experiences while conducting research, Section C: serendipitous experiences while in physical and digital environments, and Section D: demographic information. Where available, we relied on previously validated measures. McCay-Peet's (2013) scales provide a "direct measure of serendipity" in digital environments and in life in general (Q19, Q21, and Q23). These helped to establish the basis for historians' experiences with serendipity and to test to what extent the digital environments they used in their research encouraged serendipity. Open-ended questions were included to allow participants to expand on their experience. These open-ended questions help triangulate findings from the questionnaires and also expand on the numeric values by adding rich data about the experiences of scholars (Makri & Blandford, 2012).

To understand what role digital tools played in participants' research the following question was included: *Would you describe yourself as a digital historian?* (Q17) to which 48% of the participants answered "Yes" ($n=87$).

Q19 asked respondents to list three types of digital environments in which they had experienced serendipity: "Please list up to 3 digital environments where you have experienced serendipity. Please be specific, for example, if this occurs on social media, please indicate the platform (e.g., Twitter)." As a follow up to this, respondents were also asked to describe what features of each of the three listed digital environments (in Q19) they thought were most conducive to serendipity. Specifically, Q21 stated: "Please describe the features (e.g., keyword searches, browsing options, interaction with others) of this specific digital environment that you find to be most conducive to the serendipitous encounter." We were also interested in the features they thought promoted serendipity across all digital environments. For this purpose, Q23 asked: "Please describe the features of a digital environment that you find to be most conducive to the serendipitous encounter."

Online surveys have the benefits of being convenient to the participant and timesaving to the researcher (Evans & Mathur, 2005; Sax, Gilmartin, & Bryant, 2003). However, there are also downsides to online surveys, such as a lack of response from non-internet users, and privacy and security issues (Evans & Mathur, 2005). As we were particularly interested in the research habits of digital historians, the use of an online survey was justified. The survey access link was distributed via social media, listservs, and emails to history departments across Canada to reach a wide and diverse audience. As Twitter was popular among many historians, we also disseminated the link to the online

survey using the hashtag #twitterstorians, which is followed by historians. To reduce concerns over privacy and security, Qualtrics was employed for the collection of data. Qualtrics does not rely on cloud-based data storage, as data is stored locally on a secure university server. We collected demographic information from our participants such as age, gender, and academic background and no identifying information was collected to guarantee the anonymity of respondents. We obtained ethics approval and the survey was live from February through April 2015, during which time the primary researcher did weekly checks to ensure there were no cases of intentional misuse.

Data Analysis

As this paper reports on preliminary analysis, questionnaire responses were analyzed using descriptive statistics in R.

For Q19 (see wording above), participants could list up to 3 digital environments where they had experienced serendipity. Seventy-nine participants listed a total of 194 digital environments, and these were then separated into the types of digital environment that historians had previously been asked to report their comfort with in Q18. As the participants were not asked to rate these environments, they were then coded according to the same ten digital environments as Q18, with the addition of three categories ("Databases", "Archives", and "Ancestry websites") to account for the digital environments mentioned by participants that fell outside of the original ten.

Because of the complexity of the answers to Q21 and Q23, a deductive content analysis approach was utilized. Usually this approach is recommended when "the structure of analysis is operationalized on the basis of previous knowledge and the purpose of the study is theory testing" (Elo & Kyngäs, 2007). We used the previously established categories of serendipity by McCay-Peet, et al. (2014). Their five facets of an SDE identified in the literature review above provided a starting point for the content analysis. To ensure that as many of the historians' responses as possible were included in the analysis, it was important to remain open to other categories being created if the five facets of SDEs previously identified by McCay-Peet, et al. (2014) did not account for most of their responses. In the first phase, themes or phrases were used as the unit of analysis (Berg, 2005) and each of the historians' responses to Q21 were categorized into the five facets, with many answers being divided into multiple phrases and some phrases fitting into multiple categories. There were three additional themes that emerged as prominent in the responses to Q21: "People", "Heuristic Search", and "Keyword Search". "People" and "Heuristic Search", were created as sub-categories to "Enables Connections" and "Highlights Triggers", respectively. The final coding scheme used for the analysis is shown in Table 1.

Table 1. Final coding scheme

CODES	DESCRIPTIONS
Trigger Rich	The digital environment is filled with a variety of information, ideas, or resources interesting and useful to the user.
Enables Connections	The digital environment exposes users to combinations of information, ideas, or resources that make relationships between topics apparent.
Sub-code EC - People	Where the connection is made as above, but involves people as either the providers of information or the link to information.
Highlights Triggers	The digital environment actively points to or alerts users to interesting and useful information, ideas, or resources using visual, auditory, or tactile cues.
Sub-code HT - Heuristic Search	Same as above but search is involved, showing an agency on behalf of the historian
Enables Exploration	The digital environment supports the unimpeded examination of its information, ideas, or resources.
Leads to the unexpected	The digital environment provides fertile ground for unanticipated or surprising interactions with information, ideas, or resources.
Keyword Search	Anytime the respondents include keyword search. Often with none, or very little, description.

After the codes were refined and finalized, Q21 and Q23 were recoded according to the same set of categories. One additional reliability coder went through about half of the data to assess the reliability. The intercoder reliability for Q21 was Cohen’s Kappa = .62. According to Landis and Koch (1977) this score is at the lower end of “substantial” agreement strength. The intercoder reliability for Q23 was higher, at Kappa = .72, at the higher end of “substantial” agreement strength. This indicates that there is room for clarification of the coding scheme we employed, to avoid any room for confusion between codes in future studies.

FINDINGS

Digital historians, digital environments

Respondents reported where they experienced serendipity. Figure 1 shows that serendipity was experienced more frequently in a physical library or archive than it was in digital library interfaces or while researching on the web.

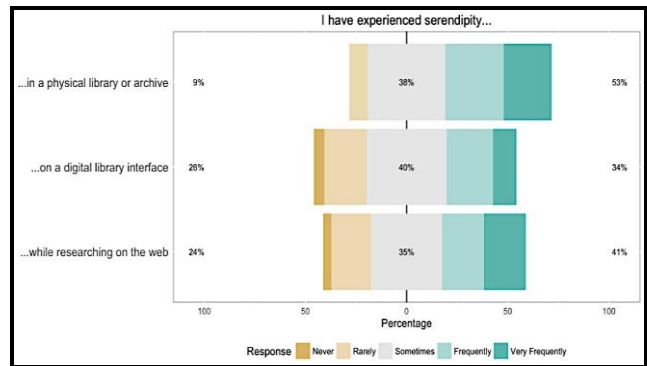


Figure 1. Environments where historians experience serendipity

We compared responses from those who had identified as digital historians with those from respondents who did not identify as digital historians. We found that those who identified as digital historians experienced serendipity more frequently in digital environments than non-digital historians. Serendipity was experienced more frequently on the web than in a library interface, but this may also be due to the frequent use of web-based search engines (Kemman, Kleppe, & Scagliola, 2013).

We then listed ten different digital environments and asked the respondents to rate their comfort level with these environments on a five-point Likert-type scale ranging from “very uncomfortable” to “very comfortable” (Q18). Figure 2 shows that respondents were comfortable with digital environments that they would come across as part of their working day, such as search engines, word processing tools, email, and library interfaces. As the survey was conducted online and recruitment was partially done via Twitter, it is not surprising that the participants were also comfortable with social media. Finally, the two digital environments where the participants indicated to be the least comfortable with were “Writing Code” and “Software Development Tools”, where only 16% and 8% indicated to be “somewhat comfortable” or “very comfortable”.

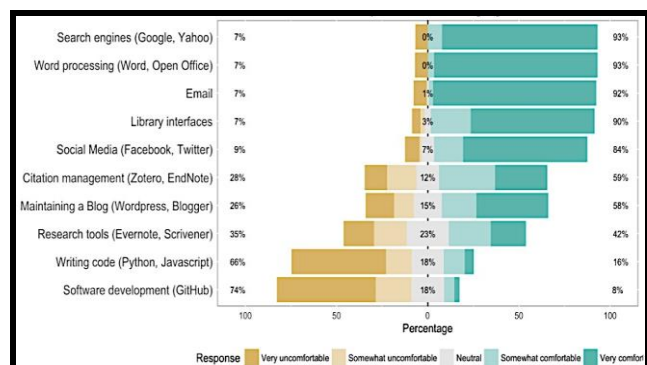


Figure 2. Respondents' comfort with digital environments

The answers to the question “Please list up to 3 digital environments where you have experienced serendipity” (Q19) resulted in a list of 194 digital environments. The answers to Q19 can be seen in Figure 3. Social media is the digital environment most commonly named by historians as a place where they experience serendipity. While the answers to the questions regarding features of digital environments (see below) support this finding, it should be noted that we used Twitter as one method of recruitment for

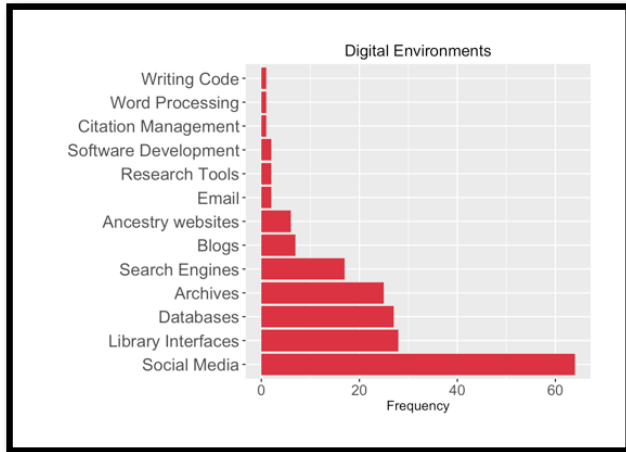


Figure 3. Digital environments where historians experience serendipity

this study, thus many of our participants are likely to feel comfortable using social media, and to use it frequently, possibly increasing their experiences of serendipity in this digital environment. “Library Interfaces”, “Databases”, and “Archives”, are digital environments in which the historians also reported experiencing serendipity.

As we originally only included “Library Interfaces” in our list of digital environments, and later added “Databases”, “Archives”, and “Ancestry websites” to account for the historians’ own answers about where they experience serendipity, more work is needed to explore this breakdown of digital environments and the experiences of serendipity in the digital and physical versions of each. Though the participants were largely comfortable using a variety of digital environments, including email, social media, and search engines, there are some digital environments, like software tools and writing code, that have not yet been integrated into the digital tools of most of these historians.

The frequency of serendipitous experiences

Encountering useful information while using digital environments was the most frequent response amongst our participants, who also tended to experience work-related serendipity slightly more often than serendipity that impacts their everyday life (see Figure 4).

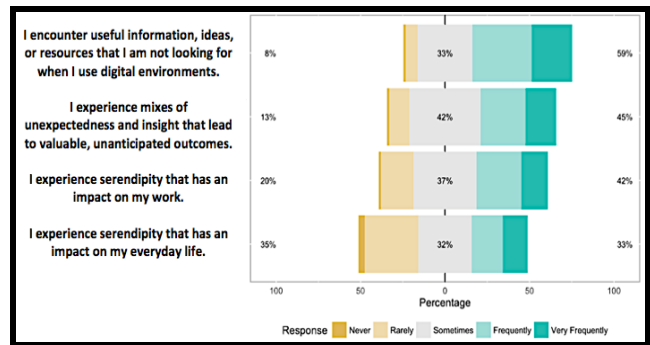


Figure 4. Experiences of serendipity in digital environments (n=80)

A large percentage of historians selected “sometimes” as their response to these questions. It was evident from Figure 5 that digital historians experienced serendipity more frequently in digital environments than other respondents.

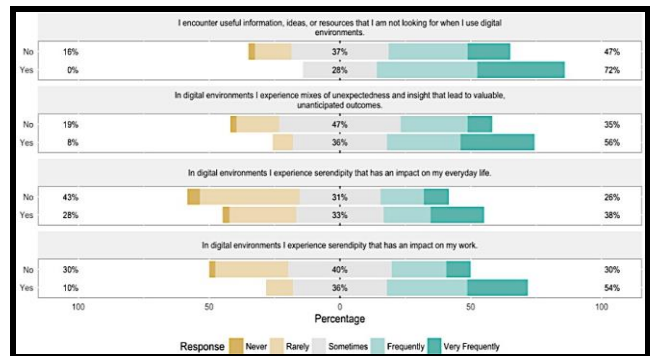


Figure 5. Experiences of serendipity in digital environments for digital/non-digital historians

Again, digital historians were more likely to experience work-related serendipity when using a digital environment, than they were to experience serendipity that impacts their everyday life. To further understand our population’s experiences with serendipity, we then asked them to think about their life experiences in general (Q23), not just in digital environments. As Figure 6 demonstrates, these responses were similar to the responses regarding the participants’ experiences using digital environments.

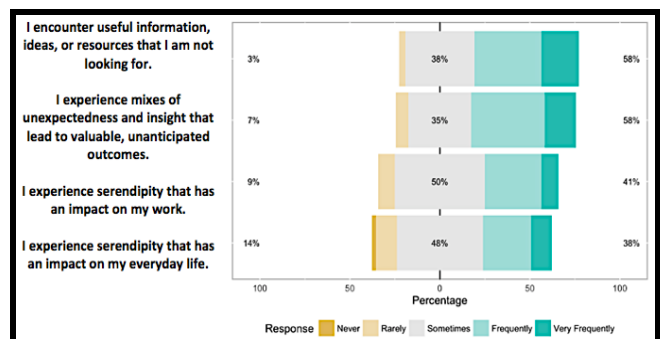


Figure 6. Experiences of serendipity in general

However, when we broke these responses down into the “Yes” or “No” answers to Q17 (*Would you describe yourself as a digital historian?*) (Figure 7), the result was that both groups reported experiencing serendipity to a similar extent across the four questions. In fact, very few historians reported to “Never” experience serendipity, except for a small percentage that reported that this phenomenon had never impacted their everyday lives.

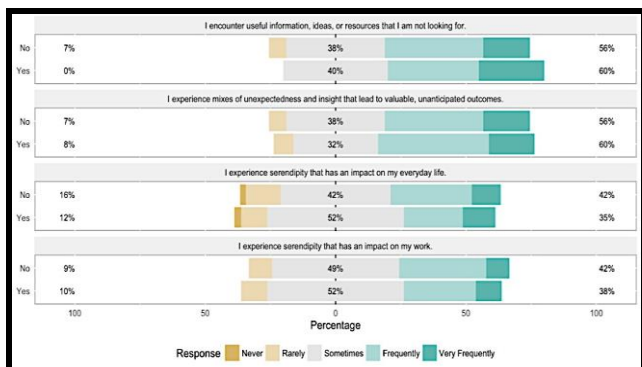


Figure 7. Experiences of serendipity in general for digital/non-digital historians

Overall then, despite our population reporting similar experiences with serendipity in their lives in general (online and offline), when it came to using digital environments, those who identified as digital historians were more likely to experience serendipity when working in a digital environment.

Features that support serendipity

To begin answering RQ2, we coded the number of times each category was mentioned (Table 2). Each of the features was mentioned in the historians’ responses to both Q21 and Q23, to varying extents. “Highlights Triggers”, “Enables Exploration”, “People”, and “Keyword Search” were all prominent categories, though all eight categories were represented by the participants’ responses, showing that serendipity was an experience that could occur in many different contexts, and that digital environments require multiple features to support serendipitous information behavior. The features are discussed individually below in detail, from the most commonly identified feature (“Enables Exploration”) to the least commonly identified feature (“Trigger Rich”).

Enables Exploration

Of the features that supported serendipity, there were three types that historians used to explore information. First, there were those related to browsing material on the web, either using links available on blogs, websites, and in citations. Google was mentioned several times, with participants indicating to use the search results to explore and browse comparable to how they would in a physical environment, as Participant 22 pointed out:

Table 2. Features of a digital environment that support serendipity

Features of a Digital Environment that Support Serendipity	No. of mentions in Q21 (n=72)	No. of mentions in Q23 (n=63)	Total No. of mentions
Trigger Rich	2	4	6
Enables Connections	8	10	18
Subcode EC – People	19	13	32
Highlights Triggers	19	8	27
Subcode HT - Heuristic Search	7	10	17
Enables Exploration	19	20	39
Leads to the Unexpected	5	10	15
Keyword Search	25	13	38

“I use Google and Google books like a library interface.” (P22)

Second, historians also spoke about the relevance of linked open data and the semantic web to their research. Finally, historians indicated that exploring a full text primary source, particularly one that was previously unavailable to them, often resulted in finding new and relevant information.

Keyword Search

As outlined in the methods section, the high number of historians who mentioned keyword search in their answers to Q21 and Q23 might have been due to our decision to mention this as an option in the wording for Q21. However, many historians expanded upon the reasons they found keyword search to lead toward serendipitous results. For example, Participant 52 reported:

“Keyword searches often bring up serendipitous results because they do are not confined to the usual ‘silos’ of archival references. They search across fonds and can bring up results from the entire archive, provided that enough is made searchable.” (P52)

Thus, it is not so much the keyword search feature that results in serendipity, but the ability of the algorithm to gather material from different places and to cast a wider net than historians might be able to on their own.

People

Social Media was reported by the historians to be the digital environment where they most commonly experienced serendipity. For these scholars, comments on blog posts, Facebook conversations, and connections to their Twitter community often led to new insights. The historians largely recognized that they self-selected this community, curating their connections, and that they had interests in common with those who they followed, particularly on Twitter. For Participant 16, this was one way in which she could exert agency over her serendipitous experiences:

“It’s a process of controlled serendipity: I follow people I’m interested in, for example, or start on a webpage that is key to my work. From there, I go on structured explorations.” (P16)

We placed “People” as a sub-code under the heading of “Enables Connections” because historians spoke of people sharing information they could relate to, or having conversations with those in their field that inspired new ideas. Some of these phrases were also coded as “Highlights Triggers”, but we felt it necessary to categorize the times that people were mentioned to demonstrate the prominence of social media amongst the historians’ responses.

Highlights Triggers

For our participants, the most common way that triggers, or alerts to interesting or useful information, were presented in digital environments were as hashtags on Twitter. Typing words this way turns them into links that allow users to click on them and see a list of current posts that include the same hashtag. Our participants noted how useful it was to be able to follow relevant hashtags, particularly around a conference they were interested in (“following conference hashtags is helpful” P25) or debates by colleagues (“hashtags that help follow debates” P36). Other ways that digital environments highlighted triggers were recommendations presented with search results and links shared by others on social media.

Enables Connections

Digital environments that enable connections often presented our historians with new ways of looking at material. Word clouds and other types of visualizations enabled new associations between materials, as Participant 57 pointed out:

“Interfaces that allow to see connections I wouldn’t have thought of, like tag clusters. This seems to somehow recreate the effect of browsing the shelves or folders in a physical archive/library.” (P57)

Another feature of digital environments that historians indicated lead them to serendipitous finds were the algorithms for keyword searches in tools such as Evernote or DEVONthink that showed you material around the term searched for, instead of just that specific term. Because

these tools allow a user to collect information from the Web and collate it in one location, when historians search, they know the information is relevant to their work. The feature they found most useful was the algorithm found and presented material, which, according to Participant 54

“Shows you what’s CLOSE to what you were looking for.” (P54)

The participants reported that this allowed them to make connections from there.

Heuristic Search

Although participants reported relying on the algorithms to present information in meaningful ways, they also take it upon themselves to understand the tools they use in digital environments and learn to use them to their advantage, as Participant 64 indicated:

“I think that test digital tools once and once again and by different ways, you can know the tools, find how use it and, if it is possible, adapt it to your needs.” (P64)

Search tools were one method of information seeking in the digital environment that many of our participants were used to manipulating. Some mentioned constantly changing their search terms, or purposefully misspelling names and places they searched for to get a wider variety of results, and therefore having a greater chance of experiencing serendipity. Participant 13 demonstrated this:

“Key word searches are good, but you must be flexible with them and change the words until you get a strike. This is something like fly fishing.” (P13)

Like historians do in physical libraries and archives, our participants used the digital tools available to them in ways that supported serendipity in their research.

Leads to the Unexpected

The unexpected was a very common term in these historians’ definitions and stories of serendipity (Martin, 2016). However, it did not feature prominently amongst the features of a digital environment that the historians felt supported serendipity. Although there were a few historians who mentioned having “illuminating, and occasionally serendipitous conversations” on Twitter that took them to unexpected places (P38), it was largely the results of a find or a conversation that lead them in a new direction, not a feature that could be relied upon. It may have been difficult for the historians to think in terms of features that “Lead to the Unexpected” as users might not recognize that the digital environment is “fertile ground for unanticipated or surprising interactions” until after they have made a serendipitous connection (McCay-Peet et al., 2014).

Trigger Rich

Finally, we only found 6 references to digital environments that were “Trigger Rich”, which were usually in passing, in phrases such as “Mostly just following hyperlinks” (P17).

This does not necessarily mean that environments that include a lot of links to other material were not found to be serendipitous, because it seemed to us that these historians simply took for granted the links available on the Web, and only drew attention to them when they were in useful or unexpected places, such as links to citations in online Works Cited sections of journal articles. Twitter was another place that could have been classified as being “Trigger Rich”, as the information on this site is constantly changing and links are provided here to other sources of information. However, here the historians predominantly mentioned the people they connected with through Twitter and how they followed conversations that interested them, rather than the preponderance of links available.

Overall, the five facets of serendipity in a digital environment (McCay-Peet et al., 2014) served well as a classification structure for the historians’ responses to Q21 and Q23. While there was some difficulty with classifying features of digital environments under the facet “Trigger Rich”, this largely stemmed from historians’ immersion in the online world, and their taking pages with many links for granted. It must be noted that we used these categories as a coding scheme, which is different from how McCay-Peet et al. (2014) employed them in their studies. The authors discerned five facets of serendipity, and showed their connection to serendipity in the digital environment via concentrated statistical analyses. We expand this work not by further validating the established measures, but rather by using them as a framework for guiding our understanding of serendipity in the digital environment, which also allowed us to remain open to the creation of sub-codes where necessary.

DISCUSSION

We presented the findings of a preliminary analysis of historians’ experiences with serendipity in digital environments. Our investigation of their comfort in these environments demonstrated a large range – while many participants were comfortable with digital tools that they used in their everyday lives (email, word processing, and social media) there were only a small percent of the participants who reported to be comfortable writing code, or using software development sites such as GitHub. Over half of the sample were comfortable using citation management tools such as Zotero or Endnote, as well as maintaining a blog.

The variety of digital environments where historians worked was highlighted throughout our investigation of serendipity. Not only did participants describe themselves selecting their digital environment based on whether they felt it supported serendipity, but they also found various ways to make digital environments they chose to use more serendipitous for their research. For many this meant learning how to change their search terms to get fewer or more results, depending on their current need. In our previous paper, we used the term “heuristic” to describe the

various methods that historians used to support elements of serendipity in digital environments (Martin & Quan-Haase, 2016, p. 1016). The descriptions of the features of serendipity in the present study provide further detail about the ways historians are working to support serendipity in their digital research environments. This led us to coin the term “Heuristic Serendipity”, which we define here as: *a process of information behavior in which historians use trial and error to create new, innovative methods of supporting serendipity throughout their research.* For the participants of our current study, this type of heuristic serendipity usually took place on Google or on library interfaces, both digital environments in which participants indicated to be comfortable.

Our participants often spoke of wanting search results that were “close to perfect”, but not necessarily limited to a single, correct answer. To create results of this nature historians have started to manipulate their search tools and other digital environments they use for research. There are two main ways that our participants indicated doing this. First, they tried out a variety of digital tools until they found what works for them. What digital environment they use, and how advanced the features are within it will obviously be impacted by their comfort and level of technological expertise. Some historians mentioned generating visualizations, which would “somehow recreate the effect of browsing the shelves or folders in a physical archive/library” (P57), while others spoke of finding a research tool with an interface they preferred, which allowed them to keep their own personal database of research material. The second method of manipulating their search tools was to introduce flexibility into their searches, by including misspellings, wrong words, and different combinations of terms. Several historians also mentioned that faceted or advanced search options allowed them to encounter things that they considered unlikely in other environments. Once they have obtained the results they were looking for, using either of the above methods of heuristic searching, the participants describe looking around this material in various ways. This form of information behavior was described much like other scholars have discussed browsing the stacks of a library (Björneborn, 2008; McKay, Smith, & Chang, 2014): searching around material, browsing through search results, etc. It is this information behavior that enables heuristic *search* to become heuristic *serendipity*. This is where historians’ own ability to connect the dots between historical research materials comes into play, and their recognition of useful, enlightening, or significant information can create a serendipitous experience. These skills are something that cannot be replaced by a single feature of a digital environment, which is one reason that historians are learning to control and manipulate these environments to suit their needs.

Finally, we asked our participants about the various features of digital environments that they felt supported serendipity.

We found that there were a wide variety of features that historians found to support serendipitous experiences; some of them were features of the environments themselves, while others were the results of historians' heuristic serendipity. Four features were prominent: those that enabled exploration (by supporting links to other material, or having full text access available), those that highlighted triggers (such as hashtags on social media, or highlighted materials as suggestions), those that allowed for keyword search (where historians could alter their search terms fluidly) and finally, those that connected them to other people.

Dantonio et al. (2012) found that academics got the most out of Twitter when they were using it while taking a break from their research work, but our historians seemed to use the tool throughout their process, as a way of following along with conferences and engaging with other about their research. Participant 63 notes that it is the "constant flow of information" that helps support their serendipitous experiences. This use of Twitter aligns more closely with the serendipitous experiences that were reported in a study of Twitter use by digital humanities scholars (Quan-Haase, Martin, & McCay-Peet, 2015). These participants reported that the ubiquitous qualities of Twitter helped them to maintain awareness of new information in their research area. For our historians, it is not only the ubiquity of the Twitter interface, but also knowing that they exert control over its features and functions that helps to support serendipity in this particular digital environment.

CONCLUSION

Historians themselves are operationalizing serendipity; remaining aware of the multiple ways to access information and then exerting control over their digital research environments to make serendipity possible. Just as historians of the past were trained to use libraries and archives to their fullest extent, digital historians must now be trained with the "critical awareness" that Solberg (2012) calls for; they must continue to recognize the strengths and weaknesses of the digital environment to continue to be agents in their own experiences with serendipity.

FUTURE WORK

Future work by the authors on this topic will include further integration of McCay-Peet's (2013) serendipity questionnaire, including a factor analysis to compare to her more recent findings (McCay-Peet et al., 2014). Now that we have made a significant step in understanding how serendipity plays a role in historians' research process, future work may include studies of other disciplines. Also, as this study benefitted from the knowledge of previous LIS studies on historians, using the results of the current study as a guide for future work on the use of technology by historians would help to show how historians' comfort level with technology, and uses of digital environments changes over time.

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