Embedding creativity into digital resources: Improving information discovery for art history

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Abstract

Over the past decades, technological advancement and the mass digitization of information resources have led to the development of a range of digital resources for academic scholarship. Understanding the needs of scholars when employing digital resources for their work can lead to the building of digital infrastructure that not only enables access to the required information but also has the potential to transform scholarship through having a positive effect on the whole scholarly workflow. Through this article, we show how the design of digital libraries and resources can be improved to enhance information discovery and use in art history, while also benefiting other key areas of the research process. By employing an ethnographic approach to the study of scholarly practices, we developed a sound understanding of art historians' behaviour when interacting with information at different stages of the scholarly workflow. Our results show that scholars exhibited highly creative behaviour when conducting core scholarly activities, such as information seeking and use. Yet, the challenges they often encountered showed that there is still more work to be done to improve digital infrastructure and tools for scholarship in the field. Part of this article will focus on the user requirements for designing systems that facilitate discovery, encourage creative use of information, and trigger inspiration.

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1 Introduction

The emergence of digital libraries and archives has greatly facilitated the need of Arts and Humanities scholars for finding diverse types of information.

Never before was there such breadth of information and services available for scholars to use; most importantly, though, such developments have offered the advantage of not only speeding up the research process,

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but also enabling innovative research inquiry. Thus, accessing and using a variety of digital resources has become a standard step in the daily work routine of scholars.

Previous research has showed that, until recently, art historians were still considered to be hesitant about the adoption of digital technologies, while many researchers were not convinced about the positive effect such technologies could have on their research (e.g. see Cuno, 2012; Zorich, 2012, pp. 19–22; Rodríguez-Ortega, 2013). However, this issue can be better understood if we consider several factors that characterize the field and are often associated with complex information behaviour and needs, making the employment of digital technologies for research purposes especially challenging.

First, the extensive list of subjects studied—often interdisciplinary in nature—and methodological approaches employed by art historians today frequently require the use of a wide array of information objects (e.g. textual, visual, and multimedia) in order to successfully answer a project's research questions. On the other hand, the different career stages of scholars, the various degrees of digital literacy as well as the difficulties often faced by researchers when using digital material—such as access problems, low image quality, copyright issues, and cost (e.g. see Beeman, 1995; Rose, 2002; Grindley, 2006; Haynes, 2008; Zorich, 2012)—can significantly impact the use of digital services and tools in research and teaching. Despite the challenges, though, art historians have started developing a greater reliance on digital resources (Beaudoin and Brady, 2011, p. 30).

Thus, the complex information behaviour of art historians, as well as the challenges they often face when interacting with digital resources, make them a great example of the impact that digital libraries and archives can have on the research process and enable us to reflect on how these can be improved to ensure that are tailored to the needs of scholars. For the purposes of this article, we aim to explore the following question:

> What can we learn from the study of scholarly practices during different stages of research and the creative interactions of art historians with information that we can apply to the building

of better digital resources for scholarship in the field?

Given the constantly evolving research practices of scholars in the art historical discipline, answering this question will significantly deepen our understanding of their information behaviour and needs; this knowledge can then be applied to the creation of better digital resources and tools to support key areas of scholarship in the field. Before we discuss our results and attempt to answer the above question, the methodological approach employed for the purposes of this study will be presented.

2 Using Ethnography to Study Scholarly Practices

This study employed an ethnographic approach to develop a sound understanding of scholarly practices in art history. Ethnography has been increasingly used in the context of library and information studies since the 1990s (Lanclos and Asher, 2016). Khoo *et al.* (2012) conducted a useful survey of ethnographic research in libraries, including the most frequently used methods, which noted an increase in the use of this type of approach to explore issues related to libraries and library users.

However, even though the use of ethnography is becoming more widespread, Lanclos and Asher (2016) argued that the circumstances under which it is often conducted do not enable librarians and information professionals to gain the full benefits of this approach. More specifically, the approach usually employed within libraries, called 'ethnographish' by Lanclos and Asher, utilizes ethnographic methods in the context of short-term, and with narrow scope, projects. Yet, in order to be able to conduct long-term and open-ended projects through which the potential of this approach can be realized (e.g. gain perspectives that quantitative approaches cannot provide), Lanclos and Asher (2016) suggested that problems, such as lack of resources and limited training in ethnography, need to be first overcome within libraries. Khoo *et al.* (2012) and Priestner and Borg (2016) also agreed that ethnography involves time-consuming processes when it comes to data collection

and analysis which require additional effort and, thus, additional support for those who conduct it.

Ethnographic methods, such as interviews and observation, have been widely employed by studies seeking to understand scholarly and user practices in the Arts and Humanities, many of which have been taken into consideration while designing this project and analysing its results (e.g. Benardou *et al.*, 2013; Antonijević and Cahoy, 2014; Antonijević, 2015; Martin and Quan-Haase, 2016; Zhang and Soergel, 2016). Even though the majority of these studies did not employ the kind of longitudinal approach that tends to characterize traditional ethnography, their authors still managed to conduct an in-depth exploration of scholarly and user practices and reveal aspects of behaviour that are not possible to uncover through employing different approaches (e.g. quantitative).

In this study, by conducting semi-structured, in-depth interviews with twenty art historians as well as observation of their physical and digital personal information collections, we aimed to identify the particular needs they have when they build them. Personal collections are at the core of art historians' workspace (e.g. Long and Schonfeld, 2014, pp. 23–25), and so are an important starting point for understanding behaviour and practices that are difficult to study otherwise, due to the private nature and the various personal criteria applied. The interviews, either in person or on Skype, were based on a semi-structured interview guide; each lasted approximately 1 h. Moreover, the interviewing phase included, when possible and with the interviewees' consent, observation of the interviewees' personal physical, and/or digital collections, taking photographs as part of the process.

Sixteen of the research participants were based at UK institutions, two scholars were based in Europe and another two outside Europe. Eleven of the participants were female and nine were male. Their technical skills varied from advanced to basic and career stages ranged from established academics to PhD students, early career researchers, and independent scholars. We were particularly interested in interviewing two groups of scholars; one where scholars worked on commonly studied areas (e.g. various areas of European art, like Renaissance art) or employed traditional art historical methods (e.g. stylistic analysis and historical investigation) and another where the topics examined (e.g. non-Western art and digital art) or the

methods employed (e.g. quantitative and digital) were considered less traditional. This categorization was based on the premise that the practices of scholars in the first group (twelve scholars in this study) had been frequently examined by previous studies in the field while the behaviour and needs of those in the latter (eight scholars in this study) had been less studied (Rose, 2002, p. 37). Identifying any similarities and differences between these two groups of scholars could provide a better insight into the needs that art historians in different areas of the field have in terms of resources, tools, and services.

The eras the interviewees explored through their projects ranged from the 14th century to today, including Byzantine art, medieval art, Renaissance, contemporary and modern art, 3D documentation of material cultural heritage, and art history education. The objects of study in scholars' work ranged from actual objects (e.g. paintings, sculpture, and manuscripts) and monuments (e.g. churches) to historical and other issues in relation to art and its artists, such as arts education and the creation of guidelines and standards.

A theoretical framework of empirically tested information behaviour models was used to analyse the interview and observation data; more information on how these models were used in the context of this study is provided in the section looking at the impact of digital resources beyond discovery. These included Ellis's (1993) behavioural model which was based on empirical, qualitative research of the information-seeking behaviour of scholars in the social and physical sciences. Ellis (1993, p. 482) presented the various behaviours involved in information seeking as features; these are starting, chaining, browsing, differentiating, monitoring, extracting, verifying, and ending. Additionally, we used Meho and Tibbo's model (2003, pp. 581–582), who after studying a group of social scientists, discovered similar characteristics in the information-seeking behaviour of their participants with those that Ellis had found, but they added three more features: accessing, networking, and information managing. These models were useful for identifying the distinctive behaviour of art historians in this study in terms of the way they look for information during the initial stages of their research.

Kuhlthau's Information Search Model (ISP) model (1991), which is concerned with the cognitive aspects

of information seeking, was valuable for understanding the reasons behind certain decisions that scholars made when interacting with digital resources and facilitated our exploration of the scholarly practices that follow information discovery. Kuhlthau's model (1991, pp. 366–368) consists of the following stages: initiation, selection, exploration, formulation, collection, and presentation. Shneiderman's (2000) framework, on the other hand, enabled the interpretation of our data concerned with the creative interactions of scholars with information (more information is provided later). Finally, given the fact that we used scholars' personal collections of information to examine how art historians collect, use, and manage information for research and teaching, Palmer *et al.* (2009, pp. 16–19) scholarly activities and primitives, based on Unsworth's (2000) concept of scholarly primitives, were fundamental for examining the practices (gathering and organizing) related to the building of personal collections.

3 Looking for Inspiration

Our study confirmed previous studies' findings (e.g. Bakewell *et al.*, 1988; Beeman, 1995; Durran, 1997; Beaudoin, 2005) in terms of the significance that information objects such as original artworks and primary resources, such as monuments, manuscripts, and archival material, and visual surrogates (physical or digital) have for art historians' work. Yet, apart from being the evidence upon which to base a research argument, in this study it became apparent that these resources could also provide inspiration to begin a project. For example, the examination of artworks can enable the discovery of the research subject and support the generation of research questions. These questions, then, in combination with the experience of the researcher, provoke searches for the required material. As Participant 04 (categorized as conducting traditional research) clearly explained:

> Personally, I tend to start with objects or images. So, an interest will often be sprung by looking at an image- often online just because it's easy to access- either in an image library or normally a museum website [Participant 04].

This quote, apart from illustrating the importance that art objects and their surrogates can play early on in a research project, also reveals the inspirational effect that digital resources containing relevant and openly available material can have on research. Graham and Bailey (2006, p. 22) also found that digital images can facilitate creativity and the thinking process of art historians, while Makri and Warwick (2010, p. 1758) had a similar finding showing the inspirational effect that information found online could have on triggering new ideas for current and future projects in the work of postgraduate architecture students in their study. At this point, it is worth noting that, according to Shneiderman (2000) getting inspiration from information is a characteristic of creative disciplines; based on the findings presented in this article, we argue that art history is a creative discipline (more information is provided later) and this characteristic should be taken into account when designing digital resources to meet scholars' needs.

Most of the participants in this study started their research in the digital environment, an approach which was also found to facilitate serendipity. Online discoveries made at this stage of the scholarly workflow were likely to influence the design of a research project and the information collected. For example, Participant 03's account (categorized as conducting traditional research) of the way they looked for material on the Web suggests that serendipity can influence the research process.

> I mean, there are a lot of these very early texts, these are Victorian texts, all these do seem to be often on the Web somewhere, but I don't intend to go looking for them now. If they come up, I'll go for them. But I don't tend to go looking for them [Participant 03].

Additionally, Participant 01's statement on 'trial and error' as a method of finding the needed information digitally suggests the existence of an element of serendipity in information discovery that can have an impact on the information-seeking process.

> I think it's generally true that people tend to find what they need digitally by trial and error. People say Google and you occasionally get a sort of a passing reference to 'Oh there is a good website, have you tried Gallica?', but there are

very little structured places to go for digital resources [Participant 01].

The above quote also implies that, often, there is a user perception that 'trial and error' during information-seeking leads to a serendipitous discovery. This discovery, then, has an impact on other decisions related to their information seeking behaviour. This can happen especially when there is a lack of or limited awareness of structured places where one can find digital resources relevant to their area of work.

There are two points that need to be discussed further to yield useful insights for designing information systems to support serendipity. The first is users' mental models around information searching and the way that digital libraries and other information environments work. The second is the different factors that affect the chances of a serendipitous discovery. Thinking about the former, Makri *et al.* (2007) found that a 'trial and error' approach to information seeking was often encountered when there was a low understanding among users of how aspects of a digital library operate, including the decisions behind the design of the search facilities. They argued that users develop mental models of how information systems and environments work based on their interactions with them; these can often be 'incomplete' and, thus, hinder them from achieving their information goals. They conclude that it is important to be aware of users' different levels of understanding of how digital libraries work to be able to support them effectively. It needs to be highlighted, that this should also be taken into account when developing relevant services and designing user-centred systems that support different information-seeking practices, including the concept of serendipity.

In the case of Participant 01, the connection between 'trial and error' and serendipity may partly be the result of having an incomplete picture of how digital libraries and the Web operate. However, we should also consider the existence of other factors that may have influenced their chances of making an unexpected, but useful, discovery during their searching sessions and which may often be difficult to incorporate into design. According to Race and Makri (2016), there are personal, internal factors that affect one's chances of a serendipitous discovery. For example, aspects of the user's personality, such as curiosity, and issues such as topical knowledge, time, and communication can all play a role in making a serendipitous discovery. Similarly, external factors, such as systemic characteristics, can also have an effect on this process.

Factors, such as the user's curiosity or communication with colleagues, may have also contributed in alleviating the negative impact that problematic access had on Participant 01's information-seeking behaviour by leading to serendipitous discoveries. Thus, even though it may be difficult to control serendipity, from the perspective of information professionals, careful planning which takes into account aspects of the users' mental models or the factors that can affect serendipity increases the possibility of influencing this process (also in Race and Makri, 2016, p. 21).

Several studies have looked into the role of serendipity in scholarly practice and examined whether it can be supported by information systems (one of the most recent is that by Martin and Quan-Haase, 2017). For instance, Foster and Ford (2003, p. 337) studied serendipity in the context of the information-seeking behaviour of interdisciplinary scholars and suggested that further examination is needed in order to understand that phenomenon which, as they argued, is '[...] a difficult concept to research since it is by definition not particularly susceptible to systematic control and prediction'. In this research, we discovered that serendipity was more likely to occur during the first stage of research, when scholars attempted to investigate a topic. At this stage, researchers tended to be more 'open' to accidental information discoveries—a personal characteristic identified by Race and Makri (2016, p. 17) as necessary to experience serendipity—and the possibilities to find unexpected information that would significantly affect the research process were greater.

Yet, the fact that some areas of research benefit from a larger pool of online resources (e.g. 19th century European art compared to Non-Western art) cannot be overlooked when considering the possibilities of discovering information serendipitously. For instance, Participant 08 (categorized as conducting non-traditional research), who was researching 19th century Japanese painting, found online serendipitous discovery less likely since an important part of the information they needed was only accessible physically.

And so, I've got all of that in Japan because it's very hard to get those books here. [. . .] I'm reading as well manuscripts, handwritten books, as a sort of social context [Participant 08].

This issue, then, generates questions regarding the extent to which information resources available online—even when including secondary material—meets the needs of scholars in the various sub-disciplinary areas of art history, such as non-Western art. The art period that a project was looking at, the geographical focus of its subject (for example, non-Western art) or the fact that the topic under investigation may have not been researched before were often connected to issues of availability of resources, conveniently accessible to scholars.

However, even in the cases when the material was available online, issues around digitization sometimes meant that it was necessary for scholars to visit a resource physically. As, Participant 16 (categorized as conducting traditional research) commented:

Printed photographs in secondary material; so modern photographic reproductions, engravings in nineteenth century periodicals or books which I usually see them digitized to begin with, which can be a problem because one digitization project makes it look entirely different from another, or I see them in the flesh [Participant 16].

Thus, aspects of the design of a resource, such as the way digitization have been conducted or its interface, and the experience it offered to the user were factors influencing scholars' information behaviour. Such issues could also influence their decisions as to which resources to use more generally. Participant 09 (categorized as conducting non-traditional research), gives an example of potential problems that can be encountered when using a digital resource, while Participant 03 explains why they avoid using particular resources.

I mean, I have a manuscript in Rome. It's held in another library, not in the Vatican, and they have digitized their collection, but for some reason that I'm still trying to understand they have digitized only the decorated part of the page. So, basically I get a decorated initial and I cannot read the text. [. . .] There are choices that have been made online that to me are completely absurd [Participant 09].

So I tend to try and avoid this sort of very dedicated websites which are special and you see all sorts of stuff because they tend not to have quite what you want and I don't seem to get quite used to finding this stuff, so I do tend to just use the search engines and see what it comes up and go from there [Participant 03].

However, despite the challenges, digital resources can be useful to researchers when they do not have a fixed idea of the kind of information they are looking for; having good quality metadata can significantly facilitate the discovery process in such cases. Participant 17 (categorized as conducting non-traditional research) shared the reasons why they find particular resources helpful under such circumstances.

There are bodies of work that I remember even if I don't remember about exactly how I'm going to find them or where they are. Resources like Rhizome are really useful because for a long time they archived a lot of Internet artworks. So that's a good cause of call which is as similar as it gets to going to an art gallery because I can look at an artwork in that archive but I can also more often than not find discussion that surrounds that artwork [Participant 17].

Moreover, digital resources were found to be particularly helpful to scholars who consulted them for teaching purposes in art history. For instance, Participant 11 mentioned finding electronic material useful when it came to preparing class material.

I teach a lot, so I tend to use electronic versions as much as possible [Participant 11].

Yet, teaching, although there is often flexibility in terms of copyright, has its own challenges in terms of the information objects to be used and the places

they can be found. For example, Participant 20 explains how the material needed is subjected to requirements posed by the topic taught as well as the level of the tutees.

> It would either be to a library or a museum or if I'm teaching an architectural subject, I'd go and see the building that I was going to be teaching and photograph it on site, because quite a lot of the things that I teach are not available visually on the Web. You can get generic images of monuments that are popularly taught, but you can't get the details that enable one to teach the material that you want to communicate. [. . .] Well, the level that you're teaching a student will dictate the specialisation of the images you're searching for [Participant 20].

This section aimed to illustrate the impact that institutional digitization and the building of digital resources can have on the first stages of the scholarly workflow in art history. Our participants' accounts suggest that digital collections and other online resources have the potential not only to enable research, but also to inspire the beginning of a project or influence scholars' decisions regarding its design and the data that is going to be collected. Yet, several of the challenges raised here indicate that digitization initiatives are not always conducted with the end user in mind, and this can reduce their usefulness to researchers. Before making suggestions for designing resources to meet the need of scholars in the field, we will look at the impact of such resources beyond the first stages of research.

4 The Impact of Digital Resources Beyond Information Discovery

Thinking about art historians' behaviour after the discovery of information, Palmer et al. (2009, p. 16) highlighted our limited knowledge around practices such as the gathering and organizing of information, along with any patterns in scholarly behaviour. Gathering, in particular, can be challenging to study; the reasons why scholars decide to gather specific information when they discover it, and the way in which they collect it are details that are difficult to capture. However, our data allowed us to make new discoveries about the actions of scholars after information discovery.

Generally speaking, art historians in this study collected any material they considered of importance for the purposes of their projects at that time or in the future; this finding is in accordance with earlier studies about Arts and Humanities scholars' gathering habits (e.g.Palmer et al., 2009, pp. 16–17). Yet, the design of our study and the employment of relevant information behaviour models enabled us to identify a pattern in their gathering behaviour not previously recorded. We started with Kuhlthau's ISP (1991, pp. 366–368) and its six stages of information seeking.

We then compared the behaviour of the art historians' participating in this study to the different

Table 1.. The gathering phases and their characteristics

Characteristics	Exploratory gathering (firstphase)	Focused gathering (second phase)
Action	Seeking and gathering relevant information	Seeking and gathering focused information
Task	Investigate/explore the topic	Build/enhance the research argument (often during writing)
Stage of research	Early	Progressed
Type	Non-selective	Selective/discriminate
Intensity	High	Low
Information amount	Large	Small
Feelings	Uncertainty/frustration	Sense of direction
Effect on personal collections	Creation and Initial organization of information	Further information organization/re-structuring

feelings, thoughts, actions and tasks associated with each stage of the Kuhlthau's model, and decided that the 'exploration' and 'collection' stages would constitute our main focus. These stages and their properties were most relevant to explain the patterns identified in our data and, more specifically, the fact that our participants' gathering behaviour tended to consist of at least two main phases (see Table 1 below, also see Kamposiori *et al.*, 2018, p. 95). Although in Kuhlthau's model, the gathering of information takes place only when the user has developed a certain confidence in their topic and, thus, it is naturally more focused, art historians in this study began gathering material much earlier, at the time resembling Kuhlthau's exploration stage (when uncertainty is more common).

Indeed, apart from being conducted in the context of exploring a new topic at the beginning of research, our participants' first phase of gathering was often a result of the feelings associated with obstacles encountered during the information-seeking process (corresponding to Kuhlthau's exploration stage), such as frustration due to limited access, which made the need to gather as much as possible (digitally and physically) more urgent. Then, a more focused gathering phase was identified which often took place at a more advanced stage of the research, after reading and during writing (especially in the cases where projects lasted for a long time) and bore similarities to Kuhlthau's collection stage. Yet, as Kuhlthau argued, it is possible for users to gather information during various stages of the research process based on their particular behaviour and needs, while entering the writing stage as well as conducting an initial organization of the collected material may enable them to develop this more focused approach which leads to a second phase of gathering (1991, pp. 368–369).

Therefore, after using Kuhlthau's ISP model to closely examine the behaviour of art historians that followed the discovery of information, and identifying the impact that the challenges associated with digital resources can have on this process, we suggest a variation of the model. This should include an additional gathering task at the exploration stage called Exploratory Gathering which will follow the Exploratory Information Seeking conducted beforehand. Moreover, the second gathering task (with the same characteristics as the one described in the model)

could be named Focused Gathering and will come after the Focused Information Seeking.

This finding was also examined from the perspective of other information-seeking studies which include aspects of information collection in their models (e.g. information gathering and information managing), such as Shneiderman's framework (2000) or Meho and Tibbo's (2003) extended version of Ellis's information-seeking model. More specifically, based on the assumption that there are two—at least—distinct stages of information seeking (of different nature and with different purposes) preceding the different gathering phases, we can then talk about repetitive tasks or a need to go back to a previous stage and, hence, refer to Shneiderman's framework (2000, pp. 119–124). Shneiderman suggested that non-linearity or repetitive tasks can be part of information-seeking behaviour in creative areas while users can have different needs during these tasks. Having argued that art historical practice could be characterized as creative, especially in terms of its interaction with information, these observations suggest that art historians have different information needs during the different phases of their information-seeking and gathering activities. This finding constitutes an addition to our current knowledge about the information-seeking and gathering behaviour of art historians and should be taken into consideration when designing digital resources and tools to support scholarship in the field.

Finally, if we consider art historians' behaviour during the exploratory stage in more detail, gathering information indiscriminately early in the research process can pose information management challenges for scholars later in their research and have an impact on other scholarly activities, such as reading and writing. As discovered in this research, scholars often had to take action with regards to the management of the collected material and sometimes, as Participant 19 also argued, even discard information, in order to be able to use it effectively (e.g. to retrieve useful information).

> But I would say the first year was the main phase of gathering and being quite indiscriminate. Then, the second year you gather but you're much more discriminate about what you choose to include and what you choose to

ignore because then you have to contain it. Contain, you know, is a keyword [laughs]. [...] It's always a struggle to keep up on top of all the information that you gather. And you have to make some decisions; even regarding things that you thought would be useful, you have to make some decisions to just discard [Participant 19].

This observation also brings to mind Meho and Tibbo's (2003, p. 584) argument about information management; even though it is not considered an actual information seeking task, information management (or managing information) is essential when personal collections play an important role in the research process (as in the case of the art historians in our study), since it can affect other scholarly practices and tasks conducted in the context of research, such as information retrieval (from personal collections). Thus, understanding that the problems that art historians face with regards to the use of digital resources can have an impact on different stages of the scholarly workflow is a necessary step towards meeting their needs and improving the research process.

5 Designing for Creativity

Creativity is a concept that has been examined by a variety of disciplines, including the humanities, psychology, social sciences, organizational theory and information studies, and science; according to Seidel *et al.* (2010), originality and innovation are at the core of the majority of definitions. In this research, we looked at creativity as part of understanding art historians' practices when they work with information and how they can best be supported by information systems. More specifically, while studying scholars' information behaviour at different stages of their research, it became apparent that aspects of the way they interacted with information could be characterized as creative; this means that the way information was discovered or used gave rise to a breakthrough moment in their work.

For the purposes of analysing this part of their behaviour, we consulted relevant studies from the field of information science; Shneiderman's (2000) framework for creativity was particularly useful. This four-phase genex framework was developed based on three different theories of creativity—inspirationalist, structuralist, and situationalist—to enable system design that supports creative work. Briefly, the inspirational view on creativity advocates brainstorming, free association, lateral, and divergent thinking and, accordingly, about strategies that support creative work by looking at a problem 'with fresh eyes' (Shneiderman, 2000, p. 116). On the other hand, the structuralist perspective supports a more methodological approach to problem solving (e.g. by looking at strengths and weaknesses) to achieve innovation, while the situationalist stress the key role that the cultural and social environment play in an innovator's work (Shneiderman, 2000, pp. 116–117).

Shneiderman's framework includes four creative activities—collect, relate, create, and donate—and potential tasks associated with them (2000, p. 123). The discussion around the framework also referred to some of the characteristics of creative work; examples are the ability to get inspiration from information (as mentioned earlier), especially visual information, and the non-linearity of the tasks involved in this type of work (e.g. Shneiderman, 2000, p. 120). Regarding the latter, and as discussed previously, by using Kuhlthau's model alongside Shneiderman's framework, we discovered that the information-seeking behaviour of art historians entailed repetitive tasks. This, alongside other creative aspects of participants' information behaviour—such as the inspiration they gained when they discovered certain types of information and, at a later stage, organized their personal information collections, and the positive impact this had on the progress of their work—enabled us to argue that art history is a creative discipline.

Regarding the first stages of research, when serendipity was found to be more likely to happen in this study, it was noted that unexpected discoveries while searching and browsing online could have an impact on scholars' work, by triggering creative thoughts and influencing the research process. The contribution of serendipitous encounters to the development of creative insights has been recognized by several studies (for example, Boden, 1996; Foster and Ford, 2003; McCay-Peet and Toms, 2011; Race, 2012; Taramigkou *et al.*, 2013; Race and Makri, 2016). For example, Race argued that a serendipitous discovery promotes creative thinking 'by fostering novel

connections and frameworks' (2012, p. 140). On the other hand, Race and Makri highlighted the link that exists among creativity, serendipity, and innovation, noting that 'most of the same factors that encourage or discourage creativity and innovation encourage or discourage serendipity as well' (Race and Makri, 2016, p. 16). Problematic access to digital resources, such as due to limited availability, low quality of digital material or non-user friendly system design, is one of the factors that can affect the chances of a serendipitous discovery and, accordingly, hinder creativity (also see Shneiderman, 2000; Race and Makri, 2016); as noted earlier, this was an issue faced by several participants in this study.

More specifically, despite the progress that digitization initiatives have made and the increased availability of online material (especially secondary literature), we found that scholars still lack digital access, particularly to primary resources and good quality, open access, visual material. Finding high-quality images, in particular, is of paramount importance for art historical research; as we argue above, the discovery of interesting digital images can have an inspirational effect in research. It is essential that digital images used in the study of art and historical artefacts are of high resolution and colour accuracy (e.g. see Rhyne, 1997). Such images are essential tools for conducting traditional and digital research as well as for teaching and publishing in art history.

Access problems continue to perpetuate some of the habits of art historians noted in previous studies (e.g. see Bakewell *et al.*, 1988, p. 86; Beeman, 1995, p. 95). These are often associated with pre-digital or non-digital contexts and could cause significant challenges at the later stages of research; for example, many of the participants in this study still had to travel in order to visit the archives and museums holding the material they were interested in, and even then, some found it challenging to locate or access content physically.

Interviewees in some areas of study, such as Asian and Japanese art, faced greater difficulty in finding the material needed for their projects (especially primary resources) online; unsurprisingly, the availability of digital resources on the Web tended to be greater in areas dealing with Western art of popular eras (e.g. Renaissance art, 18th and 19th century European art). Whereas scholars working on digital art were more likely to confront issues around the re-accessing of data, due to the temporary character of the format of the resources they used in their projects and the supporting infrastructure (e.g. software). The importance of understanding the needs of scholars in non-traditional areas (e.g. Non-western art, digital art) was first mentioned in Rose (2002) but has not yet been explored by other studies of the information practices of art historians, despite the fact that research on these types of art is growing. Thus issues of accessibility to resources that meet these art historians' needs become ever more pressing.

To address these problems, digital resources that enable art historians to discover useful information, enhance the chances of a serendipitous discovery, and facilitate the creative nature of research in the area, these should be based on scholars' practices and needs (e.g. cataloguing material in a meaningful way for scholars). Our study also shows that they must meet the needs of a diverse group of scholars with various degrees of technical ability and potentially different mental models, meaning different understanding of how digital information systems work.

Thus, the interface design should be simple and easy to use, and the functionality should encourage different types of searching. Given art historians' frequent need to browse content in collections (especially when they are not sure what they are looking for) and to engage visually with information, digital resources targeted to this group of researchers should enable the visual exploration of collections. This could be achieved by allowing users to get an overview of the material (or groups of information) in a collection, providing suggestions for similar content and offering services that facilitate intuitive interaction with information (for example, zooming in-out, flicking through) (also see Shneiderman, 1996; Whitelaw, 2015). Including related metadata alongside the digital objects in a collection, as well as information on the decision-making process with regards to digitization, will enable scholars to make informed decisions when using digital content and gain necessary details for the purposes of their work. Finally, enabling access to digital collections through different means, including the ability to view and download material, is necessary in order to meet scholars' evolving need to access and manage material across devices and tools.

Art historians have increasingly become aware of the effects that the design of a user interface, including the search facilities, of a digital resource or the digitization process preceding its building can have on their work; for instance, some of the participants (e.g. Participant 09 below) referred to the apparent interpretative choices that had been made to the content of specific resources or referred to the searching problems encountered due to the way that the material was classified and catalogued.

> I mean, I have a manuscript in Rome. It's held in another library, not in the Vatican, and they have digitised their collection, but for some reason that I'm still trying to understand they have digitised only the decorated part of the page. So, basically I get a decorated initial and I cannot read the text. [. . .] There are choices that have been made online that to me are completely absurd [Participant 09].

Our interview data indicate that poor editorial choices reduce the usefulness of the digitized content for scholars, who must then look for another resource online or visit the resource physically. Therefore, incorporating scholars' (as the potential users) views early in the digitization process, providing essential information about the choices that have been made during the building of a digital resource, and gaining user feedback about aspects of the interface design, will not only increase its usefulness for scholars and earn their trust but can also prove beneficial for the longevity of this resource. This is far from being a new recommendation; indeed, it is one that members of our research group have been making for over a decade in different contexts.

The design requirements we suggest may also seem simple: the importance of features such as clear interface design and ability to gain an overview of collections has long been known, but is not as easily achieved as might initially have been imagined (e.g. see Greene et al., 2000; Dillon, 2000; Rapp et al., 2003; Makri et al., 2007; Warwick, 2017). The experience of the users that we interviewed, and the continued hesitant stance of many art historians to adopt digital research techniques suggests that they do not yet feel that digital resources are sufficiently easy to use, or sufficiently well suited to their needs. Thus, we feel it is important to reiterate the need for such apparently basic design features and for user-centred design from the beginning of projects.

6 Conclusion

The aim of this paper was to explore how digital resources can be best improved to enhance information discovery and use in art history through examining the creative interaction of scholars in the field with information at different stages of the research process. By looking at the scholarly practices and needs of art historians at the beginning of research as well as after information discovery, we make recommendations for digital resource design that will facilitate the creative encounters of scholars with information. Achieving this will have a positive effect not only on the processes of information seeking and discovery, but also on the whole scholarly workflow.

At the first stages of art historians' research, we discovered that information encountered serendipitously online could influence the research process, for example by inspiring the beginning of a research project, directing further information-seeking activity, and triggering creative thoughts. However, it became evident that art historians still have limited access to digital resources containing primary material which is digitized and presented according to their preferences and needs. Through documenting and analysing the behaviour and needs of scholars when they seek and gather information for their research and teaching projects, we were not only able to identify the problems they faced, but also understand how these affected aspects of research beyond the early stages.

Challenges associated with digital resources (e.g. lack of digital resources in an area of study, poor digitization, or resource design) were often found to impact scholars' behaviour at later stages of their research by leading to the need for additional information seeking and gathering; this could complicate other scholarly practices such as writing. More specifically, in this study, at least two different stages of information seeking were found to occur in the course of a project where scholars had different information needs during each of them, a new discovery which has direct implications for digital resource design.

In this article, we also highlight the need for digital resources that contain better quality primary information such as images. However, user-friendly design that facilitates the discovery and use of this information is also important. Thinking about enhancing the chances of a serendipitous discovery, we argue that careful planning should take into account users' mental models and other factors that can affect serendipity, such as aspects of the user's personality. Moreover, the interface design will need to be simple and enable intuitive and creative interaction with information (e.g. through visual exploration of collections) to meet the needs of different groups of users (e.g. with various degrees of technical ability).

Incorporating scholars' views early on in the digitization or resource design process, and making the surrounding decision-making process more explicit, will increase user trust and significantly enhance usability. Despite the simplicity of some of these recommendations, our findings showed that many digital resources targeted to art historians still do not adequately meet these criteria. Therefore, it is necessary to reiterate the importance of developing digital resources with the end-user in mind if it is to ensure their longevity and usefulness for scholars.

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