Academics' responses to encountered information: context matters

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Abstract

An increasing number of tools are being developed to help academics interact with information, but little is known about the benefits of those tools for their users. This study evaluated academics' receptiveness to information proposed by a mobile app, the *SerenA Notebook:* information that is based in their inferred interests but does not relate directly to a prior recognized need. The evaluated app aimed at creating the experience of serendipitous encounters: generating ideas and inspiring thoughts, and potentially triggering follow-up actions, by providing users with suggestions related to their work and leisure interests. We studied how 20 academics interacted with messages sent by the mobile app (3 per day over ten consecutive days). Collected data sets were analyzed using thematic analysis. We found that contextual factors (location, activity and focus) strongly influenced academics' responses to messages. Academics described some unsolicited information as interesting but irrelevant when they could not make immediate use of it. They highlighted filtering information as their major struggle rather than finding information. Some messages that were positively received acted as reminders of activities participants were meant to be doing but were postponing, or were relevant to ongoing activities at the time the information was received.

*Keywords***:** Information interaction, Reflection, Relevance, Serendipity

Academics' responses to encountered information

Introduction

Academics seek and interact with information every day to find new sources, expand existing knowledge, or for inspiration. The vast amount of information on the Web can challenge those searching processes. For people at the start of their academic careers, shifting fields or engaging in interdisciplinary research (e.g., Palmer, 1999), the identification of highly relevant information can be particularly challenging. However, "sometimes, information is encountered and used without an explicit need ever having been identified. Perhaps the most interesting of such encounters are generally regarded as 'serendipitous'" (Blandford and Attfield, 2010:35). Some tools have been created to "promote a discovery environment that encourages the searcher to be creative, to be open to accidental discovery" (Race, 2012:140). Other tools provide *recommendations* for information to consume (e.g. Toms & McCay-Peet, 2009), people to meet (e.g. Eagle & Pentland, 2005), places to visit (e.g. Bellotti et al., 2008) or events to attend (e.g. Forsblom et al., 2012) based on users' personal interests. These studies illustrate the range of efforts to design tools to support serendipity but none of them has really taken off in terms of design. On the other hand, digital information environments have the potential to "kill" serendipity even when they aim to support it. Van Andel (1994:646) stresses that "the very moment [we] can plan or program 'serendipity' it cannot be called serendipity anymore." Similarly, André et al. (2009:20) argue that when "all elements of chance and accidental finding" are removed, we end "with something barely recognizable as serendipity." This raises the question whether we can design tools to support serendipity. The motivation of this study was to address that question by exploring how people respond to encountered information when an information need has not been explicitly recognized and information is not being actively sought, and how digital tools support the information journey (Blandford and Attfield, 2010).

Our study aimed to investigate how academics interacted with and made use of messages received on their mobile phones generated by a reflective app, the *SerenA Notebook app* (Maxwell et al., 2012), and whether messages were perceived as opportunities for serendipity. The SerenA app was developed to try to integrate serendipity with people's activities, particularly focusing on the notion of notebooks and capturing the action of note-taking. The goal of the app is to assist academics by sending work and leisure messages that are based on their interests, as reflected in the notes that they keep for themselves. Messages contain *suggestions* (e.g. papers to read, people to visit, events to attend) that the individual might find interesting and unexpected, and may want to follow-up on.

In this paper, we first provide an overview of the information interaction process and the phases of the information journey. Then we discuss previous studies related to interactive technology developed to support 1) these phases, and 2) users in making accidental connections and discoveries. We then describe the methodology used in the study and the data sets collected, followed by the analytical rationale used to make sense of the data. We report and discuss our findings, and end the paper with conclusions highlighting further possible studies.

Related work

Interacting with information

Marchionini (2008) describes three elements involved in the information domain: "information objects (e.g., books, articles, and other physical records); humans who create, manage, and use the objects to form mental representations; and the technologies that capture, store, transmit, and manage information objects." Over time, studies have moved from exploring human and technological elements independently, leaving aside how people acquire, manage and organize information, to investigations taking into account the relationship between people and technology. In other words, studies became more user-centered, investigating how people interact with information and how particular technologies support that interaction. The study reported in this paper investigates how people interact with different types of presented information (e.g. pieces of advice, activities, resources), how they make use of that information in their daily lives, and ways of supporting that process through interactive systems.

Investigating information interaction beyond information acquisition extends the scope of research towards a holistic understanding of the usefulness of technology to users: how we actually make use of that information, our "actions, feelings and thoughts at the time of information encountering" (Erdelez, 1999). This provides insights on, for example, how we use information to evolve our understanding of a topic, how it feeds into ongoing research, and how it inspires new avenues of research. Many of these stages are captured in Wilson's (1999) Human Information Behavior (HIB) model. Wilson reviews earlier models of both information seeking and information searching, proposing a nested model in which information behavior encompasses, but extends beyond, information seeking, and information seeking, in turn, extends beyond search behavior. The main stages of the HIB model are: recognizing the context of an information need; engaging in information seeking behavior; and information processing and use. This includes the important step of information use, but presupposes that an information need has been recognized as a "gap" (Belkin et al, 1982) and that information seeking is active. While Wilson's model refers to "passive search," there is no explicit discussion of information encountering. Furthermore, "processing and use" are merged, with little discussion of how information is assessed or interpreted within the context of the individual's knowledge and interests. These steps (of encountering as well as active seeking, and of interpretation as well as acquisition) are featured more explicitly in Blandford and Attfield's (2010) "information journey".

Blandford and Attfield (2010) explain that "information interaction takes place within the context and in the service of some broader activity." That broader activity comprises interacting with information in a range of ways (e.g. from planning a journey to writing a paper) and places (e.g. home, street, office), and via a large number of channels (e.g. other people, physical and digital media). Those interactions experienced by the individual form the "information journey", which involves seeking, encountering, interpreting and using information in the context of work or leisure. The information journey describes aspects of information interaction that are often overlooked (e.g. validating and interpreting information,

and applying that interpretation to the user's information task/need). When designing academic digital information environments, it is important to consider these aspects to support academics in not just finding information, but also with "downstream information activities" that incorporate the information found into work.

In the next section we review the information journey in more detail.

The Information journey

The information journey comprises four phases, frequently starting with the recognition of an information need followed by the collection of information. Information may be collected "through active searching, serendipitous finding or being told" (Blandford & Attfield, 2010). Subsequent phases involve interpretation and validation of information, and its use, such as in writing a report, making a presentation or making decisions (Figure 1).
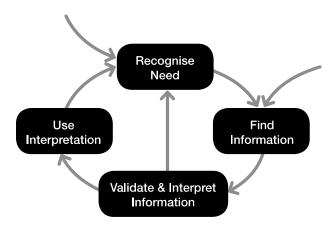

Figure 1: Information journey phases (based on Blandford & Attfield, 2010)

By interacting with information, the individual's understanding evolves. Blandford and Attfield (2010) note that the phases are not sequential as information "may be acquired incidentally (without the individual having previously recognized the need), and it may be necessary to find and interpret (or make sense of) a lot of information before any of it is overtly used." The information journey highlights that information interaction extends beyond information seeking and also includes information encountering. Considering information encountering in the context of the information journey highlights the importance of not only supporting users in encountering information unexpectedly, but also in trying to ensure that the information they encounter is useful—so that the information ends up being used in their work.

The information journey adapts to an individual's information interactions. The reflective interactive system evaluated in this study aimed at supporting the information journey by recommending information to users even when a need has not been recognized. All four phases were investigated in our study, but the focus was on encountering, interpreting and using (or saving or ignoring). A better understanding of the

information journey may provide key insights to improve the design of reflective interactive tools to support the journey.

Reflective systems and tools supporting information interaction

The information journey involves various processes, including information seeking (Kuhlthau, 1991), information retrieval (Ellis, 1989; Vakkari, 2001), sensemaking (Dervin, 1999; Pirolli and Card, 2005; Klein et al., 2007), and information management (Deltor, 2010). Many interactive tools have been created to assist those processes. For example, NewsHarvester (Attfield et al., 2008) provided journalists with integrated support for information seeking and retrieval, and sensemaking in the context of the article writing process.

Interactive tools have also been created to support information interaction through unplanned discoveries. These tools aid users in making connections and may foster serendipitous connections. For example, Stevenson et al. (2008) introduced a library classification system to enhance resource discovery based on hypertextuality of digital resources. Similarly, Thudt et al. (2012) created a "Bohemian Bookshelf" tool that allowed users to explore library collections by interacting with novel information visualizations. The tool supports unplanned discoveries by encouraging "playful exploration" with the various visualizations. Other existing interactive systems explicitly support reflection to stimulate creative thinking. For example, MIRROR (Karlsen et al., 2011) is a mobile application that helps care home staff solve unfamiliar workplace-related problems by encouraging carers to use analogical reasoning to apply solutions to previous problems, from either within or outside their domain, to their current problem.

The app evaluated in this study particularly focuses on supporting academics with making connections, generating new ideas and creating opportunities for discovering information serendipitously.

Coming across information serendipitously in academia

As discussed previously, the information journey involves finding, validating and interpreting information, and then making use of the interpretation. Sometimes this involves recognizing an explicit need (e.g. information on a particular theatre production a friend told us they enjoyed), but other times the need may be less explicit. For example, consider coming across an advertisement for a theatre production of a movie we had particularly enjoyed watching: assuming we were previously unaware of the theatre production, this can be regarded as information we "did not know we needed to know." Furthermore, this exemplifies coming across interesting information unexpectedly (or "serendipitously"). Sometimes people come across information serendipitously during active information seeking: they may be searching or browsing for information related to one topic and bump into information on another topic of interest (Erdelez, 1999). However, much of the time, coming across information serendipitously does not involve people seeking information, but information seeking *them*.

Academics' responses to encountered information

Foster and Ford (2003) quote from the Oxford English Dictionary in defining serendipity as "the faculty of making happy and unexpected discoveries by accident." They note that serendipity has particular value for the creative process but also a strong role in academic research.

In a study with experienced searchers, Watson (2008:4) reported that for information encountering to be considered serendipity it needed to be both *unexpected* or *unplanned* and *useful* or *valuable*. Makri and Blandford (2012) found that experiences that people described as "serendipitous" involved three essential elements: unexpected circumstances, an "aha" moment of insight, and a valuable, unanticipated outcome. When applied to an information discovery context, this empirically-derived definition suggests that information that people come across serendipitously should be both unexpected and valuable (information can drive insight, but cannot be insightful in its own right). Although the study reported here was not solely focused on coming across information serendipitously, we took serendipity dimensions as a way to evaluate whether information suggested by the app triggered serendipitous encounters. In place of value, we used surrogate elements of serendipity provided by a prior study (Kefalidou et al., In preparation) to measure the influence of suggestions generated by the app: together with unexpectedness, we used interestingness and whether or not information was followed up by action, as discussed in more detail below.

Several prior studies have examined the role of serendipity in academics' information journeys and indicated its benefits for information seeking. Foster and Ford (2003) found that coming across information serendipitously during active information seeking either led to the reinforcement and strengthening of the researcher's existing understanding of their information task, or to the task being reconfigured in some way. They highlighted coming across information serendipitously "as an important source of artistic stimulation" (2003:322) and a means of revealing "hidden analogies" by making mental connections between information sources and thereby stimulating creativity. In addition, Watson (2008) indicated that coming across information serendipitously could generate follow-up actions, such as "propelling" information-seeking forwards. Makri and Warwick (2010) found serendipitous information encounters to be both a driver and enabler of inspiration for postgraduate architecture and urban design students.
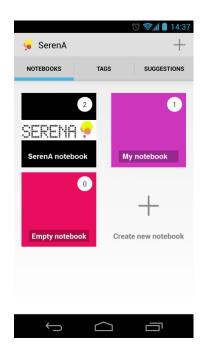
Existing studies have also investigated how and when academics come across information serendipitously. Makri and Warwick (2010) reported that their participants often came across information serendipitously when browsing images of buildings in order to inspire their design work. Sun et al. (2011) found that academics often made unexpected mental connections between people, information and ideas during the course of their work.

The aim of the SerenA notebook was to facilitate such serendipitous information encountering, and an aim of the study reported here was to test the SerenA concept. Our study bridges the information interaction domain and serendipity literature by exploring academics' information needs and identifying factors (as reported by participants) that shaped how people responded to the suggestions received. In the next section, we introduce the app evaluated in this study.

The SerenA Notebook

The concept of the SerenA Notebook was developed within a project (www.serena.ac.uk) that aimed to deliver technology that supported serendipitous interactions in research practice. The idea behind the Notebook was that it should infer researchers' interests from their notes and offer suggestions of information from resources that the researcher does not normally access to facilitate "serendipitous encounters". One of the aims of the study reported here was to evaluate the utility of the SerenA concept. The focus of this paper is on people's perceptions of, and responses to, suggestions related to their declared interests and their notes. In this context, the SerenA app is a useful experimental instrument, but not the focus of the study, so we provide an outline description of it.

The SerenA Notebook is an Android-based mobile app building on the functionality of physical notebooks and the action of note-taking to support serendipity (Maxwell et al., 2012). The app aims to interactively replicate these roles by allowing users to make notes while on the move and tag them with various hashtag keywords to enable later searching or browsing (Figure 2). The finalized app will allow users to categorize notes into notebooks, and to organize notebooks.
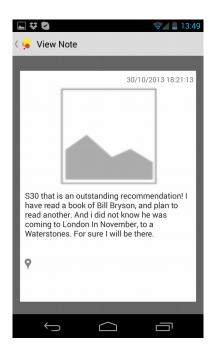

Figure 2: Screen shots of The SerenA Notebook. *Left:* Notebooks created using the SerenA app. *Right:* Note created during the study by participant U5 in response to one suggestion.

The finalized app will also allow users to view system-generated suggestions. A suggestion will be a "title-statement" followed by a URL link related to users' interests (e.g. Figure 3). The URL link contained in the suggestion will direct users to a Website containing information that they might want to look at, related to notes they had entered in the SerenA notebook. Suggestions will be generated by an underlying agent

based system integrated with the notebook making inferences between the text the user enters in their notes and information available on the Web about potential information, people, places or events that are related to the notes the user enters (Forth et al., 2013).

"Brenda Dervin has previously presented her work at the Information Seeking in Context conference. *http://isic2014.com*"

Figure 3: The figure illustrates a suggestion of a potentially interesting and unexpected person to meet related to the notes a user has made.

Study

This study aimed to evaluate academics' responses to encountered information sent by the SerenA app to (1) better understand how people engage with unsolicited but potentially relevant suggestions from a system, and (2) identify design implications for future systems intended to support serendipity-like experiences

Methodology

The app evaluated in this study was a prototype that had reduced functionality. For example, while users could create notes and notebooks, they could not edit notes or delete notebooks; and the suggestion algorithm was not implemented in this prototype. Taking this into account, we designed a multi-layered study to evaluate use of the SerenA app in naturalistic settings, and simulate key aspects of the app that were not fully in operation by human "Wizards" (Dahlbäck et al, 1993). This Wizard of Oz (Kelley, 1984) approach required wizards to generate suggestions by simulating the behavior of the underlying agent system and interactive technology as outlined above and presented in more detail by Forth et al. (2013). Wizards sent suggestions to users by text message. Sometimes suggestions were based on an individual note a user made using the app (e.g. "3D printing" or "digital fashion"). At other times, suggestions were based on connections between notes (e.g. "3D printing of digital clothing items"). Functionality for the user to provide feedback on suggestions was simulated by issuing users with an assessment log sheet (Appendix B).

For the study, we recruited participants as wizards and users. Four wizards with a Masters or BA/BSc qualification, and native level of English were recruited through an agency. 20 users were recruited from two UK universities: University of Nottingham and University College London. Users were researchers and advanced PhD students (at least on the second year or with a minimum of five years of professional experience) from diverse backgrounds (e.g. architecture, psychology, HCI, biology). Table 1 summarizes users' demographic information. The recruitment process involved an open call sent via mailing lists, and

public announcements of the study to the research populations from both participating universities, specifying the need of an Android phone, 4.0 with JellyBean or Gingerbread operating system.

User	Gender	Background	Age range	Role	Experience
1	M	Computer Science	40-49	Senior lecturer	20+ years
2	M	Biology	20-29	PhD student	5-10 years
3	F	Computer Science	30-39	Researcher	10-20 years
4	M	Human Geography	20-29	PhD student	1-5 years
5	M	HCI	20-29	PhD student	1-5 years
6	F	HCI	30-39	PhD student	1-5 years
7	F	Psychology	30-39	PhD student	1-5 years
8	M	UX	20-29	PhD student	1-5 years
9	F	Psychology/HCI	20-29	PhD student	1-5 years
10	M	Psychology	30-39	Researcher	5-10 years
11	M	Chemistry	20-29	PhD student	1-5 years
12	M	Computer Science /HCI/Digital Economy	20-29	PhD student	1-5 years
13	F	Business School / Women Studies	20-29	PhD student	1-5 years
14	F	Human Factors /HCI	20-29	PhD student	1-5 years
15	M	Computer Science /Digital Economy	20-29	PhD student	1-5 years
16	M	Computer Science /Digital Economy	20-29	PhD student	1-5 years
17	M	Computer Science /HCI/Digital Economy	20-29	PhD Student	1-5 years
18	M	Geospatial Sciences /Digital Economy	20-29	PhD Student	1-5 years
19	M	Digital Economy /Human Factors /Artist	20-29	PhD Student	1-5 years
20	F	Pharmacology	20-29	PhD Student	1-5 years

Table 1. Users' demographic information

To minimize the risk of affecting users' freedom of expression, users were told that they would be interacting with a computer system and no reference to the wizards was made (Dahlbäck et al., 1993). Users were paid £100 for a training session, ten days of the study, and debriefing interview, and wizards participated for an hourly rate as specified by an agency for home workers. Both users and wizards were given information sheets and consent forms at the beginning of the study (Ethics number: Z6364106/2013/06/12).

Multi-phase study structure

In total, the study ran over 20 days and involved three phases. Table 2 gives an overview of the study structure, and participants' (wizards and users) roles in each phase of the study.

	WIZARDS	USERS
	4 participants	20 participants
Phase 1: Training Sessions		
Tools provided	Wizards kit components: 1) Key information: Concept of suggestion & Access to Wizards interface 2) Rules & Instructions 3) Template 1: Suggestion phrasings 4) Template 2: Suggestion themes 5) Template 3: Suggestion sources 6) Template 4: Suggestion objectives 7) Log sheet	Users kit components: 1) Description of SerenA app 2) Assessment log sheet 3) Access to online registration form
Duration	60 min	45-60 min
Actions	- Get familiar with the app - Generate suggestions (as trial)	- Register online & Provide personal information and interests - Install SerenA app in phones - Create notes - Get familiar with app
Phase 2: Generation of & Interaction with Suggestions		
Duration	12 days	10 days
Actions	- Get familiar with assigned users' personal information and interests - Generate suggestions - Set suggestions three times a day	- Interact with received suggestions - Create notes in response a each suggestions - Complete assessment log for each suggestion - Take notes (optional) - Document experience (optional)
Data sets collected	**Data set 1:** Suggestions generated and sent by wizards during the study to each user.	**Data set 2:** Notes created using the SerenA Notebook App at any moment of the study period (both notes written by users about work- or hobby-related ideas, and notes created by users specifically in response to suggestions) **Data set 3:** Users' self-documented thoughts, experiences and comments on the whole study. **Data set 4:** Assessment log sheets with users' ratings for each suggestion using the following 5-point Likert scale to assess each given criteria: Not at all (1), Not Very (2), Neutral (3), Somewhat (4) and Very (5).
Phase 3: Debriefing Interviews		
Duration	60 min	60 min
Actions	N/A	N/A
Data sets collected	Not reported here	**Data set 5:** Transcripts from debriefing interviews with users.

Table 2. Multi-phase structure of the study, and summary of main tasks performed in each phase by participants.

Pilot study

Prior to the main study, we conducted a three-day pilot study. Two researchers acted as pilot wizards, while two other researchers acted as pilot users. All of them went through each phase of the study described below.

The pilot study helped identify aspects of the app and online interfaces (i.e. wizards' website and users' registration form website) which needed improvement. It also highlighted the value of testing instructions and rules for wizards so that they could generate suggestions consistently. Findings from the pilot helped formulate clearer rules including a practice walkthrough example of how to generate inferences that would lead to suggestions. The identification of particular themes that would be more useful for researchers, and the need to combine strict and flexible rules in generating suggestions, also emerged from the pilot study.

Main study

Phase 1. Training Sessions. The first phase of the study aimed at collecting users' personal information to help wizards with the process of generating suggestions, and gathering initial insights about the concept of the app and its functionality.

Wizards: At the beginning of the training session, we provided wizards with a kit. The kit included key information (explanation of the concept of "suggestions" and how to access Wizards interface – Figure 4, Right), rules and instructions to generate suggestions (Appendix A), four templates (Suggestions phrasings, themes, sources and objectives) (Tables 3 and 4), and a log sheet (Figure 4, Left).

S(n°): Title-statement # URL	Example
To define: S(n): **"According to X, Y is Z"**	*[Define | Places]* **S5:** According to Wikipedia, the inaugural professional 2014 Big Data World Championship is to be held in Dallas, Texas http://en.wikipedia.org/wiki/Big_data
To Inform: S(n): **"Did you know that X** [verb in past or present tense] **Y?"**	*[Inform | People]* **S4:** Did you know that Tim Brown writes a blog on 'Design Thinking'? http://designthinking.ideo.co
To advise: S(n): **"Please consider** [verb+ing] **X"**	*[Advise | Things]* **S1:** Please consider looking at the Information Design Association http://en.wikipedia.org/wiki/Information_Design_Association

Table 3: Template 1. Examples of suggestion types of phrasings and contents.

Suggestion Objectives
Define
Inform
Promote
Network
Advise

Suggestion Themes	Suggestion Sources
People	Yahoo
Things	Wikipedia
Resources	IEEE Xplore, ACM Library or Science Direct
Places & Organisations	Yahoo
Events	Yahoo

Table 4. Templates 2, 3 and 4. *Left:* Suggestion objectives. *Right:* Suggestion themes related to their specific information sources from where each type of those suggestions was generated. For example, suggestions related to 'People,' 'Places' and 'Events' themes were recommending information from Yahoo sources.

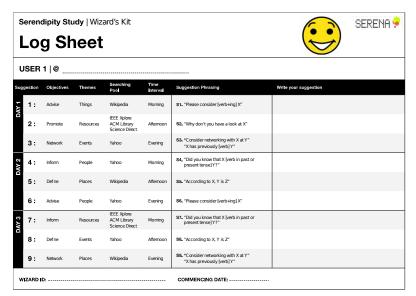Academics' responses to encountered information

Figure 4. *Left:* Example of log sheet provided to the wizards. Themes and objectives were randomly generated by an online random number generator. *Right:* Homepage of Wizards' interface created for the study.

First, wizards were introduced to their tasks and the process of generating suggestions. Then they were trained on the Wizards' interface designed for this study through which they could access users' information (profile information and notes) and send suggestions. The wizards' main task was to generate suggestions for five different themes and with five different objectives using the specific information sources for each theme described in the templates. To increase the range of users' interactions, the templates included multiple themes and objectives. The log sheet involved a randomized combination based on the templates of suggestion themes and objectives, and phrasing for each combination to guide and systematize the generation process. Suggestions aimed to be interesting, unexpected, and elicit a response from users in the form of thoughts, ideas, and potentially follow up actions.

At the end of the training session, wizards were assigned to users.

Users: At the beginning of the training session we provided users with a kit. The kit included a description of the SerenA app, an assessment log sheet (Appendix B), and information to access the online registration form. First, users generated a profile by completing the online registration form and providing their work and leisure interests, and other personal information (e.g. websites of interests, areas of expertise, places they would like to visit, conferences they would like to attend). Then they installed the SerenA app on their mobile phones, and were introduced to it. Users learnt how to create notes and notebooks with the app, and when and how to interact with incoming suggestions. Their main tasks were to interact with received suggestions and create a note in response to each suggestion. In addition, building on the work of Sun et al. (2011), users were encouraged to reflect further on the information received by creating at least one extra note per weekday throughout the days of the study using the SerenA app (i.e. a

minimum of seven extra notes), and documenting their experiences using a diary. However, we clarified that taking extra notes and documenting experiences were not a condition to successfully complete the study.

At the end of the training sessions, users were divided into three cohorts; each cohort commencing on a consecutive day.

Phase 2. Generation of and Interaction with Suggestions. The second phase aimed at testing the process of generating suggestions, users' interactions with and responsiveness to suggestions, the pertinence of suggestions, and users' interactions with the app. During this phase we collected four different types of data sets.

Wizards: At the beginning of this phase, wizards accessed users' profile information and notes through the Wizards' interface, and used that information and the log sheet to search for information and generate suggestions (Data set 1). Wizards sent suggestions three times a day for 10 consecutive days to each assigned user; in total they generated and sent 600 suggestions.

Users: During the 10-day period of the study, users interacted with the suggestions at their earliest convenience within a working day, and created notes using the app to give feedback to each received suggestion (Data set 2). Following our recommendation, some users created extra notes using SerenA (Data set 2), documented thoughts about the experience and the use of the app, and recorded all actions taken in response to received suggestions (Data set 3). All users completed the assessment log sheet to assess their experiences with each suggestion. They chose the number that corresponded most closely to rate each suggestion in terms of three qualities: how interesting, how unexpected, and how it was followed up, each based on a 5-point Likert scale (Figure 5) (Data set 4).

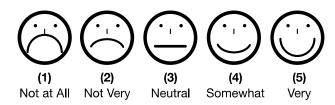| (1) | (2) | (3) | (4) | (5) |
| Not at All | Not Very | Neutral | Somewhat | Very |

Figure 5. Smiley-Scale used by users in the study to assess each criterion for suggestions (Bevan, 1995)

The above three qualities emerged from Kefalidou et al. (In preparation). That study evaluated 16 serendipity-related concepts (e.g. Makri and Blandford, 2012), and two were found the most representative to measure serendipity encounters: unexpectedness and interestingness. In line with Watson (2008), the study also indicated that when these two qualities were present, the information encounter would be followed up at some point. This "follow-up" stage could be long-term or short-term depending on people's needs and perceptions at the time, allowing further reflection that may lead to serendipitous connections (Kefalidou and Sharples, Submitted). In short, in this study we measure the degree of serendipity

experienced by participants using three surrogate elements to the serendipity qualities (insight, value and unexpectedness) introduced by Makri and Blandford (2012).

Phase 3. Debriefing Interviews. The third phase aimed at learning about wizards and users' experiences during the study, and unpacking users' responses to suggestions. We conducted a 1-hour semi-structured debriefing interview with each wizard and user. Interviews took place after the 10-day period of the study at the university from which each participant had been recruited. During this phase we collected a fifth data set.

Wizards were asked about the process of creating suggestions and challenges of responding to users' interests. Analysis of these interviews are not reported in this paper.

Users: We used an interview guide aimed at eliciting insights about users' ways of note-taking, their experiences with suggestions and serendipity encounters, and the use of the app. Throughout this phase, we modified the interview guide based on emerging aspects. In addition, we asked each participant specific questions based on their self-reported experience. Interviews were transcribed verbatim (Data set 5).

In this paper, we focus on analysis of the data gathered from users. The five collected data sets (Table 2) provided compelling evidence of how users interacted with information (i.e. the suggestions received), and their perceptions and thoughts at the time of receiving the information. We explored whether the information recommended by the app provoked any discernable behavior change or any of the suggestions spurred follow-up actions or opportunities for serendipity. Assessment ratings (Data set 4) were discussed during the interview, data sets 1 to 3 were used to identify key areas to unpack, and data gathered from the interviews (Data set 5) helped validate our interpretations and identify initial categories for top-down analysis.

The data analysis involved two layers, and combined thematic analysis (Braun and Clarke, 2006), data triangulation, and basic descriptive statistics to increase accuracy and credibility of findings. Throughout the analysis, we illustrated findings with representative participants' own words and terminologies.

Thematic analysis. First, we manually analyzed and coded interview transcripts (Data set 5) using top-bottom thematic analysis to create categories (Figure 6). Initially, we identified 21 categories including uses of the app, users' experiences, suggestions for app improvements, ways of note taking, types of following up actions, users' background and expertise, users' behaviors, and information interactions. We compared categories, and identified those for which meanings were overlapping and could be grouped together as a possible theme. We ended this layer of analysis with nine candidate themes: (1) ways in which suggestions were received (e.g. email, text), (2) note taking (e.g. paper, electronic), (3) preferred suggestion themes (e.g. academic, hobbies), (4) ways of interacting with information, (5) ways of following up on suggestions (e.g. short term, long term), (6) content scope (e.g. broad, specific), (7) serendipity experiences,

(8) qualities of serendipity, and (9) factors influencing interactions (e.g. context, timing and level of engagement).

Interview Data Extract: Participant U1	Coded for
Well, I consider [a suggestion] **<u>interesting</u>** if it contained **information which was relevant to me**, **but I might not have stumbled across it by chance**. I'm just saying I didn't know it was there. You know, it's easy – there's no point in being given links; some of the links were things that I've never seen, but it didn't surprise me were there. **If I'd needed to find something like that, I'd have been able to find it, and I'd have no need to be told about it** when I'm not looking for it, sort of thing.	1. Definition of the concept of "interesting" 2. Role of the concept for experiencing a serendipitous encounter 3. Role of a recognized need 4. Connection between serendipity qualities

Figure 6. Example of analytical rationale used for the data analysis. The figure illustrates the codes and semantic analysis used to analyze information introduced by User 1 (U1) (Based on Braun and Clarke, 2006).

Data triangulation and descriptive statistics. To make sense of Data set 4, we created basic descriptive statistics for users' assessments of each of the three qualities (i.e. interestingness, unexpectedness and follow up). After that, we triangulated the nine emerging candidate themes with users' responses to the suggestions (Data sets 2 and 3), and basic descriptive statistics (Data set 4).

An important part of the analysis aimed to determine whether participants had experienced serendipitous encounters. While we employed empirically-driven concepts related to serendipity that have been previously identified as an evaluation metric for serendipitous encounters, due to the intrinsic subjectivity involved in serendipity and the fact that "trying to decide whether or not to consider an experience to be serendipitous can result in ambiguity" (Makri and Blandford, 2012), it was not possible to objectively measure serendipity per se. For that reason, we used the basic descriptive statistics to measure levels of serendipitous encounters occurring during the study. The analysis led to the identification of different levels of *pseudo-serendipity* experienced by users. The term *pseudo-serendipity* was originally coined by Roberts (1989:X) to "describe accidental discoveries of ways to achieve an end sought for, in contrast to the meaning of (true) *serendipity*, which describes accidental discoveries of things not sought for." Later, van Andel (1994) used the same term to describe something responding to a recognized need that has been discovered, invented or created in an unexpected way. In this paper, we use the term *pseudo-serendipity* to refer to encounters experienced by users that have the potential of being serendipity in that users intended to do something in the future with those encounters (André et al., 2009). We considered users to have experienced pseudo-serendipity when they rated all three qualities with higher values: "Somewhat (4)" or "Very (5)," but we did not include neutral ratings. Based on these combinations of ratings, we determined four bands of pseudo-serendipity (Table 5).

Academics' responses to encountered information

As a result of triangulating data sets and descriptive statistics, the nine candidate themes were collated and grouped into three core themes: (1) contextual factors, (2) conditions for serendipity, and (3) qualities of pseudo-serendipity. Themes are discussed in the following section.

Results

Overall, users interacted with the information generated by the SerenA app in different ways and their responses to the information encountered varied, highlighting the subjectivity involved in serendipity and the difficulty in designing tools to support it. We report our results from a *pseudo-serendipity* rather than a (true) *serendipity* perspective as our results suggest that concepts previously associated with serendipity may act as well as concepts that can represent pseudo-serendipity.

Responses to encountered information: Contextual factors

Users interacted with the information suggested by the app at different moments. Some users engaged with the suggestions as soon as they received them. Others waited until the end of the day to interact with the suggested information, while a third group did not interact at all with some of the suggestions received. Various ways of interacting with the suggestions also emerged, expanding on the findings of prior studies (Sun et al., 2011; Kefalidou and Sharples, Submitted). Most users opened and read the app text messages, and then clicked on the included links to find out more about what each suggestion was recommending. After clicking on the link, some users just read enough to get a better sense of what was being recommended while others engaged further with the information provided by the link, seeking more information to expand the initial message. A minority of users read the app text messages, but decided not to click on the link. This indicates great diversity in how academics respond to information as different depths of interactions (shallow or deep) and moments when those interactions happen (immediate response or delayed response) emerged.

We identified nine contextual factors that influenced academics' responses to the suggested information and their openness to experience serendipity. The latter influence is discussed in the following section, while in this section we explore the influence of contextual factors in information interactions.

We organize contextual factors into two groups according to their focus of influence on participants' information interactions: contextual factors A and B (Figure 7). Contextual factors A influenced participants' behaviors and information journeys. The first of these factors was the *phrasing* (e.g. question, statement, order) of the received information followed by the *type of content* (work or leisure related), the *theme* (e.g. people, resources, events), the *information source* (e.g. Yahoo, ACM Library, Wikipedia), and *the time of day* at which the information was received (morning, afternoon, evening). Most users also stressed the importance of *workload* as a factor of poor interactions and lower levels of engagement with the suggestions:

Academics' responses to encountered information

It depends basically on how interesting I find the first impression, but also how busy I am at that moment. – U5
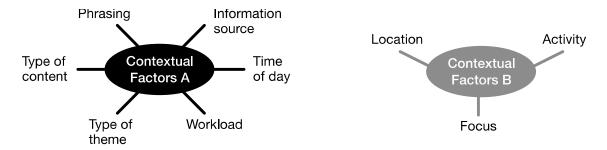

Figure 7. Contextual factors A can have a strong influence in academics' information journey, while the influence of contextual factors B is related to their openness to make connections and experience serendipity.

Some of these factors (e.g. the time of day, workload) determined many participants' level of engagement to further explore the received information, while other factors (e.g. phrasing and source of suggestions) had a stronger influence on a few participants (U3 and U7) making them decide not to click on some suggestion links.

Contextual factors B influenced more directly participants' openness and receptiveness to experience serendipity. These factors were: the *location* where participants were when the information was received (e.g. working in the office, commuting, attending a conference); the *activity* they were doing when the information was received (e.g. working, relaxing, having lunch) which determined their need for information or their openness to that information at that particular time (i.e. coherence between the information and their current focus); and the *focus* of the information in terms of their background knowledge (e.g. broad information, personalized information). Each of these factors is discussed as follows:

Location. In line with prior studies (Sun et al., 2011; Race, 2012, Kefalidou and Sharples, Submitted), users highlighted *location* as one factor that greatly influenced the time they spent exploring each suggestion. Most users argued that at the moment of receiving suggestions about events or activities, these were unrelated to their current state of mind or working situation. Therefore those suggestions were described as "interesting," (U6) but also "irrelevant or unnecessary" (U6). Some users (U3, U4, U6) stressed that receiving suggestions related to the location or context where they would be immersed (e.g. in a conference, in a coffee shop, in a library), would have increased their level of relevance and, consequently, they would have engaged further. U3 explained:

> I thought that would have been a recommendation that would have been great to receive, if we so happened to be in the same conference, and we didn't know each other before, but the application knew we were interested in the same field, that to me would have been a super valuable. (…) If the app used GPS, use some extra context aware information, to know that, the two of us are not actually super far, and we so happen to have similar interests. – U3

Academics' responses to encountered information

Activity. The second influencing factor highlighted by users was *their activity* that determined whether they had a recognized need for a particular type of information. The majority of users argued that the recommended information was not needed in the moment it was received either because they were relaxing on a weekend when they received work-related information, or because they received work-related information when they were commuting and thinking about something else. In other words, receiving information without a recognized need for it was described as "irritating" (U1) or "pointless" (U7) for some users, even when the information was unknown or interesting:

> There's no point in being given links; some of the links were things that I've never seen, but it didn't surprise me were there. If I'd needed to find something like that, I'd have been able to find it, and I'd have no need to be told about it when I'm not looking for it, sort of thing. – U1
> We are receiving information about the different things at different hours so, at the moment, we are getting ready to go to work so if we are receiving notification about something that is work related it might be a good idea because you are in the right frame of mind to receive them. But if you are receiving work related suggestions at the end of the day when you just want to relax it might piss you off because you just want to leave work behind and do something else. – U11

The fact that some users were not searching for any concrete information (i.e. had a recognized need) at the time of receiving suggestions made them less receptive to explore them. More experienced research users stressed this, claiming that they already had a variety of reliable and accurate sources from which they were extracting relevant information for their projects (e.g. email, links and papers recommended by colleagues and sent on Twitter). These sources were "a network (of colleagues and publication vendors) that [they] have formed over ten years, which had tons of history about [them] and what [they were] interested in." (U3) She concluded that:

> If there was a chance of sending the suggestion at the point in time when I have the highest chance of not being interactive and actually being willing to explore, I would have completely different reactions. – U3

As a result, when users did not have a recognized need for the suggestions sent by the app, even when they were relevant and interesting, some users were "too busy to engage with them" (U10). Similarly, Kefalidou and Sharples (Submitted) found that researchers are less likely to make connections within information that they have not been explicitly seeking than within information they were actively searching for.

Focus. Users also reported the *focus* of the suggestions as influencing their information interactions. Wizards were meant to generate suggestions combining users' profile information provided during the registration process and further notes created during the study. However, in the majority of the cases, users did not provide very detailed information during the training session or create further notes to expand that initial information. Consequently, both work and hobby suggestions were described as not specialized enough or as already known information. Users with more research experience also stressed the high level of specialism involved in academic research to explain why they were already familiar with most of the

academic information recommended by the suggestions. In contrast to prior work indicating the need for "slightly off-topic suggestions" (Kefalidou and Sharples, Submitted), some users reported information as "extremely broad" (U8) when it was not related to either their immediate work or hobby interests. Users stressed the need to have information personalized according to their interests to be found both relevant and interesting:

> It was so general and so impersonalized that I wasn't particularly interested. – U3
> All the suggestions on topics that I would be interested in were too broad to actually direct my interest in any way, shape or form. All the messages that were too off topic were too far from my interests to connect with me. – U10

The users' experiences described above indicate that, while the type of content or theme of the suggestions did have an influence on participants' interactions, its influence was less significant than that of their focus. Suggestions provided without responding to a recognized need may have higher levels of engagement if they would be related to the current user's location and activity, and based on users' background knowledge and expertise in any area.

> So if the SerenA suggestions could be more focused - but that might slightly defeat the object of serendipity but it might also increase the likelihood that I might follow up things from it – U10

These three contextual factors indicated the need to be in a particular state of mind in order to be open to experience serendipity at the time of receiving information without a recognized need. Users provided insights to determine under which circumstances suggestions provided by the SerenA app created opportunities for serendipity. In the next section, we discuss those situations, and the relationship between contextual factors and users' assessments in terms of serendipity.

Identifying conditions for pseudo-serendipity

The analysis of participants' assessments of suggestions is summarized in Tables 5 and 6. Of the 600 suggestions generated during the study, 14 resulted in pure pseudo-serendipitous encounters (Band A – Table 5), and 59 suggestions triggered pseudo-serendipitous experiences of less strength (Bands B, C and D – Table 5). From the remaining 527 suggestions, 239 were assessed "Not at all (1)," "Not Very (2)" and "Neutral (3)" across the three criteria (interestingness, unexpectedness and followed up) (Band G – Table 6), and 188 suggestions were assessed with very high ratings ("Somewhat (4)" or "Very (5)") in one criterion and a combination of "Not at all (1)," "Not Very (2)" and "Neutral (3)" ratings across the other two (Band F – Table 6). The remaining 100 suggestions were assessed with very low ratings in one criterion but the other two criteria were rated as "Somewhat (4)" or "Very (5)" (Band E – Table 5).

Academics' responses to encountered information

Assessment criteria			Strength of pseudo-serendipity
Interestingness	Unexpectedness	Followed up	
5	5	5	Band A
5	5	4	Band B
4	5	5	Band B
5	4	5	Band B
4	4	5	Band C
5	4	4	Band C
4	5	4	Band C
4	4	4	Band D

Table 5. Ratings to criteria used by users to assess their experiences with each suggestion attached to degrees of pseudo-serendipity experienced. "A" indicates strong pseudo-serendipity encounters, "B" indicates less strong pseudo-serendipity strength in the encounters, "C" denotes little indication of pseudo-serendipity, and "D" denotes very little indication of pseudo-serendipity experienced.

Band	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	Total
A	-	1	-	5	1	1	-	-	-	-	3	-	-	-	1	-	-	1	-	1	14
B	1	1	-	2	-	1	-	-	1	1	1	-	-	1	-	-	2	1	1	1	14
C	-	2	1	2	3	1	-	1	2	2	2	-	-	-	-	-	1	2	1	1	21
D	2	-	3	1	2	-	-	1	4	1	1	1	2	2	1	1	1	1	-	-	24
E	-	6	1	8	7	5	-	6	6	2	8	5	5	5	5	10	4	7	2	8	100
F	6	15	14	7	6	15	-	14	7	10	4	14	11	12	13	8	11	6	3	12	188
G	21	5	11	5	11	7	30	8	10	14	11	10	12	10	10	11	11	12	23	7	239
Total	30	30	30	30	30	30	32	30	30	30	30	30	30	30	30	30	30	30	30	30	600

Table 6. Bands (A, B, C and D) indicating suggestions assessed with higher ratings corresponding to the different degrees of pseudo-serendipity strength experienced in the study, and bands (E, F and D) indicating suggestions assessed with lower ratings.

For this study, suggestions rated in Bands E, F and G (Table 6) were not considered instances of pseudo-serendipity. For example, participant U11 rated three suggestions with "Very (5)" in all three criteria, then he rated four suggestions combining "Somewhat (4)" and "Very (5)" ratings, and the remaining 23 suggestions were rated combining "Not at all (1)," "Not Very (2)," "Neutral (3)," "Somewhat (4)" and "Very (5)" ratings. In other words, U11 reported three instances of "level A" pseudo-serendipity, one of "level B," two of "level C," and one of "level D." In another case, participant U16 reported only one instance of "level D" pseudo-serendipity (meaning that he ranked one suggestion as "Somewhat (4)" on all three scales), and all 29 other suggestions were assessed as not pseudo-serendipitous; in contrast, participant U4 reported five instances of the maximum possible pseudo-serendipity against the three criteria. Table 7 gives an example of suggestions for each band of pseudo-serendipity.

Academics' responses to encountered information

Participant	Suggestion	Response	Strength of pseudo-serendipity	Type of content
U2	S3: According to Wikipedia, Japan's ~700,000 researchers share a US$130 billion R&D budget. + Link [Sent on: 15.20.13 – **19.33**]	I would like to do research work in Asia after my PhD so found this information quite useful!	Band A (Rating for each criterion: 5-5-5)	Academic
U1	S19: Did you know the Record Shop in Amersham now stocks Warhammer products? + Link [Sent on: 21.10.13 – **09.39**]	I thought that was really impressively kind of focused. I live in Amersham; I know where the Record Shop is, and you know, I've been to look at Warhammer shops elsewhere with my little boys, and they're inconvenient to get to, so that was kind of welcome news. And I never go in the Record Shop, so I wouldn't have known about it, so it really was incredibly pertinent useful information that seemed quite miraculous to sort of… it managed to… you know, it intersected from various directions where I lived, a shop that I walk past, interest that I have with my children, a particular… it was very good. […] And it was timely, it just happened. I had followed it up by sticking my nose in there.	Band B (Rating for each criterion: 4-5-5)	Hobby
U9	S9: EHI Live has previously taken place in Birmingham + Link [Sent on: 19.10.13 – **19.47**]	I had not heard of this event before so this was unexpected and interesting. I will follow this up and see if it's something I should attend. I think because that was an event I looked it up. It said it had previously taken place, so I was like, okay, where is it taking place this year and what is it, so that was quite interesting. What else is there?	Band C (Rating for each criterion: 5-4-4)	Academic
U8	S12: According to Yahoo the international conference on software engineering was held in San Francisco this year + Link [Sent on: 19.10.13 – **19.48**]	I think I will also be submitting a paper to a specific conference, ICSE[2014]. So, I came about this after receiving a suggestion.	Band D (Rating for each criterion: 4-4-4)	Academic

Table 7. Examples of suggestions assessed by participants with ratings that indicate pseudo-serendipity experiences.

In total, only eight users reported that the study triggered "level A" of pseudo-serendipity (highest level) or came across information serendipitously at some point as a consequence of the suggested information sent by the SerenA app. Although 19 out of 20 users reported at least one instance of pseudo-serendipity (Band A, B, C or D – Table 6), 11 of them also reported during the debriefing interview that they did not experience serendipitous encounters at all. This contradiction stresses the subjectivity involved in serendipity.

In line with the work by Race (2012), two users (U2, U4) reported that the study made their minds more receptive and prepared for happy accidents to occur. Some users reported that the experience helped them identify relevant from irrelevant information (filter information) or remember to do certain things (reminders). In the latter case, users stressed that suggestions acted as "reminders" rather than as recommendations. These suggestions refreshed users' memory about a particular activity they had to do (e.g. read paper, attend conference, go somewhere), a person they had to reconnect with (e.g. contact colleague), or just reminded them that they had come across a particular piece of information before (e.g. an article, a website).

Academics' responses to encountered information

Results from this analysis are also in line with users' self-reported perceptions of serendipity and indicate the influence of many factors involved in its perception. Suggestions that triggered higher levels of pseudo-serendipitous connections were related to both academic and non-academic activities, supporting the finding that the type of content did not have a strong influence in the perception of pseudo-serendipity. No clear preference for work or hobby related information emerged. For example, participant U4 reported Suggestion 15 as "level A" pseudo-serendipity as it recommended him to sign-in in a Russian language event, which was a topic closely related to his hobby interests and also an activity which he had been "thinking about for a longer period," but also had been postponing. This suggestion acted as a reminder and encouraged participant U4 to finally attend a Russian-language related event.

Some academic-related suggestions were also assessed as high-level pseudo-serendipity such as the case of Suggestion 4 for participant U2, which made him start using blogs as a new type of information source:

> The blogs, it's something that'd never have even occurred to me before. So that's completely new. And I follow that every week now. It's a very good source of nice little tidbits of information and regular updates on stuff that's going on. – U2

Although the type of information source was highlighted as a factor significantly influencing users' interactions, it did not influence the experience of serendipity (Table 7). The fact that some users ranked suggestions generated from "non-academic enough sources" (e.g. Wikipedia) as pseudo-serendipity indicates that experiencing serendipitous encounters may not be strongly related to the source of the information. On the other hand, some users highlighted a lack of timing on the suggestions, as when they received them, most users were immersed in an activity and had no explicit recognized need for information. This situation made users less receptive for encountering unplanned discoveries. In addition, the need for further days to interact with the suggested information emerged as another cause for not experiencing serendipity:

> That's another thing for Serendipity, there must be an element of now. Something that I can take advantage of now, rather than storing it in my brain or somewhere, and remembering to go back to it. – U3
> No light bulb moments. But it was getting better from day six, I think, so if I was to let it run that might be useful. I'm wondering if I had put in more data on my form then it might really surprise me. – U15

In the next section, we discuss the relationship between the three qualities of pseudo-serendipity used by participants to assess each suggestion, and a fourth quality that emerged from this analysis.

Qualities of pseudo-serendipity

Figure 8 shows the distribution of participants' Likert-scale rankings for each quality of pseudo-serendipity. In total, similar numbers of suggestions were assessed with the highest ratings for

interestingness and unexpectedness: 249 and 243 suggestions respectively assessed combining "Somewhat (4)" and "Very (5)" ratings, while only 139 suggestions were assessed with those values for followed-up.
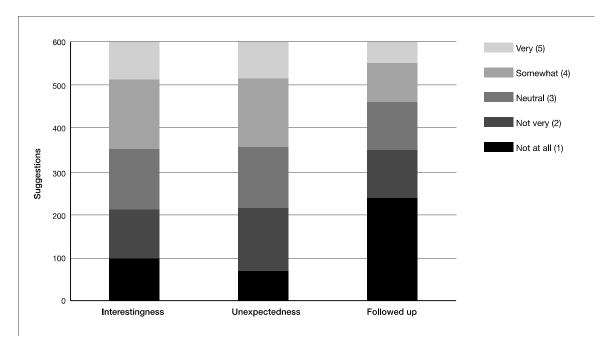

Figure 8. Distribution of participants' ratings to each suggestion across the three criteria.

Most suggestions (412) were assessed with "Somewhat (4)" ratings: 161, 159 and 92 suggestions as "Somewhat (4)" interesting, unexpected, and followed-up respectively. Only 84 suggestions were assessed as "Very (5)" unexpected, supporting participants' comments that they were already expecting suggestions related to the information they provided during the training session. From the three qualities, followed-up was the one with more disparate ratings with 238 suggestions described as "Not at all (1)" followed up, and only 47 suggestions indicated as having been "Very (5)" followed up.

Initially, we gave users three qualities to assess the suggestions. However, a fourth quality: *Relevance*, emerged as a more determinant quality to be considered when creating opportunities for serendipity.

Interestingness and relevance

Almost all participants (17 of 20) stressed a difference between a piece of information considered *interesting* and a piece of information considered *relevant*.

Barcelona, and there was also stuff, so okay, this is interesting but that's really irrelevant. – U6
Relevance doesn't mean interesting, no. For instance, this paper, it's relevant but I don't know if it's interesting because I haven't gone through it. So, there were relevant suggestions which were also interesting. – U8
Some of the articles I received I was like, oh, that's quite interesting and relevant to me and I haven't read that before, so that's quite unexpected, so I might go read that. – U9

Academics' responses to encountered information

Users assessed how *interesting* suggestions were based on various factors. Users considered a piece of information interesting when it was close to their topics of interest (work or hobby related), but also when it was something they had not known about previously. To be considered highly interesting, the learning about that piece of information should involve an enriching experience. Some users also pointed out that information needed to be unknown for them (U1, U3, U5) or they have not stumbled across it by chance before (U1, U3, U4). Participant U1 unpacked this concept describing two types of "knowing" something: directly having previously seen that something, or being able to find that something because of being aware of its existence. In his own words:

> There's two kinds of know it. There's: I've explicitly seen, visited it, and there's another kind of know it, where I haven't explicitly seen the thing, but if I could ask myself the right question and it wouldn't be a weird question to ask, I would be able to find that thing, and that's the kind of knowing... so, there's at least two kind of knowing it already, but the ones that are interesting were ones where I didn't know it already and was unlikely to sort of find it through some process of thinking. – U1

In terms of *relevance*, Race (2012) explains that it can be determined based on three levels: cognitive, situational and socio-cognitive. The first level relates to an individual's background knowledge of the information being assessed. He highlights that cognitive relevance changes as new information becomes available. In line with this finding, most users described information they already knew about as less relevant than completely unknown information. The high level of specialization of researchers' work makes them greatly familiar with the related literature, and consequently, they have developed high expectations for information to be considered relevant. There is a correlation between how relevant a suggestion was and its focus. The more focused and connected to users' (work or hobby) specializations, the more relevant a suggestion was considered, while broad suggestions were mostly described as irrelevant:

> U4: [S5] wasn't relevant
> Q: Why you found that's irrelevant?
> U4: I think because it seemed to be a very general type of a thing
>
> [S13] was interesting because I always like to read about other people's lives but it was not that relevant to my area of research. – U12

Relevance also involved an element of *now*. Users considered a suggestion relevant if it was related either to what they were working on at that precise moment or to any short-term hobby plans.

> That's really interesting to know and maybe one day, when I go to Sicily, I can visit these things. But it's not necessarily relevant in this exact moment, but it's still interesting. – U9 [S13]
> Yes, the relevance, probably… yes, what of those actually recalls the relevance at the moment. You know, interesting, it could be interesting but not relevant. – U14

Only participant U7 expressed a different view, which is in line with the study of Kefalidou and Sharples (Submitted). She argued that she would consider something both interesting and relevant if it would not be related at all to her interests, as that piece of information would surprise her and broaden her knowledge:

Academics' responses to encountered information

Maybe it's something to do with just looking at things that you never noticed before, or you actually never read the article before. Maybe it's not about your interests. You can have broad interests, but then to kind of have something new, because otherwise you just keep in your own bubble. – U7

Rather than how interesting the suggested information was itself, the level of relevance of that information determined whether users kept, discarded or followed up on each suggestion. In this study, we used interestingness as a surrogate for insight to measure levels of pseudo-serendipity. However findings indicate that relevance would have been a more appropriate surrogate for insight because users perceived the new information as connecting to a need.

Unexpectedness

The level of unexpectedness was in general rated as "Not at all (1)" or "Not very (2)" (Figure 8), while in most cases suggestions rated as "Very (5)" unexpected were those considered not related at all with users' interests.

Just like the Bananarama [suggestion], I did not see that coming. So, it wasn't interesting but it was totally unexpected, basically – U6

As indicated above, users were aware that they would be receiving suggestions generated on their profile information and any notes they created during the study. Consequently some of them were already expecting recommendations related to certain topics they have specified:

As I had put Rotterdam down on my registration form, it was not unexpected. – U15

In most cases the degree of unexpectedness did not influence users' decision to explore further or follow up on a suggestion. For example, participant U8 ranked Suggestion 7 as "Very (5)" unexpected, but he did not follow up on that information, ranking it as "Not at all (1)" in that criterion:

S7, for instance, it was completely unexpected, so I rated it as five but I did not follow it up and it wasn't really interesting. […] I could consider [networking with this particular university] but the suggestion was too large to follow it up. […] I didn't find useful was because the suggestion was too ambitious. – U8

On the other hand, participant U13, ranked Suggestion 30 as expected (i.e. Not very [2]), but she decided to follow up on that information anyway (i.e. Somewhat [4]) because it was both interesting (i.e. Somewhat [4]) and very relevant to her:

[S30] was very relevant; very interesting; not unexpected. I did read it and it has been followed up on. – U13 [Ratings to S30: 4-2-4)

In the following section we discuss users' assessments related to the last criterion and explore emerging types of following up actions.

Following up

To measure the value of the outcomes generated from the suggestions, users explained to what extent they followed up on each suggestion. The concept of "following up suggestions" referred to both instant reactions (short-term actions, e.g. opening a link, following a link, searching on Google or on an online archive immediately after receiving and checking the suggestion) and to reactions that may incorporate a more "long-term" element (long-term actions, e.g. writing a note or attending a forthcoming conference).

Although we did not directly measure the degree of relevance, during the debriefing interview, 17 of the 20 participants reported that relevance, rather than interestingness, influenced the way they interacted with the suggestions. Frequently, when suggestions were found interesting *but* irrelevant, users did not perform follow up actions. In the cases in which suggestions were considered interesting *and* relevant, they were either preserved in the form of digital or written notes, or bookmarks, i.e. "temporary storage" (Lin et al., 2004) to be followed up in the future (long-term follow up), or immediately followed up by attending an event, conference or reading a paper (short-term follow up).

> I took them more as suggestions what to do, maybe not immediately but what to do in general at some point, so I took them something to bear in mind, something I hadn't thought myself. – U4

In some cases, even when suggestions were considered interesting and relevant, a few users decided not to take any further action, because they thought that following up on that information would have been "time-consuming":

> Occasionally it came across things where I didn't know that they were there, and so that was useful, and I'd store them away. I didn't want to act on them because you don't want to act on most of these things because you'll get a zillion little tidbits all the time through wandering the Web and emails and things, and you know, you can't act – you don't want to act on most things. So I didn't act on them, but they were welcome, interesting items. – U1

Although in the majority of the cases information was kept stored but was not immediately used, when the information was not found interesting or relevant at all, users discarded that piece of information instantaneously.

In some cases, suggestions assessed as very obvious ("Not at all (1)") triggered short- and long-term follow-up actions, and in other cases no actions at all. From 84 suggestions assessed as "Very (5)" unexpected only 27 suggestions were either "Somewhat (4)" or "Very (5)" followed up, and 24 of those 27 suggestions triggered some instances of pseudo-serendipity (Figure 8). This indicated that the degree of unexpectedness of suggestions did not influence whether users followed up on the information. In most cases, merely short-term followed-up actions were performed, like clicking on and opening the suggestion links. Figure 9 describes how the three pseudo-serendipity qualities explored in the study and relevance influenced users' decision-making and interactions with suggestions.
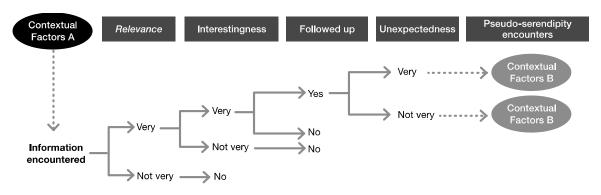
Academics' responses to encountered information

Figure 9. Academics' decision-making tree to experience pseudo-serendipity

Discussion and conclusions

In the previous sections, we reported ways of interacting with recommended, but not requested, work- and hobby-related information sent by an interactive tool. We also discussed two types of contextual factors that may influence the way academics interact with that information (information journey) and their openness to make connections (experience serendipity). We determined four levels of pseudo-serendipity experienced during the study. In this section, we relate findings to the information journey, and discuss the relationship between serendipity-related qualities, and how contextual factors may determine people's receptiveness to experience serendipity.

Supporting academics' information journey

Our study explored the information journey where the individual does not have a prior recognized information need. For some participants, when this phase (recognizing an information need) did not occur first, the remaining phases were often disrupted, and interactions with information were minimal. Other participants in the same situation found value in the information suggested, going through the entire information journey.

Unrecognized need. Academics from this study did not have a requirement to support a particular research project or expand their knowledge about a particular event they would be attending. Therefore, responses to suggestions were influenced by contextual factors A and B (Figure 7), which determined the relevance of that information at the moment when it was received. Based on that, academics decided whether to seek more information.

Find information. When academics need to find information they search on the Internet, go to libraries or discuss with peers. While searching for information, academics are also filtering information they found; they decide what is relevant and what is irrelevant for they current situation. In this study, suggestions sent to academics were generated based on work and hobby interests, but not their current needs. In other words, sent information was not filtered according to their specific research project

requirements or particular plans for holidays. To some extent, academics interacted with and filtered the received information based on its level of relevance and short-term usefulness. In the cases in which academics could not determine how to validate or use (in a short-term future) the received information, they disregarded that information." This highlights the need for it to be easy for people to "keep found things found" (Marshall and Jones, 2006) and, more generally, for people to be able to seamlessly store and retrieve information that is received so that it can be exploited when relevant.

Validate and interpret information. Academics validate information by making connections, triangulating sources or assessing its source. When academics could not connect suggestions to their interests, they could not derive meaning from those suggestions to inform either their work projects or hobby plans. In some cases, contextual factors like the information source and the phrasing of the suggestions determined how academics interpreted the received information. When validating the content of the suggestions, both work and hobby related information triggered diverse responses.

Use interpretation. In this study, uses involved short- and long-term follow-up actions. In the cases in which academics were not familiar with the information suggested (e.g. paper, a concert, meeting someone), they either took action immediately or stored the information for future reference. In the cases in which academics already knew the information suggested by the app, this information acted as a reminder of activities academics were meant to have done but were postponing (e.g. submit a paper, enroll in a language course). Some suggestions were also described as having the potential to help them make useful discoveries (e.g. start using blogs). This was discussed here as a form of potential serendipity or pseudo-serendipity.

Supporting serendipity

A small proportion of suggestions was perceived as pseudo-serendipity by participants. Contextual factors and, in particular, the relevance of each suggestion influence academics' decisions on how to interact with and their perceptions of the received information (Figure 9). Supporting existing literature, in most cases high levels of "interestingness" indicated high chances of experiencing unplanned connections. The level of "unexpectedness" when receiving unsolicited information did not have a significant influence, while the level of "relevance" emerged as the determinant quality to experience serendipity. The lack of immediate relevance in suggestions made academics less receptive. Participant U16's explanation describes this scenario with great clarity:

> Maybe if I'd got that suggestion at another time of day when I hadn't been so busy I might have more time for it but because I had so much on my mind anything that wasn't immediately relevant or of interest was pushed away.

The higher the relevance of a piece of information, the more academics tended to follow up on that information. This indicated that relevance and interestingness are not experienced as the same quality in information. E.g.:

[S7] was relevant and interesting, so that was good (U8).

In addition, contextual factors B played a significant role in helping academics be in the right state of mind to experience pseudo-serendipity (Figure 7). Academics' location (work/home) and information context (recognized/unrecognized need) when receiving the suggestions determined their receptiveness to serendipity. Furthermore, the focus of the suggestions (broad/specific) in terms of academics' work or hobby background knowledge also greatly influenced their openness to the information. Regardless of its type of content (work or hobby), a *broad* suggestion received when the person was immersed at work was less likely to trigger any opportunities for serendipity, than a very specific suggestion received in the same situation (e.g. U1).

In short, people are more likely to experience serendipity when there is coherence between the new information encountered and their current focus (state of mind). This finding expands van Andel's work (1994:646) which states that to experience serendipity people need to have "a mind 'prepared' by previous interest, thought and/or experience." In other words, what people are doing at the moment of receiving new information influences their openness to that information and also determines their need for that information. A tool supporting serendipity should consider the relevance and interestingness of information to the intended users, but also take into account their background knowledge and expertise. This way, the tool would generate highly personalized and focused information. The tool should also match the kind of (unsolicited) information that is being presented with the context and activity in which the intended-user would be at the moment of receiving the information. This would increase intended-users' receptiveness to unplanned information encountered rather than sought. The fact that participants welcomed hobby-related information as well as work-related information indicates that the findings of this study are likely to extend to people beyond academics, who were the focus of this study.

Reflection takes time

The length of the study did not allow deep reflection on the information suggested by the app. Even though some users reported having a more receptive mind at the end of the study period which led them to adopt a new habit (e.g. read blogs), the majority of suggestions indicated as relevant were not followed-up with long-term actions due to lack of time, but instead bookmarked to be checked in the future. The low levels of pseudo-serendipity reported in the study may be a consequence of the fact that unplanned connections and surprises are more likely to occur when people have had time to evaluate and interpret information, and also make use of it (André et al., 2009). To better evaluate the impact of technology on serendipity, a study should be conducted over months or years rather than days or weeks.

To conclude, the findings shed light on users' information journeys and opportunities for serendipity. We identified the role of contextual factors in the way people interact with information. Contextual factors like focus of information, people's location and activities have previously received little attention in the serendipity literature. In addition, we identified unexpected effects, such as suggestions acting as reminders

for people to do things they had been postponing, and the effect reported by a few people of being more open to opportunities as the study proceeded (i.e. a change in attitude/behavior). Future technology might play an important role in creating opportunities for reflection and making connections. However, the success of this technology may need to be determined over an extended period of time. Therefore our findings highlight the need for future longitudinal studies that build on these findings to further explore when and how to create opportunities for serendipity through design.

Acknowledgments

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Appendix A

Rules for generating suggestions given to the wizards

RULE	DESCRIPTION	EXAMPLE
Rule 1	Read **user's profile information** (Information set 1)	[see **Table 1** - page 6]
Rule 2	Read **notes made by user** (Information set 2)	[see **Table 2** - page 6]
Rule 3	Look at the given **log sheet** for the current user and identify what **theme** (people, place, resources, events, things) you are aiming for	**Theme:** Resources
Rule 4	Look at the given **log sheet** for the current user and identify what **objective** (promote, inform, advise, define or network) you are aiming for	**Objective:** Promote
Rule 5	Identify **expertise and interest keywords** on both sets of information	**User reported:** From profile information: information design, sensemaking, design thinking, travelling From notes: mark dissertations, trip,
Rule 6	**Make a list** with identified keywords	[see **Table 3** - page 6]
Rule 7	Conduct **online search** for <u>keywords</u> using the corresponding theme-related searching pool (Yahoo, Wikipedia, IEEE Xplore, ACM Library, Science Direct)	**Searching pool:** IEEE Xplore, ACM Library or Science Direct
Rule 8	Conduct **online search** <u>combining keywords and the corresponding theme</u> using corresponding searching pool (Yahoo, Wikipedia, IEEE Xplore, ACM Library, Science Direct)	Sensemaking + resource Visual thinking + resource
Rule 9	Conduct **online search** <u>combining keywords and the corresponding searching pool</u> using corresponding searching pool (Yahoo, Wikipedia, IEEE Xplore, ACM Library, Science Direct)	Sensemaking + travelling "qualitative research" sensemaking
Rule 10	Identify **search results** that could **be interesting, unexpected and followed up** suggestion candidates	[See **Image 1** - page 7]
Rule 11	**Explore** identified search results by **clicking on their URLs**	[See **Image 2** - page 7]
Rule 12	**Choose one search result** that you consider <u>interesting, unexpected and will be followed up</u> by the current user	[See **Image 3** - page 7]
Rule 13	Identify the **appropriate suggestion phrasing** from page 4	**S(n):** Why don't you have a look at X?
Rule 14	**Create one suggestion** by writing the selected search result according to suggestion phrasing (phrase and URL)	**S2:** Why don't you have a look at 'Examining the Use of a Visual Analytics System for Sensemaking Tasks: Case Studies with Domain Experts'? http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=6327293&queryText%3Dqualitative+sensemaking
Rule 15	**Send suggestion** to current user at specified time slot.	To User 28 at Afternoon

Appendix B

Assessment log sheet given to users for assessing each suggestion based on the following three criteria: interestingness, unexpectedness and followed-up actions.

How would you assess each suggestion?

Day	Suggestion	Interesting					Unexpected					Followed up				
	1															
1	2															
	3															
	4															
2	5															
	6															
	7															
3	8															
	9															
	10															
4	11															
	12															
	13															
5	14															
	15															
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6	17															
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7	20															
	21															
	22															
8	23															
	24															
	25															
9	26															
	27															
	28															
10	29															
	30															