Survey on High-level Search Activities Based on the Stratagem Level in Digital Libraries

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Abstract. High-level search activities for Digital Libraries (DLs) introduced by Fuhr et al. [8] go beyond basic query searches because they include targeted and structured searches like e.g. a journal run or citation searching. In this paper, we investigate if and how typical high-level search activities are really used in current DLs. We conducted an online survey with 129 participating researchers from different fields of study that aims at getting a quantitative view on the usage of high level search activities in DLs. Although our results indicate the usefulness of high-level search activities, they are not well supported by modern DLs with regards to the users' state of search, e.g. looking at a relevant or not relevant document. Furthermore, we identified differences in the information seeking behavior across the respondents. Respondents with a higher academic degree significantly considered journals and conference proceedings as more useful than respondents with a lower academic degree.

Keywords: Information filtering · Search process · Stratagems · Interactive IR · Survey · Digital Libraries

1 Introduction

Digital Libraries (DLs) offer direct access to a vast number of bibliographic records. As more publications are made available in electronic format the amount of material a user needs to assess becomes difficult to manage. This leads to highly fragmented interactive sessions in which users perform various types of search activities [14]. During the past, different models have been proposed that aim to model the information seeking behaviour, e.g. the information seeking behaviour model proposed by Bates [2]. Based on empirical studies of the information seeking behaviour of experienced library users she identified four levels of search activities that, amongst other, differ in their complexity: *moves*, *tactics*, *stratagems* and *strategies*. A move is the lowest unit of search activities like entering a query term or selecting a certain document. Tactics are described as a

combination of many moves like the selection of a broader search term or breaking down complex search queries into subproblems. Bates defines a stratagem as follows: "a stratagem is a complex of a number of moves and/or tactics, and generally involves both a particular identified information search domain anticipated to be productive by the searcher, and a mode of tackling the particular file organization of that domain" [2]. Hence, a stratagem could be for instance a "journal run" where a user identifies a journal to be productive for his or her research and browses the latest publications in that journal. Another example for a stratagem is to follow references in a certain document that might lead to potentially relevant material. Finally, strategies are combinations of moves, tactics and stratagems, thus, forming the highest search activity as they cover the whole information seeking process.

Moves are considered lower-level search activities whereas tactics, stratagems and strategies are considered high-level search activities [8]. Moves and tactics are commonly used during an information seeking episode and have been subject in research. Popular examples are search term recommender or thesauri that support the user in choosing appropriate query terms [10]. Stratagems and strategies, on the contrary, have attracted less attention although they are undoubtedly reasonable search activities. Fuhr et al. [8] for instance have developed a federated DL aimed at providing strategic support to the user.

In this paper, we present the results of an online survey that empirically evaluates high-level search activities based on the stratagem level. To the best of our knowledge such a survey has not been conducted yet, but is able to provide us with a deeper understanding of the users' information need when performing high-level search activities. The online survey aims at getting a quantitative view on the usage of high level search activities in DLs with respect to the users' state of search. We aim at answering the following research question:

RQ: What kind of stratagems do users perform when looking for relevant documents?
We look at different types of stratagems that were derived from the examples proposed in [2]. We investigate the usefulness of certain stratagems with regards to the users' state of search. We distinguish the users' state of search by: (a) the user has found a relevant document and wants to find similar documents and (b) the user performs a stratagem search without a preceeding document.

The paper is structured as follows: first we briefly discuss related work regarding high-level search activities and their empirical evaluation (cf. Sect. 2). In Sect. 3 we describe the setup of our survey and general demographic information about our respondents. In Sect. 4 we show the results of our survey as well as significant differences between certain groups of respondents by field of study and academic degree. A discussion of the results and possible implications on the design of DLs is presented in Sect. 5.

2   Related Work

Based on the work of Bates [2], there have been many attempts to support users with high-level search activities. In the literature, the two most notable directions in search or retrieval support are: (a) the implementation of high-level search activities as direct system functionality with proactive (e.g. spelling corrections) or automatic (e.g. normalization of spelling variants) user functions, and (b) support systems for user guidance. Theses systems often try to adapt the search situation and the capability of the user and then recommend suitable search tactics. Xie [17] and Joo and Xie [12] e.g. investigated the relationships between users' search tactic selections and search outputs while conducting exploratory searches in digital libraries.

While high-level search functions can be found in practice in DLs, support systems for user guidance have been rarely accepted. Most probably this has to do with the lacking consideration of the search situation and history and the deficient inclusion of the capabilities of the user in the search process. A qualitative study observing the usage of a DL was presented in [7]. The study starts with the observation that experienced users of DLs are more effective than non-experts. The purpose of the study was then to investigate the nature of experienced DL users in more detail in order to design interfaces that support unexperienced users. Bates concepts describe the mechanisms of search activities and tasks in a very generalized way, as an information seeking model. These concepts of specific search tactics in an evolving search have been implemented in an academic Web environment by Fuhr et al., in the project Daffodil [8].

Today many other state-of-the-art DLs support the search tactics outlined in Bates. Carevic and Mayr [5] have recently introduced simple bibliometric-enhanced search facilities which are derived from Bates' stratagems and could be easily integrated to DLs. They outlined the idea of extended versions of journal run or citation search for interactive information retrieval. Hienert et al. have studied the user acceptance of various search term recommender systems which have been integrated and evaluated in a live DL [10]. They found that the combined recommendation service which interconnects a thesaurus service with additional statistical relations outperformed all other services. Their findings contradict the typical observation that users are ignorant of advanced search features. In experimental prototypes Brajnik et al. [4] and Bhavnani et al. [3] focused on the integration of strategic tool support in the user interface to help the users to find more comprehensive information when searching. In their position paper, Wilson and Schraefel [16] highlighted the importance of exploratory search interfaces which could profit from hybrid IR/HCI approaches.

3   Online Survey

The survey was available for two weeks during August 2015 and was primarily designed for researchers and postgraduate students but not limited to a particular field of study. The respondents were recruited via collaborating universities

and institutes, mailing lists and social media (Twitter, Facebook). To keep the survey maintainable for the respondents, we focused on two of the six stratagems proposed by Bates: (a) journal and conference run and (b) citation and reference search. The survey consisted of 28 questions that were divided into four parts. The first two parts concerned the general usage of journal and conference runs as well as citations and references. In the third part of the survey the respondents were given a scenario in which they were looking for related material to a given search task in a journal named *Addiction*. Alongside the scenario, we defined six randomly arranged options on how the articles from that particular journal could be ranked (e.g. by title, by authors, etc.). The respondents were then asked to order these six options according to their preference. The fourth part of the survey concerned the general usage of stratagems in DLs. To this end, we presented the respondents all six stratagems derived from [2] (see Table 3) and asked them to rank these activities by their usage when searching for relevant documents. The survey concluded with 9 demographic questions and two optional questions regarding feedback and contact information. The quality of the survey was ensured in a two fold way: first our department *Survey Design and Methodology* evaluated the Likert scales of the survey. Second we have performed two pretests with colleagues.

Demographics: In total there were 204 respondents of which 129 completed the survey. We report on all available responses even if the survey was not completed by the respondent. 62.6 % of the respondents were male. The ages ranged from 23 to 79 years (mean = 40.3, sd = 12.2, N = 128). The respondents were asked to choose their field of work from a set of 26 options. In total 12 fields were chosen with the majority of the respondents coming from the field of Computer and Information Science (50.4 %) and Social Sciences (28.2 %). Regarding the academic degree of the respondents 54.2 % replied to have a master's, diploma or bachelor's degree, 32.1 % obtained a doctoral degree, 12.2 % were professors and 1.5 % of the respondents were undergraduate. When asked to rate their experience in searching DLs 24.4 % considered their experience as expert, 42.7 % as high, 21.4 % as moderate, 10.7 % as little and 0.8 % as none at all. Alongside their experience we asked the respondents about their usage of DLs and Google Scholar using a 5-point Likert scale ranging from never to very often. 59 % of the respondents use DLs "often" or "very often" (median = 4, mode = 4, N = 131) and 71.8 % use Google Scholar "often" or "very often" (median = 4, mode = 5, N = 131)[1].

4 Results

In the following (Sects. 4.1–4.4) we present the results of our online survey on high-level search activities. In Sect. 4.5 we look for significant differences between respondents clusters.

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[1] The central tendency of the Likert scales is presented by using median and mode values throughout the paper due to the ordinality of the scales [11].

4.1   Journal and Conference Run

In the first part of the survey we asked some general questions concerning journal and conference runs on a five point Likert scale using different item labels for each question (example for an item label regarding a question about usefulness ranging from: not at all useful (1), rather not useful (2), neither useful nor not useful (3), rather useful (4), very useful (5)). For each of the questions the negative item was left aligned. The results are displayed in Table 1 (each item-label is highlighted).

Table 1. General questions about journal and conference run (N = 156).

Task	Mdn	Mode	M	SD
How **useful** are conference proceedings or journals as a source for relevant documents during your search task?	5 (very useful)	5	4.31	0.89
How **satisfied** are you with the support of current Digital Libraries (e.g. ACM DL, Web of Science) browsing through conference proceedings or journals?	3 (neither satisfied nor unsatisfied)	4	3.27	0.9
How **important** is the quality of a conference (ranking) or a journal (e.g. the impact factor) for your confidence in the source?	4 (rather important)	4	3.44	1.06

Furthermore, we investigate how frequently the respondents use journal or conference runs. To this end we asked two questions with items ranging from "never" to "very often": (a) "How often do you browse through conference proceedings or journals to find relevant documents?" We then asked the same question but from a different perspective (b) "After finding a document (e.g. ACM DL, Web of Science) that is relevant for your current search task: How often do you browse through the conference proceedings or journals the document was published in?".

A journal run without preceding document (a) was selected "often" or "very often" by 54.9 % (median = 4, mode = 4, N = 142) of the respondents. Regarding a journal run with a preceding document (b), 35.2 % replied to use this search activity often to very often (median = 3, mode = 3, N = 142). If the respondent replied that he/she never or rarely browses through conference proceedings or journals, he/she was asked to justify his/her decision using a free-text form. A frequently stated reason was a preference for searching instead of browsing.

We Summarize: Journals and conference proceedings are considered a very useful source. 54.9 % of the respondents browse through a journal or conference proceedings often to very often in order to find relevant documents but only 35.2 % use this stratagem as a follow-up search activity starting from a relevant document.

4.2   References and Citations

In the second part of the survey we asked some general questions concerning the usage of citations and references on a five point Likert scale using different item labels. The results are displayed in Table 2.

Table 2. General questions about citations and references (N = 140).

Task	Mdn	Mode	M	SD
How **important** is the number of citations a document has received to you?	3 (neither important nor unimportant)	4	3.33	0.91
How would you rate the **usefulness** of citation rankings (e.g. h-index) where documents are ranked by the number of received citations?	3 (neither useful nor not useful)	4	3.23	0.99
Assuming there is a key document in a particular field. How **important** is it to you to find central authors citing that particular document?	4 (rather useful)	4	3.60	1.07

Furthermore, we examined how frequently the respondents use references or citations after finding a relevant document. To this end we asked two questions with items ranging from never to very, often: (a) "Starting from a relevant document: How often do you use references to find other relevant documents for your search task?" and (b) "Starting from a relevant document: How often do you use citations to find ..?". Regarding citations, the options "often" to "very often" were selected by 65.7 % (median = 4, mode = 5, N = 140) of the respondents and by 82.1 % (median = 4, mode = 4, N = 140) regarding references. If the respondent replied that he/she never or rarely used citations or references he/she was asked to provide some additional information why. For references only one response was available. He/she replied to prefer semantic tools. With respect to using citations there was an overall agreement that they are more difficult to find and therefore not that commonly used.

We Summarize: Citation and reference search are frequently used search activities. Citations and references are as well commonly used. 65 % of the respondents used citations and 82 % used references often to very often. The central tendency regarding features like the h-index or the general citation count ranges between the mid-point and a rather positive tendency.

4.3   Stratagem Usage in DLs

In [2], six example stratagems are proposed. We want to investigate the usefulness of these search activities with respect to the following search scenario that was presented to the respondents:

Table 3. Stratagem usage for the given scenario. Mean values range from lowest rank (6) to highest rank (1). (N ≥ 125)

Ranking option	M	SD	Mdn	Mode
Follow references in the current document	2.38	1.24	2	2
Inspect the list of documents that cite the current document	2.79	1.50	2	2
Keywords that describe the current document as search terms	2.82	1.63	3	1
Look for papers the authors of the current document has/have published	3.46	1.21	3	3
Browse the conference/journal the current document was published in	4.10	1.53	4	5
Browse a thesaurus to find classification terms related to the current document	5.21	1.30	6	6

"Please consider the following scenario. You want to find out about the current state of the art in a particular field. You have already found one document that is useful to your current work task."
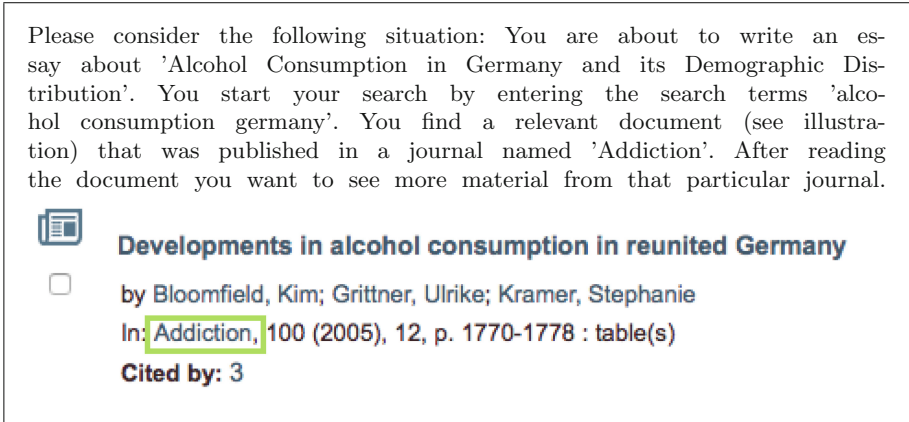
Alongside this scenario, we gave the respondents the six example stratagems derived from [2]. We then asked to order all these activities from best to worst regarding the given scenario using a drag and drop user interface. The list of stratagems as well as the results are illustrated in Table 3. Additionally, the respondents were given a free-text field where they were asked to provide other search activities they use to find related material. Amongst others, the respondents mentioned: using recommender systems, asking colleagues, using some kind of bibliometric measure/feature like co-author search.

We summarize that references, citations and keywords are the most commonly used search activities for finding relevant documents. The importance of citations and references was evident throughout the entire survey. Previous tasks showed that journals and conference proceedings are a useful source as well. Compared to the other stratagems these search activities do not appear to be used very often.

4.4   Organizing Journal Articles

Articles in a journal or in conference proceedings can be sorted in various ways (i.e. by date, by title, etc.). The ranking of the articles strongly depends on the current search task of the user. Using a search task scenario, we compare different ranking options for a journal run. The respondents were given a scenario displayed in Fig. 1 where they are looking for related material in a journal named *Addiction*. Alongside the scenario, we defined six randomly arranged options on how to rank articles from that particular journal. Four of the six options (issue date, title, author, and citation count) are well known and widely implemented

Please consider the following situation: You are about to write an essay about 'Alcohol Consumption in Germany and its Demographic Distribution'. You start your search by entering the search terms 'alcohol consumption germany'. You find a relevant document (see illustration) that was published in a journal named 'Addiction'. After reading the document you want to see more material from that particular journal.

Developments in alcohol consumption in reunited Germany

by Bloomfield, Kim; Grittner, Ulrike; Kramer, Stephanie

In: Addiction, 100 (2005), 12, p. 1770-1778 : table(s)

Cited by: 3

Fig. 1. Scenario for the task on organizing journal articles

in today's DLs. The two remaining options rank the articles based on previous search activities that were described in the scenario. One option ranks the articles by the previously entered query term (alcohol consumption Germany) and the other option ranks the articles by similarity to the current relevant article the user was inspecting based on title ("Developments in alcohol consumption.."). The respondents were then asked to order all these options from best to worst using a drag and drop user interface. The results for this task are displayed in Table 4.

Table 4. Task on organizing journal articles. Mean values range from lowest rank (6) to highest rank (1). (N ≥ 128)

Ranking option	M	SD	Mdn	Mode
By the entered query terms (alcohol consumption Germany)	2.08	1.34	2	1
By similarity to the current document based on title (Developments in alcohol consumption..)	2.23	1.32	2	2
By title	3.95	1.49	4	5
By issue and date	3.95	1.66	4	6
By number of citations	4.08	1.42	4	4
By author	4.42	1.31	5	6

We Summarize that respondents assess the ranking options based on previous search activities noticeably higher. A ranking based on the previously entered query term was slightly more often chosen (mean = 2.08, sd = 1.34) than the ranking option based on similarity to the current relevant article (mean = 2.23,

sd = 1.32). Both search activity based options clearly outperform the other four ranking options that are well known and commonly used in DLs.

4.5   Diversity in Respondents

The survey was primarily designed for researchers but not limited to a particular field of study. This leads to a variety of respondents from diverse fields of study and academic degree. Utilizing a non-parametric Mann-Whitney test ($\alpha \leq 0.05$) we seek for significant differences in respondents' groups. In particular we separated the respondents by field of study and by academic degree. The decision for utilizing a non-parametric Mann-Whitney test is due to highly skewed distributions in the responses.

By Field of Study: The majority of respondents are either Computer and Information Scientists (50.4 %) or Social Scientists (28.2 %). A significant difference between the two groups was found in the task on organizing journal articles (see Sect. 4.4). Computer and Information Scientists preferred a ranking by citations more frequently than Social Scientists (u = 1989, p = 0.047), whereas Social Scientists preferred a ranking based on title (u = 2031, p = 0.042). A further difference was found for the ranking option based on authors which was preferred by Social Scientists (u = 2002, p = 0.045). However, these differences have only marginal influence on the overall result of the ranking task because both groups agreed to perform a ranking based on preceding search activities (by similarity to the preceding article or by the entered query term).

By Academic Degree: To look for significant differences by academic degree we created two groups of respondents: The group of *junior researchers* consists of researchers having a bachelor's, master's or diploma degree (55 %) and the group of *senior researchers* consists of researchers having a doctoral degree or a professorship (45 %). Significant differences between these two groups could be found in various responses. It shows that *senior researchers* consider conference proceedings and journals as more useful for their search task (u = 2396, p = 0.017), that they are more satisfied with the current support of DLs (u = 1971, p = 0.049) and consider the number of citations as more important (u = 2112, p = 0.035). Furthermore, we found differences in the usage of Dls. *Senior researchers* utilise DLs (u = 2647, p = 0.008) and Google Scholar (u = 2142, p = 0.032) more frequently. Both systems are less frequently used by *junior researchers*.

In Sect. 4.3 we asked the respondents to rank different stratagems by their usage when looking for related material. *Senior researchers* ranked "inspecting the list of citations" on the first position (u = 2661, p = 0.017). The usage of "keywords that describe the current document as search terms" was ranked on position two by *junior researchers* and on position three by *senior researchers* (u = 2043, p = 0.042).

We Summarize that there are significant differences in the usage of high-level search activities depending on the academic degree. Respondents with a higher

academic degree significantly considered journals and conference proceedings as more useful than respondents with a lower academic degree. Furthermore, they utilise DLs and Google Scholar significantly more often.

5   Discussion

In the following we discuss the results with respect to the research question introduced in Sect. 1.

RQ: What Kind of Stratagems Do Users Perform When Looking for Relevant Documents? The survey showed that stratagems are commonly used search activities across a wide range of respondents. Journals and conference proceedings are considered very useful sources by the majority of the respondents. Citations and references are as well commonly used. 65 % of the respondents used citations and 88 % used references often to very often. However, the higher usage of references over citations does not necessarily reflect the usefulness of these search activities. Several respondents stated that various DLs do not provide access to citations. Therefore, citation search is not utilized that often. A better access to citation information in DLs could balance this difference. When looking for related material to a given relevant document the respondents preferred to use citations, references and keywords.

We showed that the usage of stratagems depends on the users' state of search. The journal run for instance is less often utilized when looking for related material to a given relevant document compared to a journal run that is performed without viewing a preceding document. Using a free text form some respondents pointed out that the content of journals or conference proceedings is topically too broad to discover something similar and therefore not that often utilized. A similar argumentation is discussed in the well-known *berrypicking* modell by Bates [1] where she argues that:" .. a journal with a broad subject is unlikely to fulfil a users information need but more useful to monitor a certain area of research whereas very specific journals are likely to meet a researchers interest."

By clustering the respondents into different groups according to their academic degree and by field of study we showed significant differences in the usage of certain stratagems. *Senior researchers* for instance asses "inspecting the list of citations" as a more valuable stratagem than *junior researchers* who prefer to use keywords that describe a certain document. Although we cannot make any assumptions which of the groups are more effective in satisfying their information needs we can assume that more experienced users are as well more effective. This was also observed in [7]. We assume that senior researchers are more interested in highly specific publications than junior researchers who try to get a broader overview about a certain topic.

Implications for the Design of DLs: The results of the survey showed significant differences in the usage of certain stratagems between *senior researchers*

and *junior researchers*. The former, more experienced group utilise DLs and Google Scholar significantly more often. To better support unexperienced users in certain situations DLs could be designed to suggest search activities that experienced users (e.g. *senior researchers*) utilise when solving a search task. Comparable approaches can be found in the literature. In [4] a coaching approach is developed that provides the user with strategic help on potentially useful search activities that were derived from [2] using a rule based mechanism. A similar approach was presented in [13] where an *Adaptive Support for Digital Libraries (ASDL)* was developed that covers sixteen predefined search activity suggestions. A more user oriented approach would be to identify search activities that expert users perform and use their search behaviour as a search strategy suggestion. This was also the main observation in [7].

Current DLs treat each activity on the level of stratagems as a basic unit ignoring search activities that have been performed in previous steps. The task on organizing journal articles for instance (see Sect. 4.4) shows a need for session-context sensitive browsing. The results indicate that the ranking of documents during a journal run should stronger relate to the users' search activity (e.g. entered query term or the inspected document). To the best of our knowledge this would be a novel feature in DLs that users could benefit from during a journal/conference run. This approach has already been proposed in [5] and is further underpinned by the results of our survey. However, the scenario that was used to assess the users' opinion on organizing journal content was composed using a relevant document as a starting point. It would be interesting to see whether the outcome of the task significantly changes when using a negative scenario in which they start from a non-relevant article. A negative scenario could possibly lead to a lower performance of search activity based ranking options. This will be investigated as part of a larger user study we are conducting. Whether search activity based ranking options are applicable during other stratagem search activities, like citation search, needs to be evaluated as well.

6 Outlook

For this survey we focused on stratagems introduced by Bates 25 years ago. Future work can be to identify further high-level search activities that are suitable to solve todays information seeking problems (compare [15]). To this end it is necessary to get a more qualitative view of high-level search activities to fully understand the users' task and goal. We are therefore conducting a user study including interviews and search diaries in which we expect to get a more detailed view on the users' information need when performing high-level search activities.

The results obtained in the survey provide a general overview about the usage of high-level search activities across a broad range of discipline and academic degree. However, it is challenging to generalize the results due to the artificial situation of the online survey. This could be overcome by looking at high-level search activities from their real usage in transaction logs. This would provide us

with quantitative behavioural usage data about the frequency of certain search activities. We are therefore conducting a large scale transaction log study to look at usage data of certain search activities in a DL for the Social Sciences *Sowiport*[2]. Besides their usage frequency we measure the usefulness [6] of certain search activities using pseudo relevance feedback (e.g. bookmark or cite a certain document found in Sowiport) as proposed in [9]. The codebook of the survey and the anonymised data is available at http://dx.doi.org/10.7802/1257.

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