

# Evaluating the Usefulness of Visual Features for Supporting Document Triage

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**Abstract.** One of many challenges the users of digital libraries face is the quick and easy identification of relevant documents as well as their effective use – a process which is called *document triage*. While there is a variety of means for supporting the actual search process in digital libraries, only few address document triage. In this paper, we investigate the usefulness of user initiated support features that might assist users in this process. Therefore, we implemented SortBoard, a visual workspace for assisting document triage in a digital library for the social sciences. The results of a user study with 16 participants show that the features are highly useful for comparing and organizing documents as well as finding and examining similarities between documents.

## 1 Introduction

Finding relevant literature is essential for researchers of all disciplines. A challenge of literature search in digital libraries is the quick and easy identification of relevant documents, including actions like investigating documents, structuring and organizing a set of documents and using their information effectively. This process is also referred to as “document triage”. According to Toms et al., two-thirds of the total time for finding relevant documents are used for “reviewing documents that had already been found” [21], while only one-third is spent on searching. There is a variety of means that support searching in digital libraries, such as term recommenders or re-ranking techniques [10]. However, the support for document triage is often limited to some kind of favorite lists or bookmarks. Although there are promising research activities regarding visual support for document triage, e.g. [1, 15, 18], this is still almost non-existent in digital libraries. In our work, we investigate the usefulness of user initiated support features for assisting the document triage process visually as well as in a transparent way for the user. We implemented SortBoard, a prototypical application and integrated it into Sowiport<sup>1</sup>, a digital library for the social sciences. In SortBoard

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<sup>1</sup> <http://sowiport.gesis.org/>.

the user can move, arrange and structure documents as well as investigate their properties and similarities.

In a user study with 16 participants, we compare SortBoard regarding its usefulness to a common method for document triage: opening relevant documents in new tabs and making notes. The results show that SortBoard’s user initiated support features are more useful than the commonly used method regarding comparing and organizing documents as well as finding and examining similarities. The most useful features are the display of a metadata box, reference and citation relations and colored highlighting of documents with similarities.

## 2 Background and Related Work

In their model of the information searching process, Ellis et al. [7,8] describe the stages academic researchers go through while searching for information. In focus of our work is the *differentiating* stage where the user views and investigates documents and decides about their relevance. This process is also often called “document triage”. In the literature, there are different definitions of this term [2,5,13]. We follow the definition of Marshall et al. [15], who describe “document triage” as “sorting through relevant materials and organizing them to meet the needs of the task at hand”. Loizides [13] distinguishes between three levels of document triage: *surrogate triage stage*, *within document triage stage* and *further reading triage stage*. In our work, we focus on the *surrogate triage stage*. In this stage, the user investigates documents, represented by surrogates, based on their metadata. It is the first encounter of a user with a document, typically after searching. The user judges the relevance of documents without looking at the full texts.

One opportunity to support users in sorting through documents is showing these documents represented as movable objects on a 2- or 3-dimensional workspace. On such a workspace the objects can be arranged (1) manually [15,16], (2) manually with automatic support by suggesting the belonging of new objects to already formed groups on the space [3,4,17], (3) automatically according to predefined categories [11,19,22] or (4) regarding their similarity to used search terms [9]. The expert tool TRIST (Rapid Information Scanning Tool) [11] allows, additionally to automatic clustering of search results, to highlight documents’ commonalities (such as the same year of publication) across the clusters’ borders. A detailed up-to-date summary of different approaches for visual support for the document triage process in digital libraries is provided by Loizides et al. [14].

In our work, we take up basic principles of an early support tool for document triage, called VIKI [15]. VIKI is a spatial hypertext system and allows users to structure and organize documents on a visual workspace like analysts used to do so with physical papers. VIKI has been further developed into the visual knowledge builder (VKB) [18]. In a more recent version of VKB [1] additionally to user-generated visualizations (like used in VIKI) system-generated visualizations are used that organize documents implicitly according to users’ search interests.

This information is also used for highlighting new information on the workspace that might also be relevant for the user. In this paper, we focus solely on user-generated visualization. The user gets system support while exploring similarities and relations between preselected documents on a 2-dimensional workspace, but has full control over it. A filter list next to the workspace shows metadata like keywords and topics and their frequency of occurrence. This list can be used to get an overview of the documents on the workspace, to get inspiration for further search terms and as a filter to find and highlight documents with commonalities. We are especially interested in the usefulness of user initiated support features and compare them to the common practice of document triage during publication search in digital libraries.

### 3 SortBoard

In this section, we introduce SortBoard, a web-based application we implemented to evaluate user initiated support features for visual document triage. SortBoard is implemented as a prototype in Sowiport<sup>2</sup>, a digital library with more than 9.5 million literature references. Taking up basic principles from VIKI [15] and VKB [18] the main intention of SortBoard is: (1) to offer a 2-dimensional workspace where a user can drop relevant documents in a digital library by just one click for further triage, (2) to sort and structure documents graphically, (3) to support users in finding similarities in a set of documents and additionally (4) to derive further search terms. All system support in SortBoard is user initiated, thus transparent to the user.

The user interaction in SortBoard is as follows: While searching for literature in a digital library, the user can drop documents directly from the result list to SortBoard by clicking on a link “Add to SortBoard”. The actual task of scanning the result list for relevant literature is not affected until the user explicitly switches to SortBoard by clicking on the corresponding link. After switching to SortBoard the user sees all the dropped documents represented as movable object cards (A in Fig. 1). The user can drag the cards to arrange them according to her preferences.

To support finding similarities and to provide an overview of the documents on the workspace we adapted the concept of faceted search, which is already used in Sowiport to filter search results in the result list. We show selected metadata of the documents as filters at the left side of SortBoard (B in Fig. 1). They are divided into five categories: author, classification, topic, document type, and notes. Next to each filter the frequency of property occurrence in the documents on SortBoard is shown (C in Fig. 1). By selecting one of the filters, all documents that match this criterion are highlighted with the same colored border, which is called colored highlighting (D in Fig. 1). This visualization of similarities should support users by structuring documents on the workspace. Selected filters are listed at the top of the list so that the user can easily remove one or all of them (E in Fig. 1). By dragging and dropping a document on the recycle bin, it is

<sup>2</sup> <http://sowiport.gesis.org/>.

The screenshot shows the Sowiport SortBoard interface. On the left, there are filter panels for 'Active filter(s)', 'Filter (5/58)', and 'Notes'. The main area displays a collection of document cards. A large metadata box (H) is open for the document 'Thinking Geographically about Work, Employment and Society'. Various arrows and labels (A-I) point to specific UI elements: A points to a document card; B points to the filter area; C points to a document card; D points to a highlighted document card; E points to the filter area; F points to a document card; G points to an information icon; H points to the metadata box; and I points to a 'notes' icon on a document card.

**Fig. 1.** SortBoard: movable object card (A), filter area (B), frequency of property occurrence (C), colored highlighting (D), selected filters (E), reference and citation relations (F), information icon (G), which triggers on mouse hover the appearance of the metadata box (H). The user can add notes (I) to an object.

removed irrevocably from SortBoard. To support users in exploring co-citation relations [20] between the documents on SortBoard, the card gets the additional note “referenced” or “cited by”. A mouse-over triggers the highlighting of the documents that are referenced in the selected object or cited by the selected object respectively (F in Fig. 1). Each movable object card provides the following information about a document at a glance: title, authors, year of publication and notes, as well as further information on demand by mouse-hovering over the information icon (G in Fig. 1). This triggers the appearance of a metadata box (H in Fig. 1) containing the following metadata: author, title, classification, topics, language, document type, URN, abstract. This metadata box opens in the direction that provides the freest space and will close automatically again after the cursor is positioned outside the box. By clicking on “notes”, the user can add notes to a movable object card (I in Fig. 1).

## 4 Evaluation

We performed a user study to evaluate the usefulness of SortBoard’s user initiated support features for assisting document triage. Our study focuses on the *surrogate triage stage* as defined by Loizides [13], particularly on the stage after the user has made a first relevance decision and the relevant document is stored

for further investigation. Following Kelly [12], we designed our lab study as a comparison between SortBoard and a common method for document triage as a baseline. We used a within-subject design with two triage methods (SortBoard and the baseline) as well as two different tasks as independent variables. We conducted our lab study in single sessions with a duration of about one hour each. Having the two triage methods and the two tasks as independent variables, we rotated them in a Graeco-Latin square design and distributed the four experimental conditions randomly but counterbalanced among 16 participants.

#### 4.1 Setup

**Triage Methods.** The first triage method is represented by SortBoard described above. To find a baseline as the second triage method, we performed an online survey and asked 102 researchers about their preferred strategies to store relevant documents during the search process in digital libraries. The results show that storing a document on a PC is the most preferred method (used by 92%), followed by opening an interesting document in a new tab (used by 91%) and making notes (used by 81%). As our digital library Sowiport does not provide full texts to all literature references for storing them on a PC, we chose a combination of the second and third most common methods “open in new tab” and “make notes”. For supporting the baseline triage method, functionalities of a common internet browser can be used. Sowiport provides a detailed result page for each document showing the same information as the metadata box of the movable object cards in SortBoard. While examining the result list a user can open a new tab by middle-click or right-click and select “open in new tab”. A word processing program or a sheet of paper can be used to take notes.

**Tasks.** We defined two identical tasks (A and B) that differed only in the topic they dealt with. While task A addressed “urban research”, task B dealt with “scientific organizations”. For each of these tasks, we defined a set of 18 documents and created a sample solution on how this documents could be grouped. The selection of the documents for the sets as well as the sub-topic groups in the sample solutions was based on reviewed document collections on each of the topics composed by social scientists. The participant’s task was to get an overview of the documents, to group the documents by sub-topics, to delete documents that are not relevant and to extract search terms that seem to be useful for further searches. Participants were requested to write these search terms in an excel sheet. The time for solving the task was limited to 15 min but could be ended earlier, if the participant stated to have finished the task.

**Apparatus.** All participants used the same laptop with a 15.6” screen and a resolution of  $1366 \times 768$ . For ease of use, an external mouse was provided as a controlling device. We recorded the screen activities as well as the think-aloud comments during the sessions using the screen capture software Camtasia. SortBoard was equipped with 18 documents of set A (respectively B) that had

to be examined. For taking notes, SortBoard's note function should be used. In the baseline triage method, 18 documents of set B (respectively A) were opened in tabs of a web browser and participants were allowed to take notes either in a word document or on a sheet of paper.

## 4.2 Procedure

The procedure of each session followed a detailed protocol to ensure the same conditions for each participant. Solely the combination and sequence of the two document triage methods and the tasks differed as described above. The procedure mainly consisted of three parts: (1) In an introduction, the purpose of the study was disclosed to the participants, and a short explanation of the stages of document triage was given. Then they were informed about the procedure of the session as well as of the recording that was taken. They signed a consent form, filled out the pre-questionnaire including questions about demographics and general search experience and then the recording was started. (2) In the second part, the participants had to solve the tasks one after another. They were introduced to the first triage method they used by a video tutorial. After that, they were handed out the first task and started solving it. After finishing this first task, they were shown a video tutorial of the second triage method. The second task was given to the participants and carried out by them. The participants noted down their sub-topics in an excel sheet and saved their groups of documents in SortBoard. 10 min after starting each task a notification was given that five minutes were left. The tasks ended after 15 min. If the participants finished a task before the 15 min expired, they signaled it. (3) In the third and final part of the session, the participants filled out a post-questionnaire including questions about task performance and usefulness.

## 4.3 Participants

Participants were recruited via email and personal request at three universities and one research institute. The group was composed of 16 German speaking researchers from different fields of the social sciences, of which six were female, and ten were male. Their age ranged from 25 to 47 ( $M = 31.31$ ,  $SD = 5.91$ ). Three participants held a bachelor's degree, six a master's degree, four a diploma and three were postdoctoral researchers. All of our participants stated that they used the internet daily and that they searched for information online daily or at least once a week. Regarding the participants' experience with digital libraries, 56% stated to have much or very much experience in searching digital libraries. Their experience regarding the two topics did not differ significantly.

## 4.4 Measured Variables

**Task Performance.** For participants' task performance we examined: (1) how well participants identified topic clusters and non-relevant documents (correctness), (2) if they needed the whole 15 min to solve the task (time) and

(3) how many new terms for future search could be found. Since the participants were allowed to finish earlier than 15 min, the time needed to accomplish it was measured, with a maximum of 15 minutes. Furthermore, in the post-questionnaire, the participants had to state if they felt they have finished the task or not.

**Usefulness.** For investigating the usefulness we followed two approaches: (1) For evaluating the usefulness of the two triage methods in order to compare them, we used the evaluation model based on the main goal and sub-goal levels introduced by Cole et al. [6]. We formulated the main goal, sub-goals, and information seeking strategies (ISSs) for our task (see Table 2). After becoming familiar with both triage methods, we asked participants on five-point Likert scales about the usefulness and support of the respective triage method, based on our main goal, sub-goals, and ISS levels. At the level of the main goal (investigating documents) and the sub-goals (obtaining an overview, identifying sub-topics, separating relevant and non-relevant documents, identifying starting points for further searching) they were asked how useful (1= “not at all useful” to 5= “very useful”) the triage method was for accomplishing these goals. At the level of the ISSs (see Table 2) we asked how well the triage method supported (1= “not at all” to 5= “very”) them in this strategies. (2) For evaluating the usefulness of the user initiated support features, we asked participants on a five-point Likert scale how useful (1= “not at all useful” to 5= “very useful”) they considered the filter list, the number of occurrence of these filters, the colored highlighting of documents that share commonalities, the opportunity to add notes as well as the display of reference and citation relations between documents. In addition, we asked how useful (1= “not at all useful” to 5= “very useful”) they considered SortBoard in general for supporting their document triage process. Finally, to gather qualitative feedback, participants were asked to note down improvements for the features of SortBoard as well as suggestions for new features that they found the tool lacking in.

## 5 Evaluation Results

We analyzed the task performance, and the results of the post-questionnaire, comprising the comparison of the two triage methods at the different levels of main goal, sub-goals, and ISSs as well as the usefulness of the user initiated support features. To determine the statistical significance, Wilcoxon Signed Rank tests were used with  $\alpha = 0.05$ .

### 5.1 Task Performance

Table 1 summarizes all findings that focus on the task performance. The number of deleted documents was significantly higher while using SortBoard for document triage than with the baseline method. The same is true for the accordance of documents that participants considered not relevant compared to the ones that

**Table 1.** Task performance with the two triage methods, mean (SD). \* $p < 0.05$ ; \*\* $p < 0.01$ .

	Baseline	SortBoard
Number of identified groups of sub-topics	4.81 (1.87)	4.50 (0.97)
Number of deleted documents	1.00 (0.97) *	<b>1.93 (1.06) *</b>
Number of deleted documents matching with the sample solution	0.69 (0.70) *	<b>1.38 (0.72) *</b>
Number of identified search terms	<b>17.75 (6.84) **</b>	11.5 (9.26) **
Time needed	14:35 (00:42)	14:04 (01:21)
Number of participants that finished earlier	8	7
Number of participants that stated to have finished the task	13	10

are not relevant in the sample solution. Furthermore, there was a significant difference regarding identifying new search terms. Participants elicited significantly ( $p < 0.01$ ) more search terms for further searching with the baseline method. There was no significant difference in the number of sub-topics that were found and in the time needed to accomplish the task.

## 5.2 Usefulness

Table 2 shows participants' evaluation of the usefulness of the two triage methods at the different main goal, sub-goal and ISS levels. The mean usefulness for accomplishing the main goal was rated significantly higher for SortBoard than for the baseline. Additionally, the ratings for identifying sub-topics and all its ISSs

**Table 2.** Mean (SD) usefulness ratings (1= "not at all useful" to 5= "very useful") at the main goal, sub-goal, and ISS levels for each triage method. \* $p < 0.05$ ; \*\* $p < 0.01$ .

	Baseline	SortBoard
<b>Main goal:</b> Investigating documents	3.19 (0.83) *	<b>3.94 (0.68) *</b>
<b>1. Sub-goal:</b> Obtaining overview	3.13 (1.09)	3.69 (1.09)
<b>ISS 1.1:</b> Extracting main information	3.63 (0.89)	3.44 (0.73)
<b>ISS 1.2:</b> Making notes	2.81 (1.22)	2.94 (1.29)
<b>2. Sub-goal:</b> Identifying sub-topics	3.31 (0.70) *	<b>4.06 (0.85) *</b>
<b>ISS 2.1:</b> Comparing documents	2.56 (0.89) **	<b>4.13 (0.81) **</b>
<b>ISS 2.2:</b> Finding similarities	2.50 (0.52) **	<b>3.81 (0.75) **</b>
<b>ISS 2.3:</b> Forming groups of sub-topics	3.13 (0.62) *	<b>4.19 (1.05) *</b>
<b>ISS 2.4:</b> Assigning documents to the groups	3.00 (0.82) *	<b>4.00 (0.89) *</b>
<b>3. Sub-goal:</b> Separating documents	3.13 (0.81)	3.81 (0.83)
<b>ISS 3.1:</b> Evaluating documents	3.13 (0.72)	3.50 (0.73)
<b>ISS 3.2:</b> Deleting documents	3.94 (0.93)	4.06 (1.00)
<b>ISS 3.3:</b> Keeping or saving documents	3.06 (1.06) *	<b>3.81 (0.83) *</b>
<b>4. Sub-goal:</b> Identifying starting points for further searching	3.19 (0.98)	3.75 (0.93)
<b>ISS 4.1:</b> Examining similarities	2.75 (0.68) **	<b>4.00 (0.52) **</b>
<b>ISS 4.2:</b> Finding new search terms	3.31 (0.95)	3.50 (0.63)



as well as for keeping or saving documents and examining similarities differed significantly in favor of SortBoard.

Table 3 shows participants' usefulness ratings for the different features of SortBoard. The tool in general was rated as "useful". The metadata box gained the highest ratings, followed by reference and citation relations and the colored highlighting, whereas adding notes and filtering — yet still rated as "rather useful" — received the lowest values. While all of the participants used the movable object cards of SortBoard and the metadata box, only 38% added notes. 69% browsed through the filter list and 56% of all participants used them to highlight documents with similarities.

**Table 3.** Mean (SD) usefulness of SortBoard's features (1= "not at all useful" to 5= "very useful").

Feature	Mean usefulness (SD)
Metadata box	4.50 (0.52)
Reference and citation relations	4.44 (0.96)
Colored highlighting	4.25 (0.68)
Frequence of property occurrence	4.00 (0.89)
Adding notes	3.88 (0.89)
Filters	3.88 (0.89)
SortBoard in general	4.06 (0.93)

### 5.3 Suggestions for SortBoard

We gained extensive qualitative user feedback from the participants. Most of the suggestions referred to the metadata box that should either be opened via clicking instead of hovering over a symbol or be aligned in the center of the screen. Another difficulty that occurred was the high number of filters displayed on the left side of SortBoard. The most popular feature suggested by the participants was the creation of labeled groups on SortBoard, e.g. by drawing a rectangle around a group or creating sub-folders. Further ideas dealt with highlighting the cards of documents that are highly relevant, such as documents with a very high number of citations, as well as possibilities for import and export from SortBoard into literature management software or the direct export of full texts.

## 6 Discussion

The results showed that participants experienced SortBoard in general as a useful tool that supports the document triage process through user-initiated support features. Participants found SortBoard significantly more useful for the following tasks (compared to using browser tabs and making notes): investigating documents, identifying sub-topics, comparing documents, finding similarities, forming

groups of sub-topics, assigning documents to groups, keeping or saving documents and examining similarities. These findings support participant's need for visual document triage tools found in previous user studies [1, 4, 11, 22]. As we concentrate solely on user-initiated support features, we showed that even without any system-generated visualizations user assistance during document triage process could be improved. Especially the results regarding the deleted documents tell us that SortBoard's features do support the user's relevance decision and the "quality check" that is part of the *differentiating* stage [7, 8]. A reason may be that on a 2-dimensional workspace the user sees all documents at a glance and gets a better overview, while with browser tabs, individual documents can be overseen easily. Additionally, the user has to switch between browser tabs to inspect and compare titles and authors, while SortBoard's movable object cards provide this important information directly. However, for seeing the abstract and further details of a document the user has to open the metadata box, which was consequently rated as the most useful feature. Participants found significantly more search terms in the baseline condition; this might be due to the fact that on the result view of a document opened in a tab the user sees all information at once while on SortBoard the metadata box has to be open explicitly. We had assumed that the filter list is very useful for the user in finding further search terms, by providing an overview of commonly occurred keywords in the documents on SortBoard. However, the filter list was not used extensively. One explanation for that was given by our participants in their qualitative feedback. The number of filters was far too high, and the terms were sorted alphabetically instead of based on their frequency of occurrence. Most of the terms provided as filters, only appear in one document and therefore were less helpful in finding new search terms. By decreasing the number of filters, e.g. by excluding those that only relate to one document, or changing their order, we assume that the filter feature, as well as the colored highlighting feature, would be used more extensively.

One of the most popular suggestions for new features was the creation of labeled groups on SortBoard. That further differentiation and labeling of grouped documents can support document triage was also found in the studies on VIKI and VKB [1, 15, 18]. The wish for colored highlighting of most relevant documents in the document set on SortBoard is in line with findings in [1]. We plan to provide additional filters (like most cited papers) to address this need. In doing so, the process is still transparent, and user initiated. Import and export of documents seems to be an important matter for many participants. It suggests that user initiated support features would be useful beyond Sowiport as well and in a broader context of the whole information searching process.

At the end of this section, we would like to summarize some limitations of our study. Since the triage methods we compared are quite different from each other, one could assume that the comparison was inappropriate. Nevertheless, working with browser tabs is the most common method used during document triage, according to our online survey which was also confirmed by the participants during the study. Also, the sub-topics the participants found with both triage methods do not differ significantly. In turn, several participants remarked

that SortBoard felt new to them and that they had needed some time to get accustomed to it. The comparatively high usefulness rankings of features that have not been used by all participants support the conclusion that they had not enough time, but see the potential of these features. Apparently, the video tutorial was not sufficient, and it might have been better to additionally give them a few minutes to make themselves familiar with SortBoard or to generally remove the time constraints of the scenarios.

## 7 Conclusions and Future Work

In this paper, we investigate the usefulness of user initiated support features for the document triage process in a digital library. Therefore, we presented SortBoard, a visual workspace for storing relevant documents, for sorting and structuring documents graphically, for finding and examining similarities between documents, and for deriving search terms for further search processes. A user study with 16 participants was conducted and showed that the user initiated support features were rated as highly useful for supporting the document triage process. We showed that SortBoard's features provide the user with a better usefulness than the baseline triage method regarding half of all goals, sub-goals, and ISSs. The user initiated support features, as well as SortBoard in general, were rated as useful on average, though there is still room for improvement.

In future work, we plan to conduct a long-term user study with an improved version of SortBoard, including the user feedback given in our study. We are interested in how a visual workspace can support the user beyond the document triage process, addressing questions like, might SortBoard be helpful for resuming a previous task, or might it be helpful to use SortBoard for different information types, e.g. to find connections between literature, research data, research projects, and websites.

As Ellis et al. [7,8] showed in their research, the information searching behavior of researchers from different disciplines differs only minimally. We are sure that the features evaluated in this work are also appropriate for researchers from other fields of study and that digital libraries could benefit from implementing similar concepts.

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