Methods for gathering and analyzing information seeking behaviour in electronic resource discovery systems

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This paper reports on the use of a combination of cognitive task analysis techniques – such as observations with 'think aloud', the Critical Decision Method (CDM) interviews and Cued Recall – to identify and understand what students and researchers do when searching for scholarly material using various electronic resource discovery systems. It describes the use of Emergent Themes Analysis to discover broad themes across all the data sets collected. This paper also presents a visual representation of the process of information seeking developed during data analysis that allowed the patterns of activities to emerge and show the relationship between different actions. Overall, it is that the use of multiple research methods can reduce the limitations of individual methods and provides complementary insights.

INTRODUCTION

Driven by economic pressures, electronic resource discovery systems (ERDS) are increasingly replacing physical collections in libraries. ERDS include library-subscribed electronic databases, e-journal portals such as EBSCO and ProQuest, federated search engines, e-books, and catalogues, However, despite heavy investment in ERDS, users are still not accessing the quality materials available in them (Wong et al., 2009; CIBER Report, 2008). They are instead, more than ever, preferring familiar search tools such as Google, which often do not lead to the high quality scholarly materials located in these electronic resources. This raises the question of why do students and researchers not use these specialised resources, despite having paid for the right to access them? We carried out a series of observation and 'think-aloud' studies, combined with in-depth interviews using a variant of the Critical Decision Method (CDM) and Cued Recall. The Cognitive Task Analysis (CTA)-oriented study involved 34 students and researchers from three universities representing the three categories of British universities: the large research intensive universities, the smaller research-led universities, and the former polytechnics. Altogether we collected over 68 hours of video and audio. We sought to understand how scholars develop their information seeking strategies, how the current ERDS help or hinder them, and why users would rather use the more familiar search tools such as Google. The outcome of this work is being used to inform national strategies for policy and investment in ERDS in the UK.

The key findings from the study found: (i) users tended to use freely available Internet resources such as Google, Google Scholar, Wikipedia or YouTube because they are easier and quicker to use and most of all they always return results regardless of quality. Whereas library-subscribed resources are difficult and complex to use, have poor usability and they lack integration between many resources; (ii) library-subscribed databases have structures that hinder the information seeking process; (iii) that study participants very rarely applied only one search strategy but tended to carry out combined searches; and (iv) participants used a variety of methods to store materials they found useful. This is reported in detail elsewhere (Wong et al., 2009).

This paper focuses on describing the methods that were utilised to collect and analyse the data. In addition, it describes how the different methods were applied in order to triangulate the findings and illustrates how the users' search strategies were identified.

METHODS

In total, 34 volunteers studying or researching topics in business and economics were recruited. They represented undergraduate, postgraduate (typically PhD students) and expert researchers (typically post-docs) from the three categories of British universities mentioned above. There were altogether 16 female and 18 male participants, aged between 22–55 years. Participants were given pseudo-names (e.g. MP10, LP2, CP4) for reasons of anonymity. The study was carried out in two parts: Part A was the observation and think-aloud study, while Part B was the in-depth interview.

Part A Observation Study

In Part A, the observation study, the participants were asked to carry out three information search and retrieval tasks using the ERDS. These tasks were of increasing ambiguity, and thus of increasing difficulty. The tasks were administered in the same order: Task 1 to 3, easy to hard, and generally lasted an hour for each participant, and they are:

- *Task 1*: Product placement is defined as: 'the placement of goods or services in movies and television programs designed to increase brand awareness and brand usage'. Find a range of examples from film and television programs, which illustrate product placement 'in action'.

- *Task 2*: The appearance of destinations or locations in films is a form of product placement. There is evidence to suggest from tourism organizations across the world, that when audiences see locations in films they are inspired to visit them, so they can 'gaze upon the places where their heroes have been'. Find evidence of film tourism from a range of different film industries to illustrate the impact this may have had on tourism.
- *Task 3*: Imagine that you are the brand manager for a new range of mobile phones for Nokia; you are required to produce evidence to demonstrate how you might use the film/television medium as a way of reaching your target audience.

By asking the participants to 'think aloud', it helped to understand the participants actions, the reasoning behind it, the challenges and difficulties posed by using the ERDS, and some insight about the users feelings when interacting with the different ERDS. Their actions on the computer and voice utterances were recorded using a real-time screen capture software called iShowU HD (http://www.shinywhitebox.com).

Part B In-Depth Interview

In Part B of the study, the in-depth interviews using a combination of a modified Critical Decision Method (CDM), and the Cued Recall technique were carried out. In the Cued Recall method, participants are presented with selected segments of the screen recordings, used as a prompt to help the participant recall and direct their recall to the specific interaction at that point in time (Puff, 1982; Omodei et al, 2005). Cued Recall technique was useful in helping us further probe aspects of user interaction that we were uncertain of or did not fully understand. The CDM is a semi-structured, open-ended and retrospective interview technique that was originally designed to elicit expert knowledge and to understand the nature of expert decision making in naturalistic settings. The method used critical and memorable incidents as a catalyst and framework for the interview (Klein et al, 1989, Hoffman et al, 1998). As the nature of expertise is difficult to articulate, the interview probes, were designed based on a number of 'principles' that helped an interviewer draw out useful articulations of expertise. In other studies, the probes for different contexts were adapted, while maintaining their original elicitation purpose, e.g. for predicting the effectiveness of novel user interfaces (Wong, et al., 2009), identifying learning strategies (Wong, 2009), and for use in a self-administered questionnaire to identify analytical processes employed by fraud investigators (Attfield et al., 2010).

The CDM probes were re-designed so that the focus was on a specific 'information seeking process' that the participant experienced during the earlier observation and 'think aloud' session. Interviews were conducted immediately after the completion of each task. Users were asked to reflect on their experiences during the session. Using the probes, they were asked to elaborate on their considerations, assessments and actions, influences on their decisions about the resources used, how they developed search terms, difficulties experienced using these resources, as well as physical vs. virtual library services that they used.

Combining CTA Methods

CTA methods allow investigation of the nature of cognitive work. They can be used for discovering "information about the knowledge, through processes and goal structures that underline observable task performance" (Schraagen et al., 2000, p.3). CTA methods help to identify the knowledge, skills, processes, and decision making required to perform a task and inform the design controls and displays as well as how dynamic processes may be represented (Seamster, et al., 1997).

The combination of CTA methods enabled us to investigate information seeking behaviour using ERDS from different perspectives. However, users were often silent during the observation despite requests to 'think-aloud'. In our study, these observations were used as a recall cue for the subsequent in-depth interviews. Using this method the probability that 'think aloud' memory degradation would occur was reduced. Applying these CTA methods helped us overcome the limitations of individual methods. For example, the information discovered during observation sessions but not supported by 'think-aloud' was often revealed during the CDM interviews. In addition, showing parts of the recorded session (Cued Recall) further helped participants recall what they did and prompted them to explain why.

ANALYSIS USING EMERGENT THEMES APPROACH

For the analysis part of the study, the Emergent Themes Analysis (ETA) approach (Wong & Blandford, 2002) was utilised. ETA is a technique for rapid yet systematic and rigorous extraction of key themes from both the observation with 'think aloud' and interview data sets of individual participants. As with most qualitative research methods, the CDM provides a large volume of data, e.g. one hour of CDM interview can result in a transcript in excess of 15 pages. Analyzing data across many interviews can take substantial time and effort. In cases like this, the ETA approach can provide rapid approach to data analysis while still maintaining its rigour and validity. ETA is a top-down approach, which uses a concept distillation process to rapidly and systematically identify broad themes that are similar ideas and concepts reported across interviews and observations. The data can then be identified, indexed and collated. The themes emerge from the data strengthening the validity of the findings. Using the same procedure, the sub-themes or specific themes within the data are identified and further categorized and analysed.

The data from all 34 observations with 'think aloud' protocol and CDM (in-depth) interviews was transcribed. We started with the observation transcripts, which allowed us to identify the broad themes by indexing and collating the data at the concept level. The data was then further broken down and organized within each theme allowing for the concepts and the relationship between concepts to be discovered. The same strategy was applied for the interview data. All the details and supporting evidence for each theme was organized into different categories following the questions developed for the CDM interviews. Following the ETA approach, the themes and sub-themes were collated and analyzed across the different study groups of all three studied institutions.

In applying the ETA method, the popular resources that were chosen and what influenced these choices were identified. The choices were influenced by: the 'power' of bringing searches together, knowledge of the subject, prior knowledge and experience of resources, knowledge of strengths and limitations of the resources, user's perception of trust towards resources, and usability of resources. In addition, the study revealed different ways of finding information, searching strategies applied, changes in searching behaviours, methods of evaluating results, difficulties and challenges experienced when using resource discovery systems, means of storing information, and the role of physical libraries. Some of the searching behaviours identified were similar to Spencer's (2006) findings. Storage of information was consistent with the work of Jones et al (2002). The issues relating to how people search for information were in line with Pirolli and Card's (1999) concept of 'information foraging theory' and 'information scent'.

The study shows that the user groups used both 'internal' and 'external' resources. However they varied in popularity. The most popular 'internal' resources used included EBSCO, ProQuest, Library Catalogue, Factivia and Emerald. 'External' resources included Google, Google Scholar, Wikipedia and YouTube. It seems that the usage of those resources was dependent on users' experience. Experts and postgraduate students tend to use 'internal' resources more frequently. Undergraduate students preferred 'external' resources such as those that are freely available on the Internet: Google, Google Scholar, Wikipedia and YouTube.

Different ways of finding information were distinguished between the user groups. Some participants used Google, Wikipedia or YouTube as a starting point. Others began their search with the library catalogue looking for books as a source for gathering background information. The Undergraduate group was more inclined to use these resources. The Postgraduate group used Google Scholar to find relevant material and then check its availability in the library. An interesting finding was that participants used their personal/social networks, e.g. friends and colleagues, who helped in learning about a topic or identifying relevant keywords. More about broad themes is reported in detail elsewhere (Wong et al., 2009).

The ETA approach allowed us to discover that library-subscribed resources are complex and difficult to use hence they are more frequently used by Experts and Postgraduate students rather then Undergraduate groups. We also discovered that the use of physical libraries is very limited (e.g. find books, order material) and the primary role of librarians was found to be guiding users on how to use specific resources of their choice, rather then providing specific support in developing people's understanding of their own needs as reported by Theng (2002).

VISUALISING INFORMATION SEEKING ACTIVITIES

It was difficult to recognize patterns of interactions and the relationships between activities embedded in large volumes of transcripts. Rasmussen & Jensen (1973) converted data into a graphical column representation where coherent episodes were chunked allowing the patterns of actions and the relationship between them to be clearly seen (Figure 1).

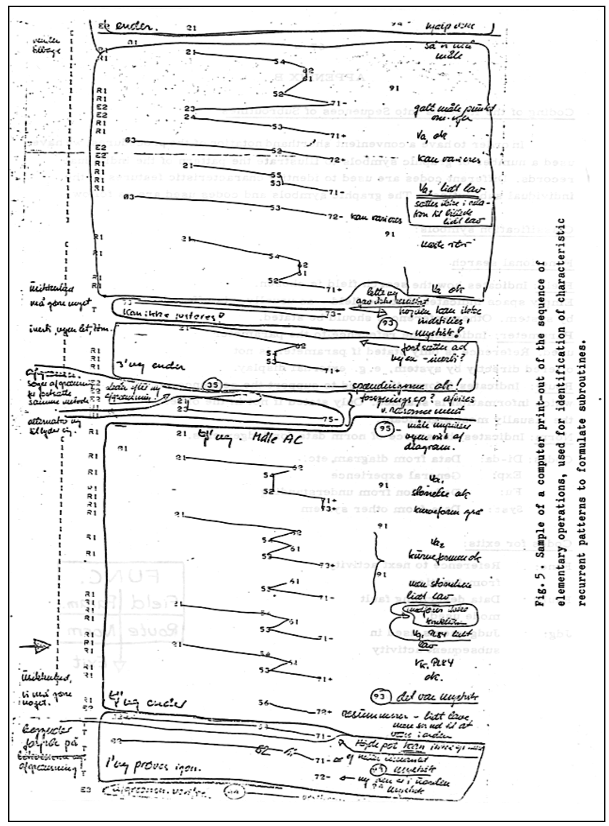
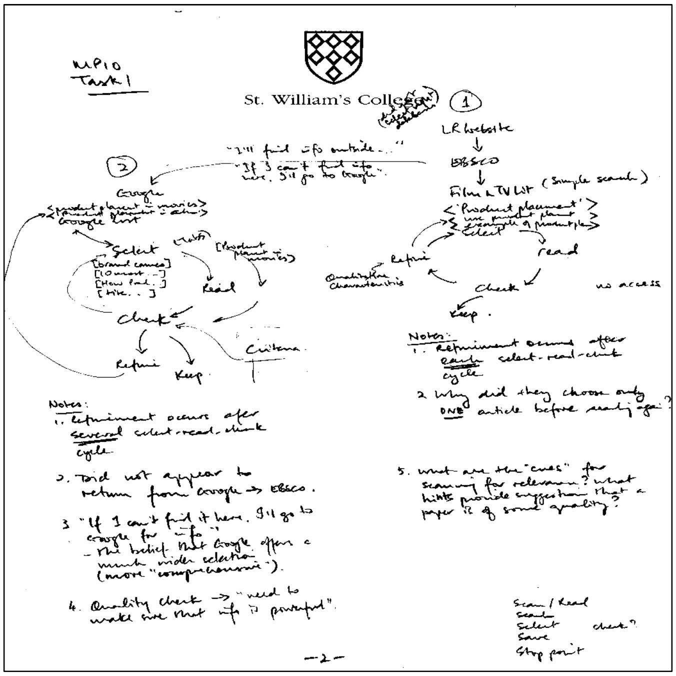


Figure 1. Diagnostic trajectories as identified by Rasmussen & Jensen (1973)

Procedure

Following Rasmussen & Jensen's (1973) approach, we started with extracting activities (step-by-step) of each user during their information seeking process and representing them graphically (Figure 2.1). Despite graphically depicting all the thinking and reasoning activities participants performed when searching and interacting with the technology, it was still very difficult and complex to identify the patterns in the information displayed. As each of the users performed between 3 and 20 searches for each given task we found that a horizontal representation of information seeking activities (against Rasmussen & Jensen (1973) column/vertical representation) would provide more clarity (see Figure 2.2). Figure 2.3 illustrates the final stage of the visual representation of information seeking activities.



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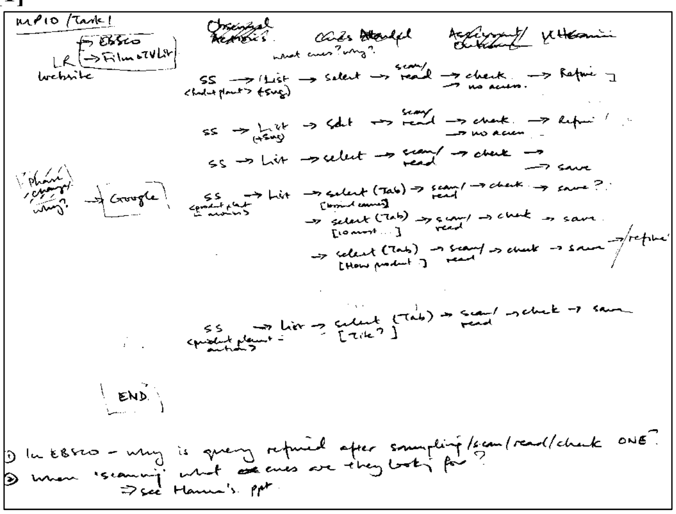

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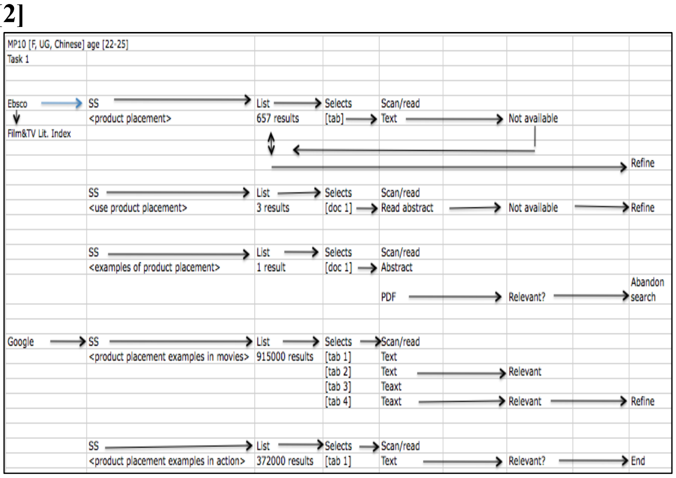

[3]

Figure 2. Evaluation of visual representation of information seeking activities for one of the users (MP10)

However, in order to make sense of the data displayed it was important to understand how the search and retrieval process was carried out. Each search consisted of a set of activities users performed for an individual search starting from selecting resources (e.g. Ebsco + Film & TV Literature Index), then viewing a list of results (List), selecting a document from the list and opening it in a new tab (Selects [tab]). The next step is working with individual documents by scanning or reading the text (e.g. Scan/read text). If the document is not available the user returns to the List and scrolls up and down ('double ended arrow') looking for a new document. The user then decides to Refine the search without selecting any other documents from the List (see Figure 3).

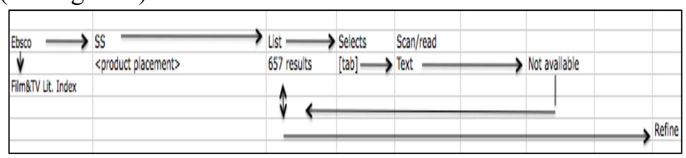

Figure 3. MP10: set of activities within one search

Users performed different searches that were represented symbolically (e.g. SS - Simple Search, LS – Link Search). The arrows were applied to indicate the flow of search activities. The 'horizontal arrow' indicates the sequence of user action while 'vertical arrows' point to the resources that were selected. Each search session ends (End) when the user decides to terminate it (see Figure 4). For each participant, each of the three tasks was similarly graphed, allowing us to identify search patterns as well as the process participants took when looking for scholarly material.

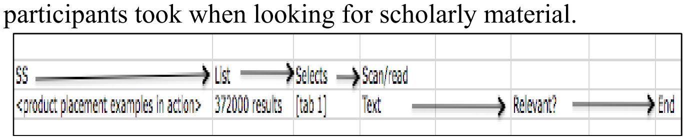

Figure 4 MP10: 'End of the session

Results

Using this method, a set of activities was identified that illustrated a user information search and retrieval process in resource discovery systems. Users start with **Initiate** where they begin the process with identifying the keywords and resources. Users applied their prior knowledge and experience before deciding on the choices of resources, keywords and the ways or strategies to approach a topic. Then they **Search** using various search functions (e.g. Simple Search, Advanced Search, Link Search), the choice of which was determined by users level of information literacy, background, domain knowledge, and their understanding of the task requirements. Each search returned a **List** of results, which is **Evaluated**. Based on the outcome of the evaluation users continued with different activities: (i) **Refine & reformulate** their search by adding, subtracting, changing, or even swapping the sequence of search terms; (ii) **Select & review** individual material for further evaluation; (iii) **Store** when material is relevant; (iv) **Abandon** the search or resource in the case when the search has not returned relevant information. Alternatively, they go back to the **List** and look for another document; and finally users (iv) C**hange the resource** when they *'hit the wall'* **-** when they exhausted all the possibilities, or *'Phase shift'*- when they change resources.

It was also discovered that the studied groups very rarely used only one search strategy (e.g. Simple Search) but changed their strategy during the information seeking process depending on the results returned. Twelve different searches were identified but not all of these searches were used with the same level of frequency. For instance: the 'Link Search' was used most frequently by the PG group and less frequently by Experts and the UG group, whereas 'Advanced Search' was used most frequently by Experts and less by the UG and by the PG group. Users were found to carry out combinations of searches. We call these 'search clusters'. For instance: re-formulated searches where terms or concepts extracted from a document were used to pursue a new search were often combined with a link search that gave the opportunity to follow hyper-links and extract new queries that were used as an input for the search terms in multiple fields. Search clusters are explained elsewhere (Wong et al., 2009).

DISCUSSION AND CONCLUSION

Understanding people's information seeking activities, which are often very complex, the reasoning behind these activities, and the processes taken when searching for material, is a very challenging task. Applying a combination of CTA data gathering methods can reduce the limitations of using individual methods. Observations with 'think aloud' and CDM interviews applied in this study provided complementary insights. Observations enabled us to identify what people did when searching for academic material whereas the CDM interviews provided opportunities to confirm (or disconfirm), clarify, and extend the insights drawn from the observations. Both methods – observations with 'think aloud' and interviews – provide voluminous qualitative data that are complex to analyse. One solution to this problem is using the ETA approach. Based on our experience, we suggest that: (i) it complements the exploratory nature of CDM, (ii) it allows the themes and concepts to emerge first and then use them to direct further exploration, (iii) it is systematic and rigorous allowing the theory to emerge from the data rather then have pre-conceived ideas or hypothesis, (v) it provides the feeling of knowing what the data offers from the early stage of the analysis. The visual representation of information seeking activities developed from the transcripts of observations with 'think aloud' provided a neat and schematic way to represent step-by-step what users did when searching for scholarly materials. This novel way of data representation allowed us to identify the patterns of activities users follow and the relationship between them when using various ERDS.

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