# **Evaluation of User Satisfaction with Digital Library Interfaces**

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*Abstract:* - Digital Libraries are one of the most common web services for information seeking. Their main advantage is also their main disadvantages: digital libraries are designed with a global approach for everyone which implies that all users are presented with the same interface. Previous studies have proved to help users search information by matching the interface to their preferences. In this context, it is essential to study the degree of satisfaction of digital libraries users with the interface and functionalities provided by a digital library. We present a study of the degree of satisfaction of Brunel Library catalogue users according to three parameters: (1) Cognitive Style, (2) Gender and (3) Level of Expertise. The results from this study provide the guidance to identify which areas of a digital library interface need to be improved and for which users.

Key-Words: - Digital Libraries, User Satisfaction, Cognitive Styles

## **1** Introduction

Digital Libraries (DLs) are collections of information that have associated services delivered to user communities using a variety of technologies [1]. The collections of information can be scientific, business or personal data and can be represented as a digital text, image, audio, video or other media. Due to the amount and great variety of information stored by DLs, they have become, with search engines in general, one of the major web services [3], which are faced by a diverse population of users who have heterogeneous background, skills, and preferences. Considering how the interfaces of DLs can support different users to accomplish their tasks is important. As suggested by previous studies in information seeking [4][5], matching the interface with users' preferences can help them to achieve their tasks in a satisfactory way. Nevertheless, in general, DLs have a global approach in which all users are presented with the same interface, regardless the diversity of users' preferences.

In order to be able to tailor a DL interface to each individual user, it is first necessary to study the degree of satisfaction of different individuals with a DL, i.e. to study if it is easy to learn and to use, and if it is flexible enough. This study should highlight if users are satisfied with the DL as it stands and which areas and functionalities need improvement. Although this study can be done using a global perspective, it is also more interesting to identify how different individual differences are relevant for DL user satisfaction. In this respect we have focused in three main human factors: (1) cognitive styles, (2) gender and (3) level of expertise. This paper presents a study of the degree of satisfaction of digital library users using (1) a global perspective and (2) an individual perspective using the aforementioned three human factors. The conclusions of the paper will present which functionalities and which users face more problems, in order to appropriately tailor the DL interface to each individual.

The paper is organized as follows: first we present the human factors used for the study. Second we present the experiment design, including the tools used, the users that took part in the experiments and how data was collected. The third section analyse and presents the results. The last section details the conclusions and future work.

## 2 Human Factors

Among all human factors, our study focuses on cognitive styles [23], gender [24], and level of expertise [22], because previous research indicate that these three factors have significant effects on users' interaction with web-based applications in general and DL in particular.

### 2.1 Cognitive Styles

A cognitive style (CS) can be defined as an individual's preferred and habitual approach to organizing and representing information [6]. Cognitive style is a personality dimension, which influences the way individuals collect, analyze, evaluate, and interpret information [7]. There are a variety of dimensions of cognitive styles, but among these dimensions, Field Dependence versus Field Independence has significant impacts on users'

information seeking [8]. Their different characteristics are:

- Field Dependence (FD): Field Dependent individuals typically see the global picture, ignore the details, and approach a task more holistically. Also they have a more social orientation than Field Independent persons since they are more likely to make use of external social frameworks.

- Field Independence (FI): Field Independent individuals tend to focus on details, and to be more serialistic in their approach to learning. These individuals tend to exhibit more individualistic behaviors since they are not in need of external referents to aide in the processing of information.

This approach also defines Intermediate users as the ones that present an intermediate behavior between the two previous cases. Results from different studies suggest that different cognitive style groups prefer and favor different interface functionalities and structures provided by web-based applications [9][10][11][12][13].

### 2.2 Gender & Level of Expertise

Gender and Level of Expertise are two typical human factors used to study individual characteristics in human-computer interaction (HCI). Different studies have already used gender as a study factor, concluding that female users have more problems when interacting with the web [24]. Level of expertise is a very interesting variable because it can highlight how the level of satisfaction and problems of a user evolve in time [22]. Some studies have already focus on implementing specialized services for DL according to different degrees of expertise [20][21]. We have classified the



FIG. 1. Basic Search Interface of BLC.

level of expertise of a user in: (1) Never used the system, (2) Novice, (3) Medium and (4) Expert. The assignation of a user to a group is done by the user according to his/her own perception of his/her expertise.

## **3** Experiment Design

This section describes the characteristics of the experiments that were designed to evaluate user satisfaction. The following subsections present the characteristics of the participants, the research instruments used, including the DL in which this study focuses, the tasks designed and data collection techniques used.

### 3.1 Participants

The study was conducted at Brunel University's Department of Information Systems and Computing. A total of 54 students participated in this study. All participants had the basic computing and Internet skills necessary to use library catalogues. The classification of users according to the human factors of the study is the following: (1) if we consider CS: 21 FI, 24 Intermediate and 9 FD, (2) if we consider level of expertise: 3 users have never used the system, 12 are novice, 21 are medium and 18 are expert.

### **3.2 Research Instruments**

The research instruments used include: (1) Cognitive Style Analysis (CSA) to measure participants' cognitive styles, (2) a digital library catalogue, Brunel Library catalogue, which is the focus of the study, and (3) a standard questionnaire to evaluate user satisfaction.

#### **Cognitive Styles Analysis**

A number of techniques have been developed to measure Field Dependence/Field Independence, and among those we have chosen the Cognitive Styles Analysis (CSA) [14]. The CSA test includes two sub-tests: (1) the first one presents items containing pairs of complex geometrical figures that the individual is required to judge as either the same or different and (2) the second sub-test presents several items each comprising a simple geometrical shape, such as a square or a triangle, and a complex geometrical figure and the individual is asked to indicate whether or not the simple shape is contained in a complex one by pressing one of two marked response keys. The output of the test is the cognitive style of a user: Field Dependent, Field Independent or Intermediate.



FIG. 2. Advanced Search Interface of BLC.

#### **Brunel Library Catalogue**

Brunel Library Catalogue (BLC) [15] is a typical digital library to access the bibliographical resources of Brunel University. BLC has two main mechanisms that provide different strategies for finding information: (1) Basic Search (Figure 1), which is the one presented by default by the system, and (2) Advanced Search (Figure 2) which is accessed through the corresponding link presented in Figure 3. Basic Search allows to run a quick search of the library catalogue using a set of keywords and one of the following commands: "word or phrase", "author" "title" or "periodical title". Advanced Search, as presented in Figure 2, presents the user with a much broader way of searching information. The user can give value to each field (a generic word, author, title, subject etc.), and combine this words using and/or Boolean

arcl	h Results	
	"Hugh Vincent" search	found 2 titles.
1	QA76.73.338¥56	2002 000 000
Detai	Java : a graphical approach / Hugh Vincent Vincent, Hugh.	
Mari	1 copy available at Uxbridge in SHELVES	<b>a b</b>
		Summary + Contents
2	JN1129.L45E48	1973
Detai	Liberals, radicals and social politics, 1892-191- Emy, Hugh Vincent.	4 / (by) H.V. Emy
Mari	6 copies available at Uxbridge	
iearc	h Again	
iearc	h Again Search for: Hugh Vincent	library: All Libraries 💌
iearc	h Again Search for: Hugh Vincent words or phrase author	library: Al Libraries 💌
iearc	h Again Search for: Hugh Vincent words or phrase author language: [NYY]	Hbrary: All Libraries V title periodical title
iearc	h Again Search for: Hugh Vincent words or phrase author Ianguage: [ANY] format: [ANY]	Hbrary: All Libranes I
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FIG.3. Result Interface of BLC.

operators. The system also allows to select other information like the library, the language, the publication year etc.

Once a user submits a query to the system using the Basic Search or the Advance Search, the system responds with the items found in the database. An example of the interface presented is given in Figure 4. The system presents a set of buttons in the top part: "Go Back", "Limit Search", "New Search", "Backward", "Forward", "Prefs" and "Exit". The "Limit Search" option is a link to the bottom of the page where the search mechanism used (Basic Search or Advanced Search) is presented with the terms used and a set of options for Search Limits (language, publication year, etc.). The limit search is obtained adding more words to the set of terms already introduced. The "New Search" option presents again the interface of Figure 1. The "Backward/Forward" buttons allow to move up and

TABLE 1. Some questions contained in Q	UIS.
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Question	Question	Area
1	The interface is: terrible $(0)$ – wonderful $(9)$	Overall reaction to the software
2	The interface is: Difficult $(0)$ – Easy $(9)$	Overall reaction to the software
4	The interface has: Inadequate Power $(0)$ – Adequate Power $(9)$	Overall reaction to the software
6	The system is: Rigid $(0)$ – Flexible $(9)$	Overall reaction to the software
17	Learning to operate the system is: Difficult $(0)$ – Easy $(9)$	Learning
18	Exploring new features by trial an error is: Difficult $(0)$ – Easy $(9)$	Learning
27	The system is designed for all level of users: Never $(0)$ – Always $(9)$	System Capabilities

TABLE 2. Set of tasks designed for the experiment and their type.

	Task	Туре
1	Find the Call Number of the book "The Man in the High Castle" by Philip Kendred Dick.	Search
2	Find the title of any book related with applications of fuzzy logic.	Browse
3	Find the number of books written by Aldous Huxley that are part of TWICKENHAM Library	Search-Browse
4	Find a book about how to implement data mining with Java.	Browse
5	Find a Java book written by Hugh Vincent.	Search
6	Find a book about 20 <sup>th</sup> century American Drama in TWICKENHAM campus.	Browse
7	Please find an IEEE journal on consumer electronics.	Search

down the items found.

#### **Satisfaction Questionnaire**

OUIS (Questionnaire for **USER** Interface Satisfaction) [16][17] is a tool designed to assess users' subjective satisfaction with specific aspects of the human-computer interface. Although QUIS is a very complete questionnaire, for the purpose of this study we are going to use a summarized QUIS test available on-line. In this version of the questionnaire is divided in five sections (Overall reaction to the software, Screen, Terminology and System Information, Learning and System Capabilities) with a total of 27 questions. Each area measures the users' overall satisfaction with that facet of the interface, as well as the factors that make up that facet, on a 10point scale. In order to focus on the research question of this study (i.e., which is the degree of satisfaction of users with a DL interface), we are going to focus on questions 1, 2, 4, 6, 17, 18 and 27. Table 1 presents these questions and the area in which they are included.

### 3.3 Task Design

The purpose of this experiments is to force the users to use all the possible functionalities of BLC interface in order to have an accurate opinion about his/her satisfaction. The main behaviors that a user that access a web library catalogue has two: browsing and searching [18]. In this context, browsing is defined as the search of and ill-defined information while searching is defined as the localization concrete well-defined of а information[19]. Participants were asked to perform a set of seven practical tasks presented in Table 2. The design of the task was interface dependent: the set of tasks was designed to involve all the functionalities that BLC provides to each user and the different behaviors (search & browse) that a user can show.

### 3.4 Procedure

The experiment was conducted using BLC. The experiment comprised the following steps:

(1) Participants were given a task sheet, which described the task activities that they needed to complete with BLC. One participant carried out the experiment at a time.

(2) The CSA was used to classify participants' cognitive styles into FD, Intermediate, or FD. Users introduced his/her gender and his/her level of expertise.

(3) Participants were observed while they were carrying out the tasks, and clarifications were given when requested.

(4) Users answered QUIS on-line, and the answers were stored.

### 3.5 Data Analysis

The data collected from the experiments was coded for analysis using the Statistical Package for Social Sciences (SPSS). The independent variables were three human factors examined in this study, i.e. cognitive styles, gender, and the level of expertise. The dependent variables were the 27 answers to the QUIS questionnaire and the independent variables were gender, degree of expertise and cognitive styles. We were seeking findings related to the satisfaction needed to analyze the dependent variables against the independent variables.

	Question 1	Question 2	Question 4	Question 6	Question 17	Question 18	Question 27
Mean	5.23	6.63	5.13	4.87	6.43	5.67	5.27
Std. Deviation	2.300	1.903	2.417	2.300	2.161	2.591	2.518

Cognitive Style		Question 1	Question 2	Question 4	Question 6	Question 17	Question 18	Question 27
Field	Mean	5.00	6.63	4.94	4.75	6.31	5.50	5.25
independent	Std. Deviation	2.852	2.125	2.620	2.745	2.549	2.582	3.044
Intermediate	Mean	5.56	7.00	5.89	5.22	6.22	5.22	5.44
	Std. Deviation	.882	1.323	1.764	1.641	1.394	2.728	1.667
Field	Mean	5.40	6.00	4.40	4.60	7.20	7.00	5.00
Dependet	Std. Deviation	2.408	2.236	2.881	2.074	2.168	2.449	2.345

Gender		Question 1	Question 2	Question 4	Question 6	Question 17	Question 18	Question 27
male	Mean	5.59	6.94	5.59	5.12	6.94	6.76	5.59
	Std. Deviation	2.425	1.560	2.425	1.965	1.391	1.480	2.399
female	Mean	4.77	6.23	4.54	4.54	5.77	4.23	4.85
	Std. Deviation	2.127	2.279	2.367	2.727	2.803	3.059	2.703

TABLE 5. Mean and Standard deviation for the selected questions and gender as independent variable.

TABLE 6. Mean and Standard deviation for the selected questions and level of expertise as independent variable.

Brunel Experience		Question 1	Question 2	Question 4	Question 6	Question 17	Question 18	Question 27
Never used the	Mean	4.40	5.40	5.00	4.60	6.40	6.20	6.60
system	Std. Deviation	1.949	2.302	2.121	1.949	2.074	1.924	.548
Novice	Mean	7.00	8.50	3.00	2.50	7.00	4.00	2.50
	Std. Deviation	.000	.707	5.657	4.950	2.828	2.828	4.950
Medium	Mean	5.38	6.88	5.75	5.31	6.88	5.88	5.50
	Std. Deviation	2.729	1.784	2.113	2.182	1.628	2.553	2.221
Expert	Mean	5.00	6.43	4.43	4.71	5.29	5.29	4.57
	Std. Deviation	1.633	1.813	2.370	2.138	3.094	3.302	3.047

## 4. Results and Discussion

Table 3 presents the global mean and standard deviation for the selected questions, Table 4, Table 5 and Table 6 presents the same values grouped by cognitive styles, gender and degree of expertise respectively.

In general, as shown in Table 3, we can appreciate that users have a neutral opinion about the interface (5.23 in Question 1), that they think that BLC is an easy interface to deal with (6.63 in Question 2) and that it is easy to learn to operate with it (6.43 in Question 17). Users also find BLC interface a little bit rigid (4.87 in Question 6). Also in all those questions users present a wide range of opinions as showed by the standard deviation (*std*), always in the range of 2, which indicates that a group of users may arise more important differences.

From a cognitive style perspective, we can see some differences among three cognitive style groups. First, Intermediate users are more satisfied with the interface than FD or FI (Question 1), and also, by comparing the standard deviation, we can see that there is a more standard opinion among Intermediate users (with std of 0.882), than among FD and FI were the std is around 2. Intermediate users also find that the system is more flexible than FD and FI (Question 6) and that it has an adequate power (Question 4). Regarding how simple is to use the system (Question 17) and how difficult is to learn to use it (Question 18), FD users find BLC easier to operate and to learn than FI and Intermediate users. Globally we can conclude that while no CS is really

satisfied with the interface as it stands, Intermediate users are more satisfied with the power and flexibility, while FD and FI user will desire more functionalities to improve the satisfaction level. Among those extra functionalities mechanisms to learn to operate the system and that add flexibility can help.

From a gender perspective (Table 5), we found that female users find it harder to learn to operate and explore the system than male users (Questions 17 and 18). In general, female users are less satisfied in all aspects with the interface, being one of the reasons the lack of learning elements.

Regarding the level of expertise, the results indicated that the higher the level of expertise of the user the lower the degree of satisfaction is (Questions 1 and 2). This can be caused because expert users expect extra services that novice users are actually quite happy to avoid. It is noticeable that novice users find the system extremely rigid (2.5 in Question 6), and that it has an inadequate power (3.0 in Question 7), while at the same time they are pretty satisfied with the interface as it stands (7.0 and 8.5 in Questions 1 and 2) compared with medium and expert users that have milder opinions (around 5.0 in all cases). Such differences between novices and experts may be due to the fact that novice users do not have a global picture of the interface.

### Conclusions

Digital libraries are one of important applications for information Seeking. Considering that the interface of digital libraries deeply affect how users find information, in this paper we have detailed a study of the degree of satisfaction of digital library users using a interface as the one provided by BLC. Our goal was to investigate the following questions: are users satisfied with the interface as it stands? If not, what tools can be needed and which users actually need those new tools?. We have proposed a study examining three human factors: (1) cognitive styles, (2) gender and (3) levels of expertise. Our results show that there is not a specific type of user that is actually satisfied with the interface, which implies that in general there is room in all cases to improve it. A more deep study shows that from a CS perspective, Intermediate users are satisfied with the interface, but that FD and FI users need some improvement, especially for helping to operate the system. This is also true from a gender approach, where females are more dissatisfied than males, mainly because of the lack of help. From a level of expertise perspective we found that an increase in expertise implies a decrease in user satisfaction. In our future work we plan to study how these results can be used to develop a personalized interface for DL.

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