An Empirical Study of Individual Differences in Digital Library Interfaces

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Abstract: - Individual differences play an important role in the way users develop different strategies for information seeking. Nevertheless, in general, the different information seeking environments do not consider these individual differences in their interface and functionalities. Previous studies have proven the importance of matching the interface with individual user preferences. Among the different environments for information seeking, digital Libraries are one of the most common ones. In this context, in order to provide an efficient service, it is essential to study how individual differences affect the interaction between users and the interface and functionalities provided by digital libraries. We present a study using Brunel Library catalogue as environment and according to three individual differences: (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, Individual Differences, 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]. Considering the importance of DLs, the amount of information that they can provide and the different formats of the information, the interface of a DL and the functionalities it provides are of crucial importance for allowing users to accomplish their tasks. Different studies in information seeking have shown that matching the interface with users' preferences can help them to achieve their task in a satisfactory way [4][5]. Nevertheless, in general, DLs have a global approach in which all users are presented with the same interface, regardless the diversity of users in terms of preferences or skills.

In order to be able to tailor a DL interface to each individual user, it is first necessary to study how individual differences affect the interaction between users and a DL, i.e. to study if it is easy to learn and to use, and if it is flexible enough for the different users that interact with theDL. 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 how individual differences affect the degree of satisfaction and the problems 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 analyzes 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 and Imager versus Verbalizer have significant impacts on users' information seeking [8].

2.1.1 Field Dependent Vs. Field Independent

The concept of Field Dependence originated in laboratory studies on perception by Witkin and Asch [25] [26]. Field Dependence describes the degree to which a user's perception or comprehension of information is affected by the surrounding perceptual or contextual field, that is, "the extent to which the organization of the prevailing field dominates perception of any of its parts" [26]. The distinction between Field Dependent and Field Independent individuals is similar to that differentiating Wholistic and Analytic [27][28]. 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 dimension 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]. In general FD users tend to feel lost in hyperspace easily [35] and prefer a guided approach to the system [36].

2.1.2 Imager Vs. Verbalizer.

The dimension of Verbalizer vs. Imager has been defined as the tendency for individuals to represent information being processed in the form of text or in the form of images [28]. Their different characteristics are:

- Imagers (I): Imagers tend to be internal and passive. In addition, imagers use diagrams more often than verbalizers to illustrate their ideas. Imagers perform better if the environment presents text and also pictorial material such as pictures, diagrams, charts, and graphs [29].
- Verbalizers (V): Verbalizers tend to be external and stimulating. Verbalizer individuals perform better if the environment presents only information in the form of text.

This dimension also defines bimodal individuals as the ones that can represent and process information equally well both in the form of text and images. There are a variety of studies that highlight the relevance of the V/I dimension with how the users interact with a web-based application [24][30]. These studies usually link imager individuals with poor retrieval success in information seeking environments.

2.1.3 Combination of FD/FI and V/I dimensions

Riding and Rayner [6] combined both dimensions to create nine families. Each combination of FD/FI and V/I dimension is called a cognitive style (CS). The nine CS are: (1) Field Independent-Verbalizer, (2) Field Independent-Bimodal, (3) Field Independent-Imager, (4) Intermediate-Verbalizer, (5) Intermadiate-Bimodal, (6) Intermediate-Imager, (7) Field Dependent-Verbalizer, (8) Field Dependent-Bimodal, and (9) Field Dependent-Imager. Each one of these five types of cognitive styles combines the behaviour characteristics of each one of its dimensions. This approach has the advantage of clustering users into highly defined types, which allows to identify clear behaviours.

2.2 Gender

Gender is a typical human factor 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][31][32]. In general, females get lost more easily and find more difficult to find information on-line than males.

2.3 Level of Expertise

Level of Expertise is also a very typical human factor used to study individual characteristics in human-computer interaction (HCI). Level of

expertise is a very interesting variable because it can highlight how the level of satisfaction and problems of a user evolve over 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 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.

There are already in the literature studies that highlight the relevance of level of expertise for web interaction and information seeking [33][34]. In general individuals with higher levels of expertise require less time to search information, needing fewer interactions and producing more correct responses.

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 FD/FI dimension of CS: 21 FI, 24 Intermediate and 9 FD, (2) If we consider the V/I dimension of CS: 20 imager, 22 Bimodal and 12 Verbalizer, (3) if we consider the nine CS combinations, and following the same order in which they were presented in the previous section: 9, 9, 3, 9, 8, 7, 2 ,5 ,2, (4) if we consider gender: 29 male and 25 female and (5) 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.

3.2.1 Cognitive Styles Analysis

A number of techniques have been developed to measure Field Dependence/Field Independence (FD/FI) and Verbalizer/Imager (V/I) dimensions, and, among those, we have chosen the Cognitive Styles Analysis (CSA) [14]. The CSA test includes three sub-tests: (1) the first one is based on classifying items within classes using just textual representation, (2) the second one presents items containing pairs of complex geometrical figures that the individual is required to judge as either the same or different and (3) the third 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. There are 48 statements in total covering the three subtests. Each type of statement has an equal number of true statements and false statements.

These three sub-tests have different purposes. The second sub-test is a task requiring FD capacity, while the third sub-test requires the disembedding capacity associated with FI. This provides a big advantage with other methods that only measure one of the factors. Regarding V/I dimensions, it is assumed that Visualizers respond more quickly to the appearance statements (second and third subtests), because the objects can be readily represented as mental pictures and the information for the comparison can be obtained directly and rapidly from these images. In the case of the conceptual category items (first subtest), it is assumed that Verbalizers have a shorter response time because the semantic conceptual category membership is verbally abstract in nature and cannot be represented in visual form. The computer records the response time to each statement and calculates the V/I Ratio.

The CSA measures what the authors refer to as a FD/FI dimension (WA ratio) and the V/I dimension (VI ratio). Both ratios are real numbers that are used to identify each dimension. For the FD/DI dimension, the recommendations is that WA scores below 1.03 denote Field Dependent individuals; scores of 1.36 and above denote Field Independent individuals; and scores between 1.03 and 1.35 are classified as Intermediate. For the V/I dimensions the recommendation is that VI ratios below 0.98 denote Verbalizer individuals; scores of 1.09 and above imager individuals; and scores between 0.98 and 1.09 bimodal individuals.

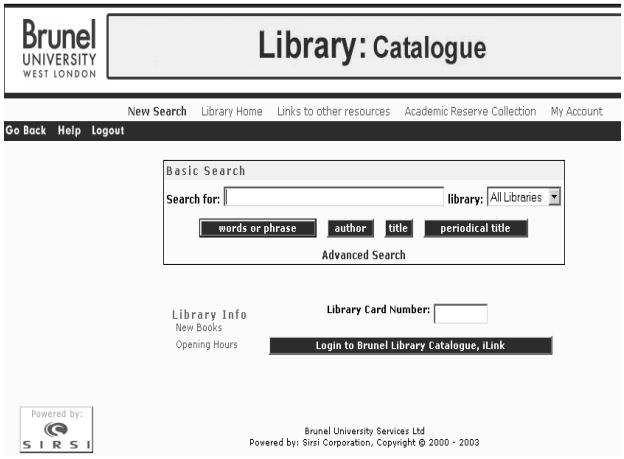

FIG. 1. Basic Search Interface of BLC.

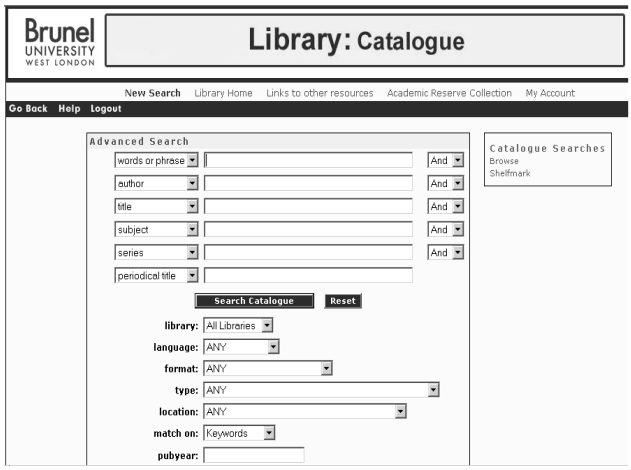

FIG. 2. Advanced Search Interface of BLC.

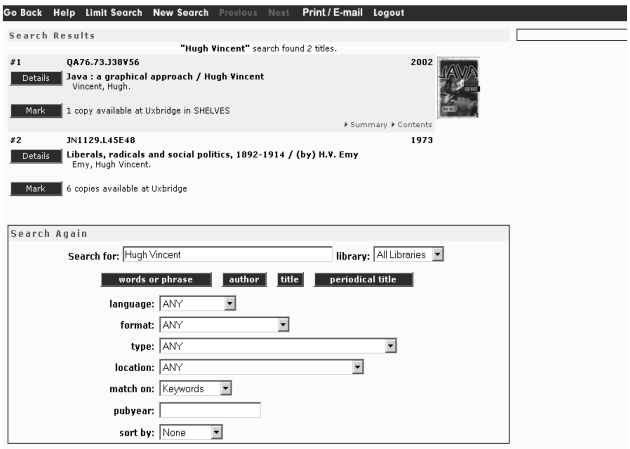

FIG.3. Multiple Result Interface of BLC.

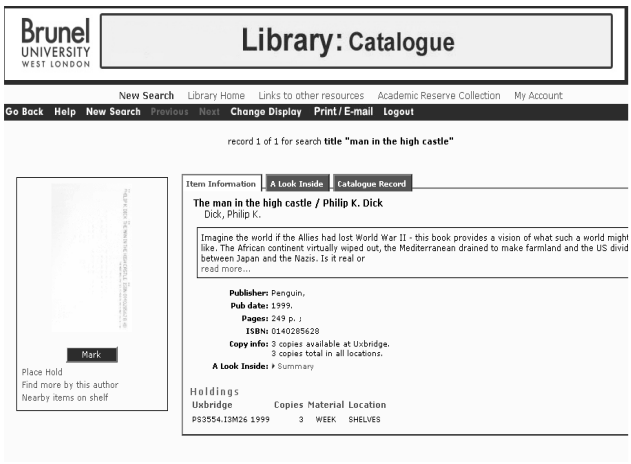

FIG.4. Single Result Interface of BLC.

3.2.2 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 1. 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 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 3. 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 down the items found. Once an element of the list is selected, the interface presents all the information available for that item, as presented in Figure 4.

3.2.3 Satisfaction Questionnaire

Questionnaire for User Interface Satisfaction (QUIS) [16][17] is a tool designed to assess users' subjective satisfaction with specific aspects of the human-computer interface. Although QUIS is a very

TABLE 1. Some questions contained in QUIS.

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	Type
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 20th century American Drama in TWICKENHAM campus.	Browse
7	Please find an IEEE journal on consumer electronics.	Search

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 10-point 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 experiment 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 accesses 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 of specific well-defined 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 and 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 and Verbalizer, Bimodal or Imager. 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 centrally.

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.

4. Results and Discussion

Table 3 presents the global mean and standard deviation for the selected questions, Table 4, Table 5, Table 6, Table 7 and Table 8 presents the same values grouped by FD/FI dimension, Imager/Verbalizer dimension, the nine CS families, 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.

Considering the FD/FI dimension, we can see some differences among three groups. First, Intermediate and FD users are more satisfied with the interface than FI users (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 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 (Questions 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 dimension is really satisfied with the interface as it stands, Intermediate and FD users are more satisfied with the power and flexibility, while FI users 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. The fact that FD users are more satisfied with the interface than FI user is probably motivated because, being the interface as simple as it is, FD user avoid the problem of feeling lost [35], and feel like the system is guiding them [36]. Those are the same reasons why FI users are less satisfied.

Regarding the V/I dimension (Table 5), in

TABLE 3. Mean and Standard deviation for the selected questions and cognitive style as independent variable.

	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

TABLE 4. Mean and Standard deviation for the selected questions and FD/FI as independent variable.

FD/FI		Question 1	Question 2	Question 4	Question 6	Question 17	Question 18	Question 27
Field Independent	Mean	5.00	6.63	4.94	4.75	6.31	5.50	5.25
	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 Dependet	Mean	5.40	6.00	4.40	4.60	7.20	7.00	5.00
	Std. Deviation	2.408	2.236	2.881	2.074	2.168	2.449	2.345

TABLE 5. Mean and Standard deviation for the selected questions and Verbalizer/Imager as independent variable.

Visualizer/Verbalizer		Question 1	Question 2	Question 4	Question 6	Question 17	Question 18	Question 27
Imager	Mean	4.57	5.79	4.21	3.71	6.14	4.79	4.64
	Std. Deviation	2.174	2.259	2.723	2.431	1.875	2.636	2.649
Bimodal	Mean	5.80	7.30	5.80	5.50	7.30	7.00	5.60
	Std. Deviation	2.860	1.337	2.201	1.958	1.337	1.333	2.836
Verbalizer	Mean	5.83	7.50	6.17	6.50	5.67	5.50	6.17
	Std. Deviation	1.169	.837	1.169	.837	3.502	3.450	1.329

TABLE 6. Mean and Standard deviation for the selected questions and each family of cognitive styles.

FD/FI	Imager/Verbalizer		Question 1	Question 2	Question 4	Question 6	Question 17	Question 18	Question 27
Field Independent	Imager	Mean	4.40	5.40	3.80	3.50	6.50	5.60	4.90
		Std. Deviation	2.221	2.366	2.821	2.550	1.780	2.119	2.767
	Bimodal	Mean	5.13	7.50	5.50	5.38	7.13	6.38	4.87
		Std. Deviation	3.523	1.195	2.390	2.560	1.356	1.923	3.182
	Verbalizer	Mean	5.33	7.00	5.67	6.33	4.33	4.00	6.00
		Std. Deviation	.577	.000	1.155	1.155	4.619	4.359	1.732
Intermediate	Imager	Mean	5.70	7.10	4.30	4.70	6.30	5.30	5.30
		Std. Deviation	1.337	1.595	3.433	2.908	1.703	3.057	1.636
	Bimodal	Mean	5.38	6.88	5.75	4.50	7.50	4.25	6.00
		Std. Deviation	1.408	1.808	1.488	2.878	1.414	3.327	3.024
	Verbalizer	Mean	4.71	7.00	5.29	4.86	6.14	6.14	5.57
		Std. Deviation	1.704	1.155	2.138	2.035	.690	.900	.976
Field Dependent	Imager	Mean	2.00	3.00	.00	2.00	4.00	3.00	2.00
		Std. Deviation	2.221	2.366	2.821	2.550	1.780	2.119	2.767
	Bimodal	Mean	5.33	6.00	5.33	4.50	7.33	7.33	5.50
		Std. Deviation	1.633	.894	1.862	1.378	1.633	1.506	1.517
	Verbalizer	Mean	8.00	9.00	6.00	7.00	9.00	9.00	7.00
		Std. Deviation	1.337	1.595	3.433	2.908	1.703	3.057	1.636

TABLE 7. Mean and Standard deviation for the selected questions and gender as independent variable.

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 8. 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 system	Mean	4.40	5.40	5.00	4.60	6.40	6.20	6.60
	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

general in can be said that Verbalizers are far more satisfied with the interface than Imagers (Questions 1, 2, and 4). This is probably caused because the interface does not have any relevant presentation of the information in the form of images. One of the main differences between both dimensions is that Imagers see the system as far more rigid than Verbalizers (Question 6, 6.50 compared to 3.71). Again, this difference is caused because BLC has mainly a textual interface.

Considering the nine CS families, the results of each independent dimension is also reflected in

Table 6. The CS more satisfied is the Field Dependent-Verbalizer, which basically finds that the interface, as it stands, provides them with what is needed to find information. On the other side, the combination of Field Dependent-Imager has the worst opinion of the interface, having problems with lack of flexibility and with how to operate and learn the system. In general, any combination that implies an Imager user has worst opinions and more problems that its Verbalizer counterpart. The rest of CS stand more or less in the middle, in general not being satisfied with the interface as it stands but being able to use it to find information.

From a gender perspective (Table 7), we found that female users felt it was 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. This is in accordance which other studies that show that females have more problems when interacting with the web [31][32].

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 is probably 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).

5. Conclusions

Digital libraries are one of the most important applications for information seeking. Considering that the interface of digital libraries deeply affects how users find information, in this paper we have detailed a study of the degree of satisfaction of digital library users using an interface as the one provided by BLC. Our goal was to investigate how individual inferences affect the interaction between users and Brunel Library Catalogue. 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 a specific type of user, Field Dependent – Verbalizer, which is satisfied with the interface, but for the rest of users, no one 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 FD/FI dimension, Intermediate and FD users are satisfied with the interface, but 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 general, BLC would benefit from: (1) a presentation with more graphical information, in order to satisfy imager users, (2) a system more flexible, in order to satisfy FI users and (3) a system easier to learn to satisfy female users and (4) extra functionalities to satisfy the information seeking needs of the more experienced users of the system. Of course, in order to increase user satisfaction, these variations should be presented only to the users that actually need them; in other words, personalization is needed to increase user satisfaction.

In our future work we plan to study how these results can be used to develop a personalized interface for DLs. Also, we plan to develop similar studies in other information seeking environment to test to which extent the conclusions we have found apply to a generic search environment and to extend our study to usability questionnaires, specifically to CSUQ/ASQ (Computer System Usability Questionnaire/After Scenario Questionnaire). It also will be interesting to cluster the users of the study using various human factors (not just one or two as it has been presented) in order to better identify user necessities.

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