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An Exploratory Factor Analytic Approach to Understand Design Features for Academic Learning Environments

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Abstract. Subjective relevance (SR) is defined as usefulness of documents for tasks. Using digital libraries as examples of IR systems, this paper enhances objective relevance and tackles its limitations by conducting a quantitative study to understand students' perceptions of features for supporting evaluations of subjective relevance of documents. Data was analyzed using factor analysis to identify groups of features that supported students' document evaluations during IR interaction stages to provide design implications for an IR interface supporting students' evaluations of documents. Findings seemed to suggest an implied order of importance amongst groups of features for each interaction stage. The paper concludes by discussing groups of features, its implied order of importance, and support for information seeking activities to provide design implications for IR interfaces supporting SR for academic research.

Keywords: Subjective relevance, exploratory factor analysis, interface design

1 Introduction

Information retrieval (IR) systems are traditionally developed using the "best match" principle assuming that users can specify their needs in queries [3]. It retrieves documents "matching closely" to the query and regards these documents as relevant. Here, relevance is computed objectively without considering users' contexts [23].

This paper enhances objective relevance and addresses its limitations by taking a quantitative, subjective relevance (SR) approach. The SR concept provides suitable theoretical underpinnings for our approach as it focuses on document's relevance for users' needs [12]. This paper builds on an initial study [14] where features supporting users' evaluations of subjective relevance of documents were elicited. Here, we aim to understand university students' perceptions for elicited features. Specifically, our approach uses factor analysis to investigate groups of features and their implied order of importance to provide design implications for IR interfaces supporting SR.

Our approach may show designers how users' perceptions of importance of features may be elicited and how factor analysis may be used to imply order of importance for features so that better decisions may be made to design IR interfaces supporting users' relevance evaluations of documents. Similarly, our work applies to digital libraries by helping designers determine features to design in IR interfaces in digital libraries so that users are guided to find documents for their needs.

2 Related Work

Different approaches have attempted to enhance objective relevance by developing user-centered IR systems. One method adopts an algorithmic approach to support techniques like collaborative browsing and collaborative filtering in IR systems. Collaborative browsing aims to understand how users interact with others to facilitate browsing processes and retrieve relevant documents. An example application is *Let's*

Browse [15]. Collaborative filtering helps users retrieve relevant documents by recommending documents based on users' behaviors and behaviors of similar users. Example applications are *Fab* [1] and *GroupLens* [22].

In the digital library domain, researchers have tried to design user-centered systems that helped users retrieve relevant documents. One such work is the *Digital Work Environment* library [17] which points users of a university digital library to relevant documents based on their user categories and tasks. Another example uses a participatory design approach through techniques like observations and low-tech prototyping to develop a user-centered children's digital library called *SearchKids* [9].

Another research area of relevance judgments looks at user-defined criteria and dimensions affecting relevance judgments, such as, [2] and [18]. These works seem to indicate factors affecting users' evaluations so that designers may provide appropriate information in IR systems to help users find documents for tasks.

3 Theoretical Framework

Our approach differs from those highlighted in Section 2. Firstly, our work focuses on the location stage in the information life cycle [11], where we use SR to elicit features supporting users' evaluations of relevance of documents. Secondly, we conducted a quantitative study identifying users' perceptions of elicited features. Factor analysis was used to discover groups of features for IR interaction stages and their implied order of importance amongst groups to provide design implications for IR interfaces supporting users' evaluations of relevance of documents for academic research.

Our approach here builds on our first study [14]. SR [6], information seeking in electronic environments [16], and a model of user interaction [20] were used to provide rationale for the first study. In that study, the SR concept was used to elicit features. SR was defined as usefulness of an information object for users' tasks [4]. SR also referred to the degrees of intellectual interpretations that a user conducted to interpret if an information object was useful [4]. The four SR types were [6]:

- <u>Topical relevance:</u> This relevance is achieved if the topic covered by the assessed information object corresponds to the topic in user's information need.
- <u>Pertinence relevance:</u> This relevance is measured based on a relation between user's knowledge state and retrieved information objects as interpreted by the user.
- <u>Situational relevance:</u> This relevance is determined based on whether the user can use retrieved information objects to address a particular task.
- <u>Motivational relevance:</u> This relevance is assessed based on whether the user can use retrieved information objects in ways that are accepted by the community.

The first study also investigated how stages in Marchionini's [16] model of information seeking were mapped to phases in Norman's [20] model of user interaction. The mapping indicated how users might interact with an IR system to complete tasks. The mapping showed that Marchionini's [16] model was in line with Norman's [20] model to highlight three stages (see Figure 1). It was implicitly inferred that Norman's [20] stages of task completion could be implied in each stage as each stage involved completing a task, such as, query formulation.

In the first study, subjects completed a task using example IR systems. The task got subjects thinking about what features supported their relevance evaluation of documents. Subjects brainstormed SR features for IR interfaces. Elicited features were analyzed using SR types, stages in information seeking and phases in the model of user interaction to understand how students' used features during IR interactions. Features not coded to SR types were removed. Details of this study are found in [14].

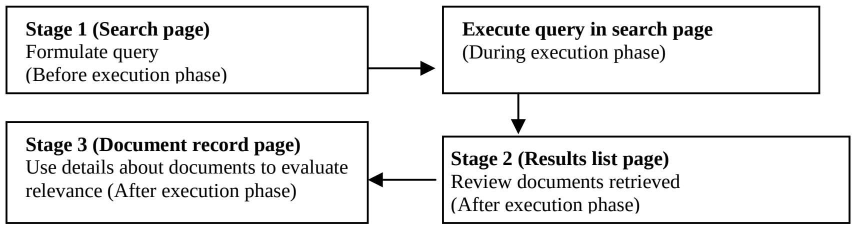

Figure 1. Stages of Users' Interactions in IR Systems

4 The Pilot Study

Using digital libraries as examples of IR systems, we designed a survey form and conducted a quantitative, pilot study based on analysis of SR features from the first study. In an ideal situation, various methods, like, review IR systems and asking large groups of users could be used to get features for the survey. However these methods could yield many features and made decisions on what features to include in the survey difficult. Hence, we used SR features from the first study to design the survey.

The pilot study was exploratory and aimed to gather students' perceptions of features elicited in the first study. Specifically, the pilot study investigated students' perception of features as they imagined completing a task in a digital library. Data gathered were analyzed using exploratory factor analysis (EFA) as EFA could remove redundant features and identify relationships so that groups describing most of the original data was discovered [13; l9]. Thus, groups of features supporting students' IR interaction stages could be identified to provide implications for designing IR interfaces supporting SR. Reasons for conducting the pilot, quantitative study was because a qualitative study could be expensive and time consuming as there was a need to interview subjects, videotape and transcribe interviews. Moreover, the qualitative study might gather rich data with many relationships that made it difficult to remove redundant features and group important features for IR interaction stages.

4.1 Designing the Survey Form

The survey form's design was grounded by analyses from the first study [14].

- Part 1 provided a brief overview of the study.
- Part 2 included a glossary of difficult terms to help participants rate SR features.
- Part 3 consisted of two sections. Section A contained a list of 50 SR feature questions. A five-point Likert scale (very important; important; neutral; not very important; not important) was used to rate each SR feature. Our previous work [14] indicated that SR judgments were related to users' tasks and IR interactions. Hence, a task scenario and stages that students might experience were highlighted at the start of Section A. The IR interaction stages were: S1) formulate and execute query in the search page; S2) review documents in results list; and S3) view details in the document record page to support evaluation of documents. Participants considered the task and stages as they rated SR features. This approach was in line with Carroll's [5] scenario-based design. Section B contained demographic questions.

The survey form was pilot-tested with 2 self-reported information seeking experts and 2 novices. Their feedback indicated that questions should be organized according to IR interaction stages. Analyses of features in the first study [14] were used to re-organize questions. Due to space constraints, we cannot show the survey form.

4.2 Methodology

The survey form was handed out during 6 Master's level and 8 Undergraduate level classes. As participants rated their perception of importance of SR features, they did not actively complete the task but they imagined IR interaction stages using the scenario described. 465 valid responses were received. A valid response was defined as a form that had all 50 SR feature questions answered.

Profiles of Participants

48.4% of students were males and 51.6% of students were females. Ages ranged from 18-49 years old and 65% were less than 23 years old. The high percentage of students younger than 23 years old was because most of them were undergraduates.

Data Analysis Method

EFA was conducted according to organization of questions into the 3 interaction stage. EFA was conducted using principle components analysis with varimax rotation and a 0.4 factor loading. This factor loading was considered acceptable for EFA [19].

Three heuristics were used to extract the number of factors for each analysis. In the first heuristic, factors were extracted above the "elbow" of the scree plot [13; 19]. The second heuristic extracted as many factors that had eigenvalues greater than 1 [13; 19]. The third heuristic was to compare eigenvalues from a dummy dataset with eigenvalues from the real dataset, and factors in the real dataset that had eigenvalues higher than those in the dummy dataset were retained [13]. These heuristics provided a range of factors to explore to derive the most meaningful factor solution. The most meaningful factor structure was selected using these criteria [7]: 1) the factor structure should account for at least 50% of the variance amongst features included in the structure; 2) each factor had at least 3 features; 3) no or few cross factor loadings and 4) factors must be meaningful. Reliability of each factor was checked using Cronbach's coefficient alpha [8]. A threshold value of 0.6 was selected. This value seemed lenient but was acceptable [21] in the literature. If a factor had an alpha value below 0.6, items in it were removed and the analysis was repeated.

It is emphasized that the final factor solution for each interaction stage was decided based on the criteria for most meaningful factor structure and we did not aim for each factor to account for more than 50% of the variance amongst features in the solution.

5 Findings and Discussion

Findings are described here. We attempted to reflect functionality of features and SR types features supported in the factor name. Thus, we found it difficult to come up with intuitive names. Factors for stage 1 are described in detail. Due to limited space, findings for stages 2 and 3 are shown in tables and described. We also discuss the implied order of importance for factors in each stage and its implications towards interface design. Findings are discussed in terms of how features support information seeking activities stated in Ellis' [10] behavioral model of information seeking.

5.1 Findings for Stage 1 (Search Page)

We started with a comprehensive set of 17 SR features for the search page. EFA reduced it to 14 features and loaded them to 3 factors. The factors accounted for 54.543% of the total variance (that is, the dispersion of data) in the 14 features. The features were coded to pertinence relevance in the first study [14], thus, factor names attempted to reflect this fact. SR features here were coded to pertinence relevance because success of determining pertinence relevance depends, to a certain extent, on the ability of users to formulate queries. In turn, users' ability to formulate queries is dependent on their knowledge of a topic or perception of information need [6].

Table 1 shows factor loadings for stage 1. Factors are labeled as S1_F1 to S1_F3 to indicate that it supported stage 1 and its respective factor number in this stage. Tables 2 and 3 are constructed similarly. Factors for stage 1 are described in detail below.

- *Factor S1_F1: Search Options for Query Formulation and Pertinence Relevance*

Features in Factor S1_F1 (see Table 1, column S1_F1) seemed to indicate that search options guided students formulate queries especially for those who cannot articulate their needs. Alpha value for this factor was 0.852.

Table 1. Factor Loadings of SR Features for Stage 1

SR features	Factor loadings		
	S1_F1	S1_F2	S1_F3
1. Search in journal title field	0.834		
2. Search in abstract field	0.799		
3. Search in author field	0.791		
4. Search in document full text	0.757		
5. Provide search tutorials and examples		0.695	
6. Provide advanced search mode		0.607	
7. Provide basic search mode		0.600	
8. Provide "clear query" button		0.563	
9. Provide search history		0.526	
10. Basic search considers query as a phrase if no Boolean operators are specified		0.494	
11. Method of entering and executing queries should be simple like search engines			0.720
12. Provide search entry boxes			0.664
13. Search in keywords field			0.431
14. Search in title field			0.404

- *Factor S1_F2: Other Features for Query Formulation and Pertinence Relevance* Factor S1_F2 described other features that could support query formulation in the search page. Example features were: provide basic and advanced search modes (see Table 1, column S1_F2 for all features). This factor's alpha value was 0.644.
- *Factor S1_F3: Basic Features for Query Formulation and Pertinence Relevance*

.This factor included basic features that allowed students to specify their queries when they knew their information need, such as keywords describing contents and titles of documents (see Table 1, column S1_F3 for features). The alpha value here was 0.669.

5.2 Discussion for Stage 1 (Search Page)

Principles of EFA indicated that the first factor extracted would account for the highest percentage of total variance in all variables analyzed and subsequent factors would account for as much of the remaining variance as possible that was not accounted by the preceding factor [13]. Thus, the order in which factors were extracted and the percentage of total variance in all features analyzed were used to imply the order of importance for factors in each stage. This rationale for implying order of importance amongst factors was used to discuss findings for all stages.

- *Most Important SR Features for Stage 1*

Factor S1_F1 contained the most important SR features for stage 1 as it accounted for the highest amount of total variance in the 14 features analyzed for this stage (34.142%). This factor indicated different search options for the search page (see Table 1). Thus, students might have found search options to be most important as it showed the types of information that could be searched. Search options in Factor S1_F1 differed from those in Factor S1_3 (see Table 1, rows 13-14). This was because search options in Factor S1_F1 were more comprehensive and allowed students to search for documents using different means, such as, by author, abstract, or full text whereas search options in Factor S1_F3 seemed to support query formulation for students who knew the titles and keywords of documents they needed.

- *Second Most Important SR Features for Stage 1*

Features in Factors S1_F2 (see Table 1) were the second most important SR features as it was ranked second for percentage of total variance in the 14 features analyzed (11.293%). Thus, it was inferred that besides providing search options, students also wanted other features to support query formulation. For example, if different search modes were designed, students could select a search mode depending on their needs.

- *Third Most Important SR Features for Stage 1*

Features in Factor S1_F3 (see Table 1) were ranked third for the amount of total variance in the 14 features analyzed in stage 1 (9.109%). Reason could be because students felt that the feature, "provide search entry boxes", was redundant as search pages should have text boxes for users to enter queries. Factor S1_F3 was similar to Factor S1_F1 as search options were available in both factors. However, search options in Factor S1_F3 might not be as important as those from Factor S1_F1 as students might not know keywords or titles of relevant works. Thus, search options in Factor S1_F1 would provide more access points for students to search for documents.

Analyses of SR features for stage 1 yielded three factors ranked in implied order of importance. Hence, depending on students' needs and design resources, different groups of SR features might be designed in the search page. For example, if resources were limited, then the most important SR features in Factor S1_F1 could be designed. However, if comprehensive support for query formulation was needed then all three factors of SR features could be designed to provide basic and advanced search pages.

Features highlighted in factors for stage 1 seemed to support the information seeking activities of starting, browsing and monitoring. Features here might support starting as students could have initial references that were recommended by their teachers and they might formulate queries to find out if these documents were available. Alternatively, students might already have a clear understanding of their need and were actively browsing (that is, semi-directed / semi-structured searching) to look for relevant documents or they could be searching the system to monitor developments within interested areas. Figure 2 shows the designed search page with most important SR features. Search option with highest factor loading was designed on the top and the one with the lowest factor loading was designed at the bottom.

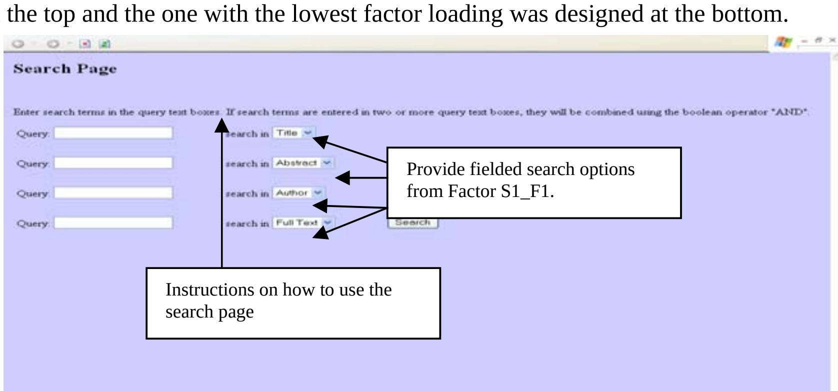

Figure 2. Search Page with Most Important SR Features

5.3 Findings for Stage 2 (Results List Page)

A comprehensive list of 21 SR features for stage 2 was packed to 5 factors. The factors accounted for 52.567% of the total variance in all 21 features. Factors are labeled as S2_F1 to S2_F5, factor loadings and alpha values are described in Table 2.

Factor S2_F1 was labeled "*point students to documents supporting topical, situational and motivational relevance*" as features (see Table 2, rows 1-5) were coded to these SR types and indicated different ways of pointing students to other documents. Features in Factor S2_F2 (see Table 2, rows 6-10) could help students find suitable contents and document types for their needs. Moreover, features were coded to topical, situational and motivational relevance in the first study [14]. Hence, this factor was named "*features for evaluating contents for topical, situational and motivational relevance*". Features for Factor S2_3 (see Table 2, rows 11-13) were coded to topical and situational relevance in the first study [14] so this factor was named "*alternate ways of presenting results list to support topical and situational relevance*". Factor S2_F4 was labeled "*extra information to evaluate documents for topical, situational and motivational relevance*" as features (see Table 2, rows 14-17) were coded to topical, situational and motivational relevance in the first study [14]. These features provided additional information about retrieved documents and its source to facilitate document evaluations. Features for Factor S2_F5 (see Table 2, rows 18-21) included those that were commonly available in results list and they were coded to topical relevance in the first study [14]. Hence, this factor was named "*common features available in results list page to support topical relevance*".

5.4 Discussion for Stage 2 (Results List Page)

- *Most Important SR Features for Stage 2*

Factor S2_F1 (see Table 2) were inferred as the most important SR features for stage 2 as it had the highest percentage of total variance in all features analyzed (26.060%). The survey form asked students to rate features with the assumption that the results list included a list of retrieved documents. Hence, it was inferred features in Factor S2_F1 could be built on top of retrieved documents in the results list page.

- *Second Most Important SR Features for Stage 2*

Features in Factor S2_F2 (see Table 2) focused on allowing students evaluate appropriate contents and document types for their needs. This factor was inferred as second most important because it was ranked second in terms of total variance in all features analyzed for stage 2 (7.911%).

- *Third Most Important SR features for Stage 2*

Factor S2_F3 (see Table 2) focused on providing novel ways of presenting results list and providing explanations of how documents were ranked. Features here might indicate that students were willing to try new ways of presenting documents in results list and determine if these methods were effective. Features in this factor were inferred as third most important because its percentage of total variance in all features analyzed was ranked third amongst factors extracted for stage 2 (6.912%).

- *Fourth Most Important SR features for Stage 2*

Factor S2_F4 focused on features that provided additional information to help students evaluate documents for their needs. Thus, if students could not get sufficient information, they might turn to features in Factor S2_F4 to get more information to support their document evaluations. Features here were implied as the fourth most important for stage 2 as its percentage of total variance in all features analyzed (5.916%) was ranked fourth amongst the five factors for this stage.

Table 2. Factor Loadings of SR Features for Stage 2.

SR features	Factor loadings				
Factor S2_F1: Point students to documents supporting topical, situational and motivational relevance (Alpha value: 0.738)					
1. Recommend related documents and topics based on query	0.796				
2. Recommend related documents for each document retrieved	0.781				
3. Provide details of other people the author had worked with	0.603				
4. Recommend documents based on what others have looked at	0.461				
5. Recommend related documents based on user's profile and searching behavior	0.453				
Factor S2_F2: Features for evaluating contents for topical, situational and motivational relevance (Alpha value: 0.697)					
6. Provide an abstract for each document retrieved in results list		0.732			
7. Allow users to preview abstract before downloading full text		0.723			
8. Highlight search terms for each document in results list		0.676			
9. Provide an option so users can choose to display a paragraph or a few lines in which search terms appear in full text		0.502			
10. Categorize documents retrieved based on types of documents like journals, conference proceedings, etc.		0.447			
Factor S2_F3: Alternate ways of presenting results list to support topical and situational relevance (Alpha value: 0.643)					
11. Rank documents in results list in terms of how many times it has been used by others			0.720		
12. Provide explanation of how documents are ranked			0.713		
13. Present results list in pictorial format			0.491		
Factor S2_F4: Extra information to evaluate documents for topical, situational and motivational relevance (Alpha value: 0.614)					
14. Provide link that shows general information about document's source				0.631	
15. Provide link to document source's table of contents				0.615	
16. Provide subject categories for each document retrieved				0.610	
17. Provide selected references cited for each document retrieved				0.610	
Factor S2_F5: Common features available in results list page to support topical relevance (Alpha value: 0.617)					
18. Rank retrieved documents in results list in order of relevance					0.716
19. Display results list					0.660
20. Rank and provide relevance percentage for documents retrieved in results list					0.608
21. Allow searching within documents retrieved in results list					0.506

- *Fifth Most Important SR features for Stage 2*

Features in Factor S2_F5 (see Table 2) were inferred as fifth most important for this stage as its percentage of total variance in all features analyzed was ranked fifth (5.767%). Reason might be because students rated features based on their assumptions of common features in results lists. Hence, features here were redundant as they matched students' perspectives.

The factors seemed to include features that were exclusive to their respective factors except for an overlap amongst features in Factors S2_F3 and S2_F5. The overlapping occurred as features in both factors related to ranking of documents retrieved. However, there were slight differences. The feature in Factor S2_F3 (see Table 2, row 11) focused on ranking documents retrieved based on frequency of use whereas features in Factor S2_F5 (see Table 2, rows 18 and 20) focused on ranking documents in order of relevance and relevance percentage.

An order of importance was implied amongst the factors for stage 2. Thus, features in different factors could be implemented as groups. Students might activate clusters and incrementally add them to the interface as pop-up boxes and pull-down menus

Features highlighted in factors for stage 2 seemed to support the information seeking activities of chaining and differentiating. Students might perform backward chaining by following references cited in documents to gain access to other documents. Backward chaining might be supported by the feature, “provide selected references cited for each document”. Forward chaining was also supported by features in factors for stage 2 which involved providing links to other possible relevant documents through recommendation methods, such as, by users’ profiles, and related topics. Most features in factors for stage 2 aimed to provide information to help students differentiate if a retrieved document was worth evaluating in more detail in the document record page. Examples of such features were: provide abstract, and categorize documents based on document type. Figure 3 illustrates the designed results list page incorporating most important features for stage 2 (Factor S2_F1). Features were built on top of a ranked list of retrieved documents.

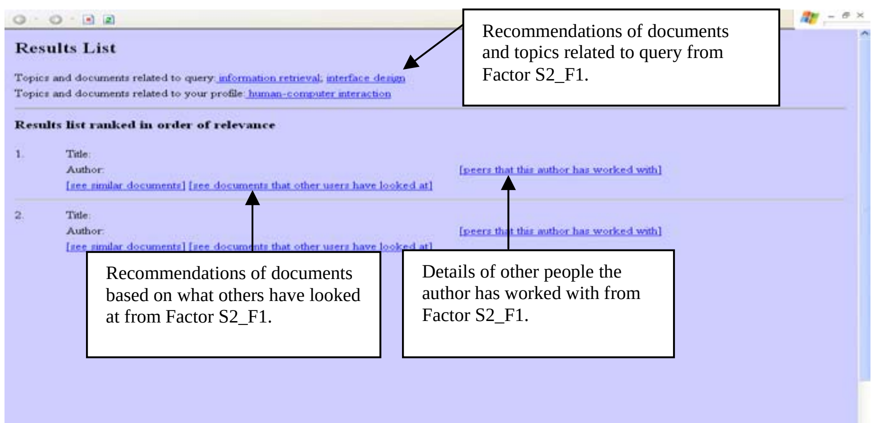

Figure 3. Results List Page with Most Important SR Features

5.5 Findings for Stage 3 (Document Record Page)

Twelve comprehensive features were loaded to 3 factors. Factor loadings, factor names and alpha values for stage 3 are shown in Table 3. The factors accounted for 58.959% of the total variance in the 12 features analyzed.

Factor S3_F1 was named “*seek others’ help to evaluate documents for pertinence and motivational relevance*” as features identified (see Table 3, rows 1-4) were coded to pertinence and motivational relevance in the first study [14]. Features here seemed to allow students discuss relevance with authors and other users. Features in Factor S3_F2 (see Table 3, rows 5-9) were coded to situational relevance in our first study [14] and facilitated management of full text. Thus, this factor was labeled “*features that support access and management of full text for situational relevance*”. Factor S3_F3 (see Table 3, rows 10-12) provided full text and highlighted search terms so students could evaluate relevance of highlighted text in relation to contents. Moreover, pointing users to full text of documents cited could be helpful when students found the current document to be relevant.

5.6 Discussion for Stage 3 (Document Record Page)

- *Most Important SR Features for Stage 3*

Features in Factor S3_F1 were inferred as the most important features as its percentage of total variance in all features analyzed was the highest (33.822%). Students rated features based on an understanding that the document record page provided detailed information, such as, title, author and publisher. Hence, it was inferred that students were keen to discuss with others to find relevant documents and features here could be built on top of detailed information in document record page.

Table 3. Factor Loadings of SR Features for Stage 3

SR features	Factor loadings		
Factor S3_F1: Seek others' help to evaluate documents for pertinence and motivational relevance (Alpha value: 0.795)			
1. Provide asynchronous collaborative features	0.896		
2. Provide synchronous collaborative features	0.869		
3. Provide author's contact details	0.653		
4. Allow users to ask experts to evaluate documents retrieved	0.652		
Factor S3_F2: Features that support access and management of full text for situational relevance (Alpha value: 0.761)			
5. Allow full text to be saved using its title as the default file name		0.823	
6. Allow full text to be saved in a compressed version		0.794	
7. Print full text without "highlighted / bolded" search terms		0.628	
8. Provide "reader" software in the document record page		0.623	
9. Specify on what pages in full text do search terms appear and provide link to the page		0.459	
Factor S3_F3: Highlight portions in full text and point users to other documents for situational relevance (Alpha value: 0.657)			
10. Highlight search terms in full text			0.830
11. Provide links to full text of documents cited in the current document			0.676
12. Allow users to download full text in PDF format			0.676

- *Second Most Important SR Features for Stage 3*

Factor S3_F2 focused on providing features that facilitated access and management of full texts. Hence, it was inferred that students wanted easy access and management of full texts so that they would extract relevant content for tasks. Features here were deduced as the second most important features as its percentage of total variance in all features analyzed (15.233%) was ranked second amongst factors for stage 3.

- *Third Most Important SR Features for Stage 3*

Features in Factor S3_F3 were specified as third most important features for stage 3 as its percentage of total variance in all features analyzed (9.904%) was ranked third amongst factors for this stage. Reasons could be: 1) students wanted to read full text to extract information rather than be pointed to texts; and 2) students might only find full text of some cited documents to be relevant.

The three factors extracted for stage 3 seemed to indicate that three important groups of features could be designed. Features in these groups seemed unique and there were no overlaps. Thus, depending of design requirements different groups of important features could be designed. Features indicated in factors for Stage 3 seemed to support the information seeking activities of differentiating and extracting. This was because the document record page provided detailed information so that students could differentiate if the retrieved document was useful. Moreover, the document record page also provided access to full text so that students could extract contents.

Figure 4 shows the designed document record page with most important SR features for stage 3. As students rated features based on an understanding that the document record page provided detailed information about the document, like, title, author and publisher, features in Factor S3_F1 were built on top of such information.

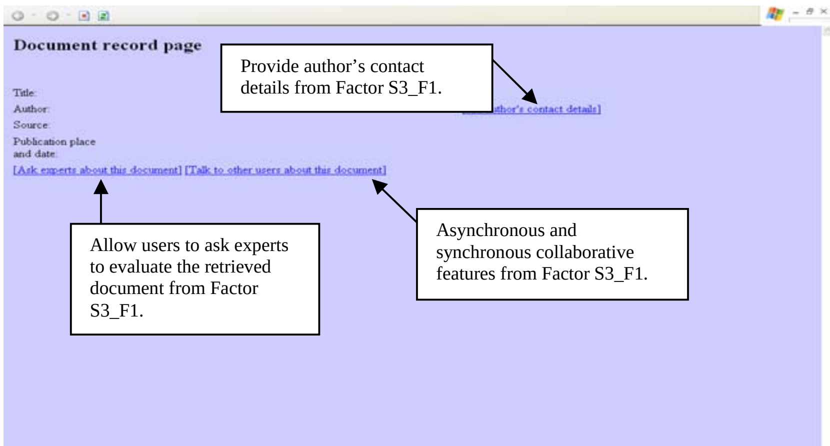

Figure 4. Document Record Page with Most Important SR Features

6 Conclusion and On-going Work

Our approach differs from approaches described in related work section. Firstly, our approach used SR as a theoretical basis to elicit features supporting document evaluations. We also used stages of IR interaction to understand how students might use features to complete tasks in IR systems. Secondly, we investigated students' perceptions for elicited features using EFA. Findings discovered were not surprising but our approach gained the following insights:

- EFA extracted groups of SR features to support each stage of students' IR interactions. Although all groups of features were important to form the factor solutions to support students' document evaluations during IR interactions, there seemed to be an implied order of importance amongst groups. Thus, depending on requirements, different groups of features could be designed in IR interfaces.
- The groupings seemed to indicate clusters of SR features that could be implemented collectively. Student might activate different clusters and features could be added to the interface in the form of pop-up boxes and pull-down menus.

Findings presented are preliminary and have limitations. Firstly, the pilot study gathered student's perception of importance of SR features without actual context of use. Students might have different understandings of SR features and could be problematic when students did not have prior experience using it. Hence, future work may focus on verifying and evaluating our findings in a qualitative study where users could comment on importance of SR features in actual context of use. Findings presented are exploratory and applied specifically to students who participated in the study. Future work might use EFA to discover groups of SR features supporting IR interactions for other students in different task scenarios so that insights might be gathered on the needs of larger student populations for IR interfaces supporting SR.

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