A Closer Look at Children’s Information Retrieval Usage

Towards Child-Centered Relevance

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ABSTRACT

Access to information suitable and understandable for children is key to their development. Regrettably, current state-of-the-art Information Retrieval (IR) is mainly made with adults in mind, resulting in IR systems that do not suit children well: they require complicated queries and often retrieve inappropriate results in a format unsuitable for children. To confirm this, this paper presents four groups of salient problems children have with IR. To explain these problems, a comprehensive review of children’s use of IR systems is given, defining relevant aspects of the user, system, interaction, and context, and relating these to the search performance of children. Based on this framework, an integrative perspective on relevance is proposed, specifically geared at children’s needs. It is proposed that complexity, interestingness, and affective value are key relevance criteria for children, and should be incorporated in an information system for children, if to arrive at an optimal search result and experience.

Categories and Subject Descriptors

H.3.1 [Information Storage and Retrieval]: Content Analysis and Indexing; H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval

General Terms

Human Factors, Algorithms

Keywords

Children, Information Retrieval, Relevance

1. INTRODUCTION

Several studies indicate that children, compared to adults, use IR systems in a different way. However, most current IR systems are focussed on adults. Accordingly, they require the typing of complex queries and the use of a correct spelling and efficient vocabulary. Moreover, the search results are often aimed at people who are average literate, requiring sufficient reading skills and a large enough knowledge base, including abstract concepts [12, 5].

Children are still developing their skills and knowledge, and, consequently, have different needs for an IR system.

One of the most notable developmental theories illustrates this. Jean Piaget [29] indicated four developmental stages: sensorimotor (age 0-2), preoperational (age 2-7), concrete operational (age 7-11), and formal operational (age 11 - ...). Some achievements in these stages, relevant to IR systems, are: in the preoperational stage children learn to use language and can classify objects according to one feature; in the concrete operational stage children learn to think logically about objects and events, achieve a notion of the conservation of number, mass, and weight, and can classify objects according to several features; and, only in the last stage children learn to think logically about abstract concepts. Some simple implications of these stages can already be derived, for example the use of simple language and the use of only concrete concepts until age 11.

Current research has found several shortcomings in the use of IR systems by children. Considering the vast amount of studies showing many different problems, an overview of them is given. For ease of comprehension, the problems will be grouped in four categories.

The first group of problems is related to an insufficient mental model. Numerous researchers found that children to some extent miss an understanding of the workings of the IR system. This manifests itself while making search queries by the use of natural language, repetitive keywords, and the limited use of Boolean logic operators [5, 21, 6]. This lack of system understanding is not a sure thing, as most studies show large interpersonal differences.

Having an insufficient mental model is not unique to children. Borgman [7] shows that unexperienced undergraduates also have problems in utilizing Boolean logic for an IR task, especially those from social majors. Such findings have been explained by the Mental Model Theory [28], stating that users construct a mental model of a system by continually forming and verifying hypotheses. An incorrect model decreases success when using the system, especially on complex search tasks [7]. Following its definition, the correctness of a mental model depends mainly on training and previous experience.

The second group of problems is related to the vocabulary problem. Numerous studies show children have difficulties in choosing the right words. Often, they misspell their keywords or use keywords that are too broad or too narrow [5]. These findings are often attributed to a lack of vocabulary, which is a known problem in IR research; i.e., the vocabulary problem.

The vocabulary problem has been a major problem in IR. A surprisingly large interpersonal variability in word choice,
something fundamental to language, leads to a bare 10% hit rate for a single access term [13]. Furthermore, a lack of domain knowledge reduces the chance of finding a correct access term.

The third group of problems considered is the chaotic search behavior often employed by children using an IR system. This is witnessed by: little reading of the retrieved sources, little focus on the search goal, and many looping and backtracking actions [5, 33]. Rouet and Coutelet [31] show that document search behavior changes with age, such that older children use more cues to search through a document in a more directed way.

Partly, chaotic search behavior is normal at the start of an information search; i.e., the so-called pre-focus phase [22]. It is indicative for not having a directed search goal. However, it is also typical for children that they often don’t form a focus at all, nor seem to remain concentrated for a long time [27].

The fourth group of encountered problems is in the used relevance judgements by children. Often they scan the text for a specific word or a ready-made answer. For example, a source was seen as irrelevant if not containing a searched-for word in its topic [27]. Furthermore, children tend to take everything as being true and correct [33].

Normally, relevance judgements change over the search process. Where in the beginning a lot of documents are considered relevant, near the end only documents very specific about the problem are considered relevant. Furthermore, the relevance of the early gathered documents is reconsidered [22].

As the different groups of problems show, current IR systems are not optimal for children. And, as several of the problems are not unique to children, the problems indicate the general need for systems focused on the special needs of (less experienced) users. In order to get more grip on the use of IR systems, the next section will give a comprehensive overview of the various aspects relevant during an information search. Using this dissection of IR use, implications for the processes.

The processes in Table 2 are iterative in nature, thus different steps users normally proceed through in their search for information. Furthermore, the dimensions (i.e., variables) influencing IR use are reviewed in four categories. These categories are constructed upon the combination of the classifications made by Lazonder and Rouet [23] and Tanni and Sormunen [36], and follow a basic HCI structure:

- **Interaction.** Search process [22], Information Problem Solving (IPS) activity [23], and access and interaction dimensions [36].
- **Context.** Contextual variables [23] and learning task dimensions [36].
- **User.** Individual variables [23] and learner dimensions [36].
- **System.** Resources variables [23].

## 2. USAGE DIMENSIONS

This section gives a theoretical view on the problems encountered (Section 1), reviewing theories from library and information science [e.g., 22], cognitive and educational psychology [e.g., 23], Information Retrieval Interaction (IRI), and Information Search & Retrieval (IS&R) research [e.g., 37, 36]. This section will further elaborate on gaps in functionality and knowledge regarding children’s IR usage.

The next sections elaborate on the process of IR use; i.e., the different steps users normally proceed through in their search for information. Furthermore, the dimensions (i.e., variables) influencing IR use are reviewed in four categories. These categories are constructed upon the combination of the classifications made by Lazonder and Rouet [23] and Tanni and Sormunen [36], and follow a basic HCI structure:

### 2.1 Interaction Dimensions

Table 1 gives an overview of the dimensions characterizing an IR interaction, and their relation to other dimensions. The search process is the first interaction dimension reviewed. It involves the cooperation between the user and the system in solving the (perceived) information problem, and thus, in performing the information search activity throughout the search process. Hence, the achieved search performance is one of the dimensions. First, we will describe various models of the search process, after which other models of the interaction are given.

IR use is viewed as a process. Table 2 summarizes different views on this process. As can be seen, there is a considerable overlap between the views. The process starts with some shortage of information (e.g., a learning task, an information problem); i.e., initiation and selection, pre-focus, or define problem. Then, through searching, the user refines the problem and forms a focus on the problem at hand; i.e., exploration or search. Finally, the user gathers relevant information solving the problem; i.e., collection and presentation, post-focus, or integration [23].

The processes in Table 2 are iterative in nature, thus different steps are repeated. Furthermore, the dimensions (i.e., context, interaction, user) change when proceeding through the processes.

**Pattern of information seeking** is the second interaction dimension reviewed. Three patterns have been discerned: fast surfing, broad scanning, and deep diving. The search goal is characteristic for the pattern, respectively: finishing the search as quickly as possible, finding as much information as possible, trying to understand. The fast surfing pattern is often found with children (see Section 1). These patterns have been shown to be (partly) determined by study approach and personality traits [14]. Moreover, the study approach is directly related to motivation and interest, discussed in, respectively, Section 2.3.2 and 3.
Related to the pattern of information seeking are the performed relevance judgements. Fast surfers tend to only accept documents which contain the whole answer, as often done by children as well (see Section 1). Broad scanners tend to select new, unique, documents related to the search topic. Deep divers select high quality, detailed, highly topical documents [36].

Within a document children perform different document search strategies as well. As Moore [27] showed, children tend to linearly scan documents searching an exact match with their keyword. Rouet and Coutelet [31] differentiate between a top-down strategy, where students utilize structural cues of a document, and a linear strategy, similar to what [27] showed. Children develop their search strategies with age; 9 year olds mostly use a linear approach, whereas 13 year olds often use a top-down strategy. It is hypothesized that working memory, metatextual knowledge, and functional comprehension strategies are key factors in efficient search strategies [31].

The interaction dimensions already cover part of the identified problems. In particular, the pattern of information seeking is directly related to the chaotic search behavior and the performed relevance judgements, and can be explained by latent user variables (personality, Section 2.3.2) and actualized user dimensions (motivation, Section 2.3.2).

### 2.2 Context Dimensions

The second category refers to the context of the user [36]. Meaning, "all relevant characteristics of the situation (place, time, equipment, people and messages) that pre-exist to the search activity" [23, p. 756]. The context dimensions are summarized in Table 3.

Inspired by the learning sciences (e.g., Vygotski), collaboration and scaffolding (i.e., instructional support) are possibly important factors. There is some evidence for a non-beneficial effect of collaboration on information seeking pattern: pupils are more concerned with getting pieces of information from their peers rather than creating a shared understanding [2]. On the contrary, group learning has been shown to foster the interaction, and procedural knowledge is knowing how to use an IR system, i.e., a mental model, can be seen as a type of domain knowledge which increases search performance for complex problems [7]. The use of domain knowledge is related to age. Children are less apt to use previous knowledge when using an IR system [6].

Cognitive skills and procedural knowledge is knowing how to do something [29]. For the retrieval of often written information, literacy skills are important; i.e., the ability to read, comprehend, and write. Around age 9 there often is a turning point, where the child goes from learning to read

<table>
<thead>
<tr>
<th>Information Process [22]</th>
<th>Search</th>
<th>IR Process [37]</th>
<th>Information Problem Solving Activity [23]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiation</td>
<td>Pre-focus</td>
<td>Define problem</td>
<td>Search (scanning/studying)</td>
</tr>
<tr>
<td>Selection</td>
<td></td>
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<tr>
<td>Exploration</td>
<td>Formulation</td>
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<tr>
<td>Formulation</td>
<td>Post-focus</td>
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<tr>
<td>Collection</td>
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<tr>
<td>Presentation</td>
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</tbody>
</table>

### Table 2: Overview of three search process models.

Namely, structuredness, complexity, and abstractness. Information problems, coined rule-using problems [20], tend to be ill-structured and complex. Though, this depends heavily on the exact search task and the user. For example, problem structuredness and complexity influence search performance [34]. Moreover, the search performance of ill-defined (i.e., structuredness) problems is partly determined by epistemic beliefs [34] (See Section 2.3.1).

Also in an educational perspective, the means and time a student is given to solve a research assignment, together with the educational setting (e.g., a problem-based curriculum focused on the process of learning), are important determinants for, respectively, search performance [36] and learning outcomes [17].

The context dimensions do not explain any of the problems encountered in Section 1, but do indicate methods to improve: scaffolding and collaboration. Scaffolding can change the motivation and affective state of the child, whereas collaboration can foster a deep learning approach. Hence, indirectly, the context can solve many of the shown problems.

### 2.3 User Dimensions

The user dimensions can be divided in trait characteristics and state characteristics, which respectively indicates long-term, relatively stable (i.e., latent), and short-term, more unstable (i.e., actualized) user characteristics. Not mentioned but imaginable other characteristics are gender, age, and personality (e.g., the big five). Please note that gender differences are often easily stated (e.g., in technology use / interests), but should be interpreted with care because of often undecided accompanying evidence [11]. Table 4 and 5 give an overview of the, respectively, latent and actualized user characteristics.

#### 2.3.1 Latent User Dimensions

Domain knowledge is a trait which specifies the knowledge about a topic. This is more than just factual knowledge, especially structural knowledge about the relations between facts is an important determinant in problem solving (e.g., search performance) [20]. Knowledge about the workings of an IR system, i.e., a mental model, can be seen as a type of domain knowledge which increases search performance for complex problems [7]. The use of domain knowledge is related to age. Children are less apt to use previous knowledge when using an IR system [6].

Cognitive skills and procedural knowledge is knowing how to do something [29]. For the retrieval of often written information, literacy skills are important; i.e., the ability to read, comprehend, and write. Around age 9 there often is a turning point, where the child goes from learning to read
Table 3: Interrelations of context dimensions.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Interrelations</th>
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</thead>
<tbody>
<tr>
<td>collaboration</td>
<td>study approach** [19]</td>
</tr>
<tr>
<td>scaffolding</td>
<td>motivation* [22]</td>
</tr>
<tr>
<td></td>
<td>affective states* [22]</td>
</tr>
<tr>
<td>problem</td>
<td>search performance** [34]</td>
</tr>
<tr>
<td></td>
<td>search performance X epistemic beliefs** [34]</td>
</tr>
<tr>
<td>means, time</td>
<td>search performance* [36]</td>
</tr>
<tr>
<td>educational setting</td>
<td>learning outcomes* [17]</td>
</tr>
</tbody>
</table>

*Note. * weak relation, ** strong relation

Table 4: Interrelations of latent user dimensions.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Interrelations</th>
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</thead>
<tbody>
<tr>
<td>age</td>
<td></td>
</tr>
<tr>
<td>gender</td>
<td></td>
</tr>
<tr>
<td>personality</td>
<td></td>
</tr>
<tr>
<td>domain knowledge</td>
<td>search performance X age* [6]</td>
</tr>
<tr>
<td>structural knowledge</td>
<td>search performance** [20]</td>
</tr>
<tr>
<td>mental model</td>
<td></td>
</tr>
<tr>
<td>cognitive skills</td>
<td></td>
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<tr>
<td>literacy</td>
<td></td>
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<tr>
<td>information literacy</td>
<td></td>
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<tr>
<td>familiarity</td>
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<tr>
<td>learning style</td>
<td></td>
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<tr>
<td>metacognitive skills</td>
<td></td>
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<tr>
<td>self-regulation</td>
<td></td>
</tr>
<tr>
<td>epistemological beliefs</td>
<td>relevance judgements* [40]</td>
</tr>
<tr>
<td></td>
<td>information seeking pattern* [40]</td>
</tr>
</tbody>
</table>

*Note. * weak relation, ** strong relation

to reading to learn. Information literacy is the “ability to access, evaluate, organise and use information in order to learn, problem-solve, make decisions in formal and informal learning contexts, at work, at home and in educational settings” [9], and thus somewhat overarching the IR use. Related to the information literacy is the familiarity with the problem type, stating that routine problems appear more well-structured to the experienced solver [20].

Complementary to cognitive skills is the concept of learning styles, reflecting patterns of thinking [20]. One of them, the study approach, differentiates between individuals with a surface approach and a deep approach. Respectively, aiming for finishing a task with the least of effort or aiming for personal understanding [36]. These are related to the information seeking pattern; the surface approach is linked to fast surfing, whereas the deep approach is linked to deep diving [14].

The next set of traits are metacognitive skills and knowledge; i.e., thinking about thinking. Self-regulation is an important skill. It embodies skills such as goal setting, planning, self-motivation, attention control, application of learning strategies, self-monitoring, self-evaluation, and self-reflection [29]. Epistemological beliefs, knowing about knowing, includes beliefs about: the certainty of knowledge, the structure of knowledge, the source of knowledge, criteria for determining the truth, the speed of learning, and the nature of learning ability. In other words, people form a theory about knowledge and learning [29].

Self-regulation is stated to be related to reading comprehension; i.e., learning outcomes [10]. Furthermore, Epistemological beliefs, are related to relevance judgements (e.g., recognizing authoritative information sources) and information seeking pattern (e.g., handling conflicting information sources) [40]. Metacognitive skills and knowledge, among which self-regulation and epistemological beliefs, improve with age. For example, children become increasingly realistic about their memory capabilities and the speed of learning. They learn more learning strategies and become better in structuring facts [29, 20].

Since the problems and the described user traits are both related to age, the latent user dimensions explain all problems described in Section 1. In specific, first, domain knowledge, which increases with age, explains the problems regarding the mental model of the user. Second, the literacy skills explain part of the vocabulary problem. Third, the learning style, epistemological believes, and self-regulation skills influence the pattern of information seeking and relevance judgements.

2.3.2 Actualized User Dimensions

The perceived problem, as contrary to the actual problem (e.g., an assignment), is the user’s view of the problem. This depends on, among others, the familiarity of a problem [20], the motivation, etc. The importance of motivation is perfectly illustrated by Tanni and Sormunen [36]: most students see a research assignment as a reporting exercise, where “reporting means seeking other peoples’ answers to someone else’s questions” (p. 901). Furthermore, the per-
ceived problem changes when the search proceeds [22], from an ill-structured problem to a more structured problem; i.e., the search proceeds to a focus. This point is typical for a reduction in the difficulty of the perceived problem: the user has given structure to it, has gained control over the problem. Task complexity and difficulty have been confirmed to have a negative correlation with the experienced valence (i.e., the affective state; see Section 2.3.2) [3].

Motivation is an important user state, influencing the effort exerted and the persistence shown in solving a problem. It has been found to be a strong predictor of problem-solving success [20]. Motivation is often divided in intrinsic motivation; i.e., a genuine interest, and extrinsic motivation; i.e., some external incentive. Intrinsic motivation can be explained by two determinants: a task performance which leads to a sense of mastery and competence, and a novelty which leads to a sense of curiosity, attention, and interest [30]. Hence, this is closely related to latent user characteristics [35], the perceived problem (and its progress; e.g., a focus), and the affective state.

Kuhlthau [22] stresses the affective states a user experiences throughout an information search. She observed the following emotions from students performing an information search: uncertainty, optimism, confusion, frustration, doubt, clarity, confidence, relief, and (dis)satisfaction. Hence, it seems like searching isn’t always a positive experience. The emotions can partly be explained by one of the previous parameters: task performance and sense of mastery. Simply put, advancement in a (not too easy) task will bring about a category of mental states: enjoyment, sense of mastery, sense of control, and competence [30]. Positive affect has been theorized and shown to enhance problem solving, information integration, and intrinsic motivation [18].

In sum, the actualized user dimensions are all directly related to the search outcome: the perceived problem, the motivation, and the affective state of the user throughout the search are all great predictors of search success. In relation to the problems described in Section 1, the actualized user dimensions mainly operate via the information seeking pattern and relevance judgements.

### 2.4 System Dimensions

Although there are several exceptions, most IR systems currently use queries for users to communicate their information need. And, this method works well; regular users know how to operate an IR system to find what they want. However, as the presented outline shows, there is more to an information search than just one query. Except for the query, there are more facets the system influences.

First, the interface appears to be important as well. The interface can reduce any of the problems, such as cognitive overload or disorientation [23]. For example, visual information search metaphors have been investigated as an alternative to the query interface [25].

The information resources available are likely to be very influential on the eventual success of an information search. Thus, the data corpus should contain the information needed and in a format needed. The corpus often differs from the whole web to a library to a subset of websites.

The media type can be different as well; e.g., video, picture, text, or hypertext [23]. Different media types put different demands on the user. For example, Homer et al. [16] show that learners who have a visual learning preference had less cognitive load when learning from videos. Furthermore, Rouet and Levonen [32] showed hypertext can cause feelings of disorientation and creates complex cognitive demands [32].

Text characteristics can help readers in finding information and understanding the text. At least three types exist. First, signaling devices are such as titles and (sub)headings. Second, typography like bold, italic, font use, and capitalization. And, third are structural elements; e.g., graphics, (sub)sections, table of contents, and indexes. These elements have been shown to interact with, amongst others, age and number of search terms, in students success to find information [8].

The system dimensions form the methods to act for the system to alleviate the problems of Section 1. For example, the next section will show how, through changing the retrieved information sources, the system can aim at improving the actualized user variables.

### 3. Child-Centered Relevance

The previous section has presented a framework containing numerous variables of influence when performing an information search. These variables have been related to age as well, indicating why children sometimes have problems with using an IR system (See Section 1). Using the framework, this section will look at a notion of relevance suited for children. This child-centered relevance looks at characteristics of information beyond topicality, salient to improve the actualized user dimensions (e.g., the experience). Several possible lines to influence the actualized user dimensions are, per dimension:

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**Table 5: Interrelations of actualized user dimensions.**

<table>
<thead>
<tr>
<th>Concept</th>
<th>Interrelations</th>
</tr>
</thead>
<tbody>
<tr>
<td>perceived problem</td>
<td>problem**</td>
</tr>
<tr>
<td></td>
<td>familiarity**[20]</td>
</tr>
<tr>
<td></td>
<td>motivation*[36]</td>
</tr>
<tr>
<td></td>
<td>search process**[22]</td>
</tr>
<tr>
<td>motivation</td>
<td>search performance**[20]</td>
</tr>
<tr>
<td></td>
<td>perceived problem**[30]</td>
</tr>
<tr>
<td></td>
<td>affective state*[30]</td>
</tr>
<tr>
<td>affective state</td>
<td>search performance**[22]</td>
</tr>
<tr>
<td></td>
<td>information seeking pattern**[22]</td>
</tr>
</tbody>
</table>

*Note. * weak relation, ** strong relation
• Perceived problem. The complexity of the retrieved documents, influencing the perceived problem.

• Motivation. The interestingness of information, next to task performance a core determinant of intrinsic motivation [30].

• Affective state. The affective value of the information and interactivity of a website influence the affective state of the user.

Please note that this is not supposed to be a comprehensive nor prioritized list. Each of the italic written concepts will be elaborated.

The presented parts of relevance have been confirmed by other studies. For example, Barry and Schamber [4] showed numerous relevance criteria: scope, validity, clarity, currency, tangibility, quality, accessibility, verification, and affectiveness. [15] showed interestingness, accessibility, and language are among children’s relevance criteria. Moreover, each of the parts are intrinsically related to the actualized user dimensions, enhancing the affective state, motivation, and reducing the perceived problem of the user.

3.1 Complexity

The perceived problem can be influenced by reducing the complexity of a search. When incorporating this into the notion of relevance, the expectation is that retrieving an information object close to a user’s skills and knowledge (See Section 2.3.1) will reduce the perceived complexity of the information need. Moreover, adjusting the complexity of the search results can be especially salient for the beginning of a search, where the user often has less structure in his information problem. For example, if the user has an unstructured information problem for a relatively unknown topic, the scope of the retrieved information objects should be quite large, whereas the used vocabulary should not be too specific. Numerous studies confirm that understandability, comprehension, and complexity are among the core relevance criteria users apply to documents [4]. Moreover, navigational complexity of a website is also related directly to the user experience [26]. The following characteristics have already been identified and linked to the complexity of a document: readability, entropy, semantics/scope, and coherence. Automatic extraction of these characteristics has been shown feasible [38].

3.2 Interestingness

Interest is, together with a sense of control in the perceived problem, core to intrinsic motivation [30]. Interest is often viewed as a cognitive construct; “liking and willful engagement in a cognitive activity” [35, p. 23]. Moreover, interests differ between people and between groups of people; e.g., children have different interests than adults.

Table 6: Interrelations of system dimensions.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Interrelations</th>
</tr>
</thead>
<tbody>
<tr>
<td>data corpus</td>
<td>search performance**</td>
</tr>
<tr>
<td>media type</td>
<td>learning preference** [16], affective state** [32]</td>
</tr>
<tr>
<td>text characteristics</td>
<td>search performance** [8]</td>
</tr>
<tr>
<td>interface</td>
<td>perceived problem*, affective state* [23]</td>
</tr>
</tbody>
</table>

Note. * weak relation, ** strong relation

4. DISCUSSION

As indicated in Section 1, current IR systems are not optimal for children. To support this statement, four groups of problems were introduced, concerning the mental model, vocabulary, (chaotic) search behavior, and relevance judgments. These problems could (partly) be explained by dissecting core factors relevant in IR usage, concerning the human, system, interaction, and context. For example, the problems concerning the mental model can be explained by the domain knowledge of the user; the vocabulary problem is related to the literacy skills and domain knowledge; the chaotic search behavior is partly explained by self-regulation or motivation, and partly by learning styles; and, finally, rel-
evance judgements are related to the epistemological believes of the user. All of the mentioned attributes improve with age: e.g., knowledge and (meta)cognitive skills increase with age, making it clear why these problems are often found in children’s IR usage.

Section 3 introduced one direction to address the identified groups of problems, through indicating those aspects of information objects which are in particular salient for children’s IR experience. As such, trying to achieve a notion of, so-coined, child-centered relevance. Three parts of child-centered relevance were elaborated: complexity, interestingness, and affective value. Though an implementation of any of these is not (yet) straightforward, the feasibility has been illustrated. Through adjusting the complexity, interestingness, and affective value to the user, the perceived problem, motivation, and affective state can (theoretically) be influenced. This immediately shows the need for further research: it is yet unclear if child-centered relevance can indeed influence these variables, and with that, the user experience of IR for children. Moreover, the balance between these variables is also an unsolved issue: how complex, novel, and positive should an information object be, compared to topicality, to be relevant to an un-experienced user?

The child-centered relevance looks at the search results and the (actualized) user variables. However, instead of focussing on the information objects and the (actualized) user variables, implications can be derived for other aspects of the IR system as well. The introduced HCI-model (interaction, context, user, system) illustrates the full length of possibilities. For example, when looking at the system dimensions, the interface can be altered, including the interaction paradigm (e.g., query-based) and results presentation (e.g., synopsis of search results). Moreover, the interaction can be extended to support every step of the search process (See Table 2). Lohmann et al. [25] give an example of an explorative interface for images, supporting a fully different approach to accessing and presenting information objects. Therefore, the overview given in Section 2 mainly serves a broader view on IR, a necessity when retrieving information for children, or broader, users with special needs.

It is key for children’s development to give them access to information understandable to them, in a way which suits their view of the world. However, current IR systems do not support children well: they require complicated queries, and often retrieve inappropriate results in a format unsuitable for children. This paper aimed to facilitate the creation of child-centered information access, based on an understanding of the behaviour and needs of children. It is part of a larger project, PuppyIR, which constructs an Open Source Framework that will provide the infrastructure to develop child-focused and child-friendly components to be deployed within child information services.

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