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Where a Little Change Makes a Big Difference: A Preliminary Exploration of Children's Queries

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Abstract. This paper contributes to the discussion initiated in a recent SIGIR paper describing a gap in the information retrieval (IR) literature on query understanding–where they come from and whether they serve their purpose. Particularly the connection between query variability and search engines regarding consistent and equitable access to all users. We focus on a user group typically underserved: *children*. Using preliminary experiments (based on logs collected in the *classroom* context) and arguments grounded in children IR literature, we emphasize the importance of dedicating research efforts to interpreting queries formulated by children and the information needs they elicit. We also outline open problems and possible research directions to advance knowledge in this area, not just for children but also for other often-overlooked user groups and contexts.

Keywords: Queries · Children · Search · Query processing

1 Introduction

In their recent SIGIR perspective paper, Alaofi et al. [2] spotlight a crucial gap in the Information Retrieval (IR) literature regarding *understanding where queries come from*; that is, why they are worded a certain way or whether *query*

[1] "Multiple queries can represent a single information need" [8]. In this context, query variability refers to the various keyword or phrase combinations searchers can employ to articulate their requirements when faced with the same information need [2,8].

All authors contributed equally to the discussions presented in this work.

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variability[1] can affect the search process, as not all queries lead us to useful information. Expanding on this discussion, we bring attention to a user group often underserved in the IR realm: **children**. Native users of search engines (SE) [17] who are in the process of acquiring vocabulary and domain knowledge, children struggle with translating their information needs into queries that prompt SE to retrieve and rank resources that are actually about what they were looking for [21,45,58]. They have in-development (cognitive) skills and an affinity to search tools that differ from adults and thus deserve actions tailored to them.

Literature on children and their interactions with IR tools is relatively limited [33]; more so from the IR perspective—the human-computer interaction community has long recognized children as important actors and has allocated efforts to outlining user experiences with and for children. Of note, strategies that simplify query formulation using images [50] or spelling suggestions specifically responding to children's query misspellings [20]. Several probabilistic, lexical, and neural-based models offer children query suggestions [5,7,48,56,57,63]. How children (re)formulate queries, along with SE performance in response to children's queries, have also been explored from diverse perspectives, including relevance, suitability, and emotion [6,12,13,34,41,59,60,60]. For the most part, the children IR community has focused on understanding search behavior and system performance. However, it has seldom considered factors that may influence how children choose the keywords to initiate the search process and the cascading effect on the results they see.

In this work, we discuss insights emerging from an initial exploration of query variations formulated by children in the **classroom** context. Given the preliminary stage of our exploration and to control *scope*, we limit our analysis to *children ages 9 to 11 in the classroom context*. Whenever possible, and to offer context to our findings, we discuss alignment with observations from experiments and literature concerning commonly-studied searchers (adults) reported in [2]. Further, we outline future directions for this research area inherent to the user group and context under scrutiny. Focusing on children enables the inspection of a range of issues, as they are not biased by previous experiences or keep them undisclosed because of social pressure-shame; on the contrary, they are more open given their limited digital and literacy skills, as reported by involved observers, teachers, and parents [22,52]. We argue that studying children could be a means to better understand other user groups experiencing similar issues relating to (lack of) access to information. With that, we invite the IR community to leverage discussions in this manuscript that add to those in [2], and together use them as a blueprint to study this area further.

2 Preliminary Exploration

To decipher children's queries, where they come from, and what social, linguistic, and cognitive factors, among others, influence their formulation, we probe query variability and their effect on search results.

Contrary to [2], we cannot turn to known **test collections** like TREC-8 Query Track [14], UQV-100 [9] or ClueWeb12C [15], as they do not explicitly

capture the interactions with SE of non-traditional user groups, such as children. To bypass this limitation, we reached out to Landoni et al., who shared the logs produced for the studies presented in [39,41]. Data collection took place using the same protocol in three different classrooms in two Italian-speaking countries. We were permitted to use anonymized data (stored in a secure location) for research purposes. As part of regular instruction, children engaged in online inquiry tasks related to subjects common to the primary school curriculum, e.g. science and history. Search prompts for these tasks invited children to discover resources explaining for example current environmental concerns or how to recognize different types of volcanoes. Further, some questions were fact-based (e.g., "Where was ancient Rome founded?") and others open-ended (e.g., "How were the pyramids built?").

This resulted in the logs we use as a test collection, called `CQL`, comprised of topics (search prompts), queries, and the corresponding SERP (up to the 10^{th} result) generated using Bing (https://www.bing.com) (advertisements which are often present in SERP were excluded; to prevent user profiling, each query induced a new browsing instance). Each SERP result is labeled as (non-) relevant by expert educators. Overall, `CQL` includes 345 queries across 64 topics and 1,538 unique labeled URLs. In the context of this work, as in [2], we define **variations** as the set of queries formulated to address the same user information need (i.e., queries generated in response to the same search prompt—topic.).

We associate each SERP result with a **reading level**. For this, we used Python's Textstat (https://pypi.org/project/textstat/), a library for readability prediction of texts in Italian based on *Flesch Reading Ease*. As reported in [4,44], there is no consensus on the "best" or "more suitable" readability formula to use when determining the text complexity of texts; more so for texts written in languages beyond English. Consequently, we use Flesch Reading Ease for readability estimation, given its popularity and broad adoption in the literature [26,28]. We also append the **emotion** inferred for each SERP result using Python's FEEL-IT (https://pypi.org/project/feel-it/), which is based on the Italian BERT model UmBERTo, fine-tuned to predict four emotions: *anger*, *fear*, *joy*, and *sadness* [11]. We adopted FEEL-IT, a state-of-the-art strategy specifically designed and empirically proven to be effective when applied to Italian text [10,11]. Due to the preliminary nature of this work, we bypassed manual assessment for reading level and emotion labeling in favor of automated strategies. Moreover, the reading level and emotion of each SERP result were inferred from its title and snippet text sample. Although using snippets as a proxy for the content of the corresponding full page has been shown to be a viable alternative [3,53], we expect to examine the whole text of SERP results in future iterations of this study.

Variability. We first look at whether children, like adults [2], adopt a range of alternatives to express the same underlying information need. Analysis of `CQL` reveals query variations for 38 (of the 64) topics, with an average of 7 query variations per topic. We depict in Fig. 1 (top) variation counts grouped by topic, which range from 2 to 18, with a median of 5.5. To ease visualization, we excluded from the figure topics for which no variations were found. It is worth noting that while these results verify variability exists, as stated in [2], it is still

unknown what causes these variations among children or how to design SE that can "alleviate or potentially exploit" [2] this variability to better serve them.

Commercial SE. To explore the effectiveness and consistency of search results, we probe `CQL` utilizing multiple lenses. We use MRR and nDCG@5 to investigate disparity in relevant resources instigated by query variations; with Rank Bias Overlap (RBO) [62] we measure the consistency of retrieved results across variations. As in [2], to compute RBO, we compare the SERP generated for any pair of query variations for a given topic, which we then average. Visible from Fig. 1 is that, except for a handful of topics, query variability causes fluctuations in performance (MRR and nDCG@5, resp.). It is also apparent (from RBO) that (even minor) changes to how queries are expressed or the terminology used can yield dissimilar result sets.

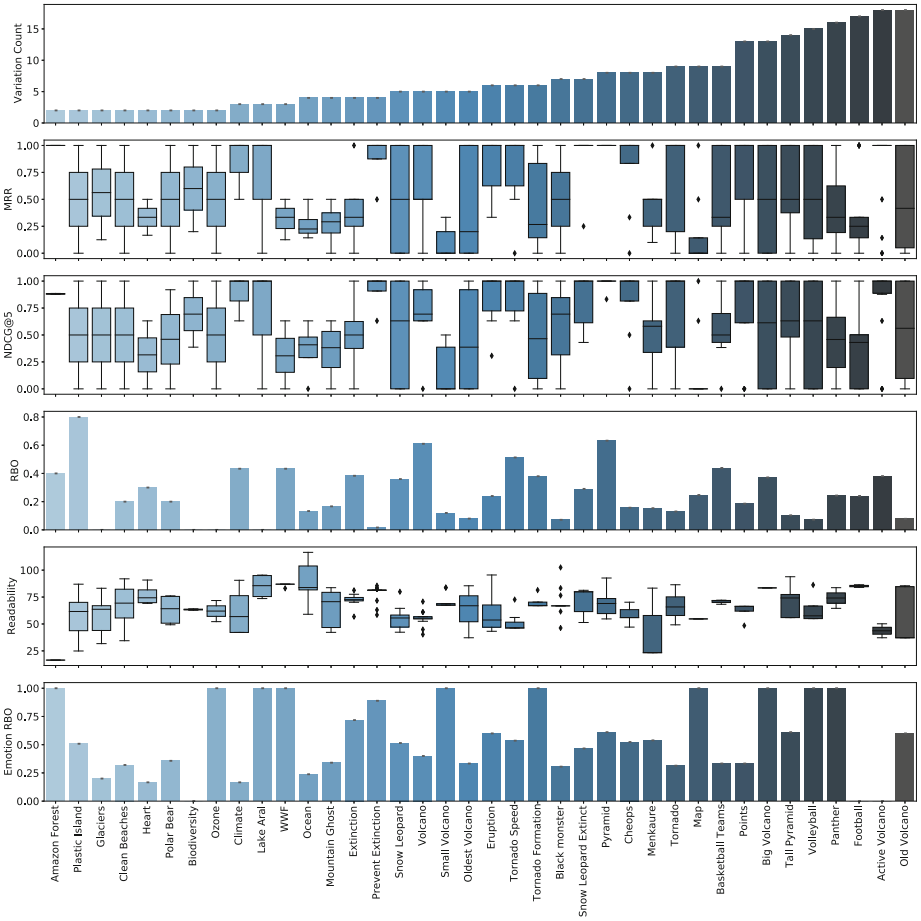

Fig. 1. Different measures are used to assess query variability based on `CQL`.

We see discrepancies in the position of the first relevant result retrieved, the number of relevant results positioned earlier in the ranking, and the result sets retrieved. These initial outcomes exemplify the impact of query variability on SE (also demonstrated in [2]), evidencing inequity on how SE serve searchers simply by them using different terms to address essentially the same topic. For example, 'plastic island' and 'plastic island place' (translations from the original Italian) are similar, yet they yield different results, with the top-1 being relevant for the former and not for the latter.

Readability. With children at the center, we must consider the potential connection between query variability and text complexity. For this, we gauge the readability level of the first result retrieved for each query variation. As discussed in [6,29], children tend to linearly explore SERP, starting from the top. This is why it is crucial to determine if even slight variations negatively impact children, i.e., lead to results that may address the intended information need but are above a level children can read and understand, rendering them useless. In the case of Flesch Reading Ease, the higher the score, the easier the corresponding text is to read. A score of 80 aligns with the expected reading level for 10- to 11-year-olds. Query variability visibly alters the results young searchers are exposed to (Fig. 1-Readability). For most topics, the readability score is far below the one they can comprehend. This emphasizes the need for `IR` research on boosting children's abilities to formulate queries (via scaffolding or novel query formulation strategies) that can ease the reach of suitable results, as well as incorporating readability as another measure of relevance for children. The latter can leverage foundational knowledge resulting from existing research in the medical domain that argues in favor of considering readability (among other factors) as a criterion for optimization beyond topicality [19].

Emotions. Recent studies examine the emotion profile of commercial SE, i.e., the emotions inferred from results retrieved for queries formulated by diverse user groups [36,42,46]. This motivated examining changes in emotions, if any, that are the direct result of query variability. We again rely on RBO as a proxy to capture the (dis)similarity of emotions observed among top results (the first and perhaps only children will engage with) generated in response to query variations. The higher the RBO, the more homogeneous the emotions inferred. As illustrated in Fig. 1 (bottom), query variations spur results conferring the same emotion for very few topics. As mentioned in [42], the affective lens is one of importance to expand upon, particularly in the context of younger children without the presence of the expert-in-the-loop (parents or teachers, depending on the context of the search), as well as other non-traditional user groups, such as those afflicted with mental health disorders [46].

3 Directions Inherent from Children and the Classroom

Here, we examine the research directions that resulted from reported initial findings (Sect. 2), and how these in turn call for further study areas to be investigated to obtain a holistic understanding of where children's queries come from.

Alaofi et al. [2] anticipate that understanding where queries come from requires revisiting *information-seeking models*. This is also true for children's queries, as literature about the information-seeking behavior of this user group is limited and seldom grounded on theoretical models [16]. Further, to our knowledge, existing theoretical models do not explicitly account for users for whom the concepts of uncertainty and aboutness might be challenging to grasp [37,45].

There are no *test collections* to guide children IR advancements. Developing collections representative of children with different skills and abilities, even within the same age range, capturing a variety of topics would be indispensable. In turn, this would enable the collaboration among researchers and practitioners on the creation of benchmarks to compare the effect of query variations across user groups. At the same time, the need to protect children's *privacy* [1,54,61] somehow interferes with gathering, building, and curating collections to enable researchers to study how starting from the same prompts describing a search task, different queries are formed, with only very few of them retrieving resources that are safe, readable, relevant, and trustworthy for children to use.

Lessons learned from children IR literature indicate that, as mentioned in [2], context and cognition factors, mediated by age, could shape children's query variability. We believe that the *roles* children play when searching (which are not mutually exclusive) can also impact their keyword selection to engage with the search process [23,24,38]. This is prompted by the mapping between cognitive bias in IR already identified in the literature for traditional user groups [27] and search roles observed among children [24,42]. We look at *the classroom* as providing context and social support to children, as well as the necessary scaffolding while developing media literacy. An example is *query elicitation from teachers* and how assisted searchers (children who depend on guidance to have a successful search experience) [38], outperform online searchers working in isolation. Similarly, Rutter et al. [51] look at how communication between teachers and children helps them to better express their information needs and retrieve useful information. we need to better understand how the choice of keywords used by teachers in the formulation of a search task together with those shared in a class discussion can result in several query variations and identify those bringing to *safe, useful, understandable, and trustworthy* results.

Further, the *interplay between distraction and reformulation of a particular query*, is summed up in the role of the distracted searcher [22,38], easily attracted by other activities and quickly abandoning the search task. *Task complexity and formulation* are crucial in children's search experience [51]. The quest for the right complexity to equally avoid boredom and frustration relies on teachers' expertise and their ability to match children's ever-changing interests and skills.

The spread of online *mis/disinformation* is something to be attentive to when it comes to children [32], who are known to be easily influenced and less critical than adults [30,49]. The rule-bound searcher [22,39] believes *fixedness* is a way to keep safe by starting from the same trusted source, often Wikipedia, and repeating the same query with no reformulations. Instead, as children's safety is paramount, they need to be actively trained in formulating queries

that can deter the retrieval of misinformation, recognizing trustworthy sources, and developing the ability to judge the quality of the results they are offered [49]. Query autocompletion to support formulation in this context might not always be effective [31]. Further, there is a lack of research on what constitutes dis/misinformation for children beyond fake news [43,55]. These are some of the reasons why it is of utmost importance to allocate research so that SE can "cope with query variations that have been 'nudge' towards misinformation" [2].

Input *modality* is another influential factor [2], more so for young searchers. Researchers already note changes in how children express their queries depending upon the interface they interact with (a text search box, a voice-driven search like Alexa, or personalized conversational agents) [7,35,39,52]. We wonder whether those distinguishing traits would remain if we were to study children addressing the same search prompts on different devices or if children's perceptions of technology would bias their formulation [18].

4 Concluding Remarks

Equity in IR technology is a complex problem. The IR community has risen to this challenge with works on fairness, bias, and accessibility [25,47,64], but there is still much to be done. With their call for SE to *"provide more consistent, accurate and relevant search results regardless of the searcher's framing of the query"*, Alaofi et al. [2] expand the discourse in this area by highlighting query variability and its potential impact on equitable information access. Inspired by their work, and aiming to bring attention to young searchers, we inspected queries produced by children ages 9 to 11 in the classroom, i.e., in a specific state of cognitive and linguistic development, and captured factors that can contribute to the discussion.

With this work, focused on facets specific to young searchers, we hope to add to the comprehensive picture started in [2] on how searchers select the keywords they use to initiate a search, and how in turn query variability could hinder access to information. Paraphrasing Bilal "valuable findings from work related to children IR could serve as another layer towards advancing knowledge in mainstream IR" [40]. Consequently, we posit that this work can encourage similar and perhaps more rigorous investigations once benchmarks will be available to run comparisons across user groups. These investigations will enable us to learn more about children (beyond the ages we study) as well as other user groups and contexts underserved in IR literature for which it is critical that the queries they employ mitigate mis/disinformation, including searchers affected with mental health disorders, those with low literacy, and language learners (e.g. refugees seeking online resources). This will require multidisciplinary teams with expertise beyond IR to ascertain the various factors that make query variability so crucial.

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