

To Infinity and Beyond! Accessibility is the Future for Kid’ Search Engines

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Research in the area of search engines for children remains in its infancy. Seminal works have studied how children use mainstream search engines, as well as how to design and evaluate custom search engines explicitly for children. These works, however, tend to take a one-size-fits-all view, treating children as a unit. Nevertheless, even at the same age, children are known to possess and exhibit different capabilities. These differences affect how children access and use search engines. To better serve children, in this vision paper, we spotlight accessibility and discuss why current research on children and search engines does not, but should, focus on this significant matter.

CCS Concepts: • **Social and professional topics** → **Children**; • **Human-centered computing** → *Accessibility*; • **Information systems** → *Web searching and information discovery*.

Additional Key Words and Phrases: children, information retrieval, accessibility, personalization

1 "YOU GOT A PLAY-DATE WITH DESTINY!": FOUNDATION

A wide range of users regularly turn to search engines in varying settings, e.g., work, home, and school [1, 11, 27, 42]. For decades, the Information Retrieval (**IR**) community has introduced algorithmic solutions to improve and expand the performance of search engines; it has also studied the people who utilize them. The bulk of existing research works respond to the requirements of “general” users who are, for the most part, adult searchers. We could, however, name other “non-traditional” user groups, e.g., expert searchers, searchers for whom English is not their first language, and children¹, who routinely use search engines, but struggle to best take advantage of them as they are not designed with non-traditional searchers in mind. Children, in particular, have specialized cognitive and physical requirements when it comes to information seeking using search engines [6]. With children making up almost a quarter of the population and being heavily reliant on search engines to satisfy their information needs [41], we scope our discussion to encompass *search engines and children*.

From a preliminary literature review on Google Scholar and the ACM Digital Library using queries including “web search children” and “search engine children,” it emerges that research about children and search engines started in the late 1990s. To our knowledge, the earliest publications include those by Dania Bilal [4, 5], who aimed to understand how children interact with search engines specifically designed for them, as well as Martyn Wild [52], who studied how children use the Internet for information seeking. These contributions provided the groundwork for future research looking into (i) how children use search engines, (ii) modifying search engines algorithmically for children, and (iii) the design of search engines tailored to children [14, 23]. Thus far, promising research in this area has probed each stage of the information seeking process. Given that children struggle with query formulation, it is not unexpected to see

¹Here, whenever we state children we refer to any person under the age of 18, as per UNICEF’s Convention on the Rights of the Child [46] who have unique needs and expectations when using search engines.

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projects studying how children express their information needs in the form of queries or introducing new strategies to ease the burden of query formulation [8, 25, 49]. Query suggestions could, to a degree, facilitate the task of identifying effective queries to initiate the search process. Oftentimes, however, suggested queries are the result of query-log-based strategies which are heavily influenced by searches conducted on search engines by general users. To address this limitation, researchers have produced query suggestion strategies that are more appealing to children and that best respond to their search intent [16, 36, 44]. When looking at results retrieved in response to children's queries, Anuyah et al. [2] and Bilal and Huang [9] investigate the reading level of SERP and whether they align with a child's reading level. When considering the relevance of retrieved resources, children tend to explore search engine result pages (**SERP**) sequentially, i.e., from top to bottom [26, 32], as opposed to deciding relevance through scanning SERP snippets and clicking on a given result. This prompted researchers to investigate ways to both filter and re-rank resources so that those more relevant and suitable for children make their way to the top of the SERP [7, 13, 18, 20, 38, 40, 48]. From the standpoint of how children use search engines, Foss et al. [21] as well as Duarte Torres and Weber [17] study children's interactions at different stages of the information seeking process.

The literature that we have discussed has been pivotal to the advancement of IR regarding children and search engines. Yet, research has been sporadic throughout the last two decades and limited to few research groups. We attribute the inconsistent nature of this type of research to issues related to obtaining children's data and the ability to freely share benchmarks as well as labeled data to inform development and evaluation, which other domains do not have with as datasets are fallible, e.g., CLEF, TREC, etc. More importantly, these scholarly works focus on children in specific age ranges, e.g., 8 to 11 year-olds or adolescents. This is a concern as (i) children in these user groups do not exhibit uniform (search) behavior, and (ii) the full spectrum of requirements and expectations of children (18 and under) has been overlooked. Given the exigency of supporting children's search, a one-size-fits-all solution is not adequate. Instead, various lenses that take into consideration the different skills children possess should be pursued when altering or designing search systems. In this paper, we spotlight the *accessibility* lens. Explicitly, we discuss the demand for making search engines more *accessible* for children of different mental, physical, and learning/developmental abilities.

2 "WE GOT TO GET THIS WAGON TRAIN A-MOVIN'!": GAPS

The call to create accessible search engines is not a new idea [29, 43]. IR researchers have allocated efforts to explore how adult searchers affected by dyslexia deal with search engines [22], the information-seeking process of adults with invisible disabilities [39], and how to best adapt search engines to searchers who are vision-impaired [50, 51]. Unfortunately, substantial progress has yet to be made by the IR community regarding accessibility for children—the population currently under study—beyond some preliminary investigations like autism [54]. To highlight some opportunities for adapting search engines to support children with disabilities, we provide some motivating examples showcasing the necessity to dedicate scholarly efforts to holistically look at children, search engines, and accessibility.

Query formulation. Downs et al. [15] present a specialized spellchecker (KidSpell) tailored explicitly to children to help with query formulation, as there are trends in how children misspell words that differ from those observed among adults. We posit, however, that KidSpell would not necessarily work for children with dyslexia, who are prone to make different types of misspellings [30, 34]. Additionally, KidSpell incorporates a visual and audio component that may adversely impact users with autism by unintentionally inducing sensory overload [37].

Query suggestions. Madraza Azpiazu et al. [36] introduce ReQuIK, a query suggestion strategy for children ages 8 to 11 that infers children's intent from their original queries. ReQuIK, which conventionally displays suggestions, may not be applicable for children who are vision impaired. Vision hurdles could indeed be bypassed by relying

on conversational voice search, which Lovato et al. [35] explore, but this too comes with accessibility gaps. For a conversational voice search to be effective, it must understand the verbal input provided by users, which is difficult in the case of children in general [12, 19, 23, 24, 45, 53], but is further exacerbated when children have speech impediments or disorders like Tourette syndrome.

Ranking. Milton et al. [38] and Usta et al. [47] propose new ranking algorithms to prioritize retrieved results that are relevant to educational contexts. Both rankers depend upon a user's age, which is mapped to a respective school grade and then used to identify online resources that align with the educational curriculum outlined for a said grade. By assuming that a child's age directly matches with their developmental stage or reading ability, the rankers cannot account for children that have disabilities like autism or dyslexia.

Interactions. Landoni et al. [31] investigate whether adding visual cues to SERP displays to provide clues for resource relevance eases the process of locating resources addressing children's information needs. Aside from the visual issues that we have already discussed, the authors utilize a traditional SERP which can be difficult to navigate for young children who lack fine motor skills [23]. When considering children with more extreme physical disabilities, like missing limbs, cerebral palsy, or muscular dystrophy, it becomes almost impossible to employ standard keyboards and mice to interact with SERP.

SERP. Landoni et al. [33] explore the emotional responses captured in SERP generated by children searching for classroom-related materials. The authors point out that during their user study, teachers observed emotional responses evoked in child participants by search results. The ethical nature of whether distressing search tasks are suitable for children on an emotional level is also brought up. This concern is escalated when considering children with mental health disorders, particularly those with bipolar, depressive, anxiety, attention deficit (ADD/ADHD), or post-traumatic stress disorders. Additionally, research strategies that leverage the emotions of children must also consider that some of them may not have an adequate emotional maturity level or ability to feel emotions, which is a symptom of antisocial personality disorder, psychopathy, or sociopathy.

The examples we have discussed neither in any way represent an exhaustive list of all known disabilities that impact children nor the open problems related to the accessibility of search engines. Instead, they are meant to offer a glimpse of how existing research is underserving children with disabilities and their potential use of search engines.

3 "WELL, THEN, LET'S FIND OUT TOGETHER!": FUTURE

Even from the few examples we have drawn attention to in Section 2, it is clear that there are plenty of research gaps that emerge when considering the complex problem of accessibility. Indeed, living up to the requirements and expectations of how children with disabilities use search engines and how search engines can better support them, is not an easy feat. We hypothesize that research in this area cannot be done in isolation and that instead, it will require long-term, dedicated collaborations involving researchers from multiple disciplines. Increasing accessibility of search engines is one important step forward towards creating an environment where all users, especially children, have equal access to essential information. Accessibility is a broad concept, one that encompasses multiple lenses. As a starting point to foster discussion in this area, we shine a light on three categories of disabilities that affect children's ability to use search engines: physical, mental, and developmental/learning.

Consider, for instance, physical interfaces, e.g., augmentative communication devices or voice synthesizers, that are meant to convey ideas for disabled people – how do researchers ensure users can use such devices to interface with search engines as a means for users to form queries? How do search engines handle input received from any assistive hardware and translate users' information needs into queries or trigger click interactions? While some hardware has

already been designed, e.g., specialized controllers in the video game industry, to improve accessibility for users with motor disabilities, what can we learn as a community from these specialized tools and adopt to make search more accessible? What about the way that SERP are presented, would spacing of results be an issue? Do audio and visual aspects of SERP present barriers or distractions for children with disorders such as anxiety or ADD/ADHD?

Many interfaces on child-oriented search engines are designed to be more engaging by using audio and visual elements. Some of these visual elements are based on bright colors, which are known to have inherent emotions attached to them, e.g., red is associated with sweets and green with healthy [28]. What sort of impact do these visual elements have on children with mental disorders? Black and other dark colors are often associated with connotations of depression. How do search engines deal with depressed children as users? How would a search engine know if a child is suffering from some form of trauma that could be triggered by results presented to them? Many mental health issues will go undiagnosed for years. How can a search engine be aware of and adapt to something that even the users, their teachers, or their parents do not know?

With developmental conditions where age and maturity differ, how do search engines account for the difference in development? In their current state, modern search engines are heavily text-based, requiring that users can adequately read and understand the resources returned. When a child is behind in their reading level or math skills due to dyslexia or dyscalculia, how do search engines adapt so that they can provide resources that are at children's cognitive level instead of age level?

The questions we have expounded here are not comprehensive of all the avenues to explore. Instead, our goal is simply to encourage researchers to consider significant barriers that, nowadays, search engines exhibit when it comes to serving children with disabilities. As previously mentioned, tackling such a complex and diverse matter should take place in a multidisciplinary setting. Together, researchers from domains including education, mechanical & electrical engineering, developmental & clinical psychology, sociology, natural language processing, human-computer interaction, machine learning, and medical must ruminate on what accessibility means to them. It is only based on their reflection and collaboration with IR researchers that will enable the design, development, and assessment of search engines that respond to real-world necessities and can therefore provide the appropriate support that children with disabilities need when interacting with search engines. It is key to remember that accessibility does not have to be thought of as a burden, as it enhances search engines without reducing their effectiveness [3]. While the current generation of IR researchers has focused on the effectiveness of search engines, it is imperative to inspire the next to focus on accessibility as it is a long-term problem. It is also imperative that we involve researchers coming into the IR community to (i) successfully be part of interdisciplinary research teams and (ii) update IR curriculum taught at undergraduate and graduate institutions to increase awareness about different types of users and accessibility issues affecting IR-related systems –beyond search engines–as they will be the ones carrying the torch forward. As Eve Andersson, the Director of Google said, “the accessibility problems of today are the mainstream breakthroughs of tomorrow” [10].

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