



Web Search Interfaces for Children: A Systematic Literature Review



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ABSTRACT

The development of digital literacy in children is strongly influenced by the design of web search interfaces. Most mainstream search engines focus on adult users and do not align with children’s cognitive, linguistic, and social abilities. This systematic review examines how current web search interfaces support children’s information-seeking behaviors. It also identifies gaps between design intentions and the needs of young users. A comprehensive search was conducted across major databases, including Semantic Scholar, Scopus, Springer, ACM, and PubMed. After screening and deduplication, 27 high-quality studies were included. These studies cover empirical research, interface design, digital literacy, and child-friendly search tools. Findings show that children struggle to formulate effective queries, interpret results, and evaluate credibility. Misunderstandings of how search engines work contribute to these difficulties. Adaptations such as voice-based interfaces, gamification, and visual aids can improve engagement and performance. However, real-world use is still dominated by Google and Bing. Emerging technologies like conversational agents, AI-powered chatbots, and collaborative search models offer potential to reduce cognitive load and provide better support. These tools also introduce challenges related to transparency, trust, and educational alignment. Overall, current web search interfaces do not fully meet children’s needs. The review provides insights for researchers and designers. It highlights the importance of developing search systems that are literacy-aware, developmentally appropriate, and equitable for young users.

1. Introduction

Web search interfaces are a key gateway for children to access information. They support both formal and informal learning. They also help children develop digital literacy skills. Digital technologies are now deeply embedded in daily life and education. As a result, children use search engines at younger ages. Many do so independently. Guidance is often limited or absent. Most mainstream search systems are designed for adults. They assume strong language skills. They assume advanced cognitive abilities.

They also assume prior knowledge of how search systems work. These assumptions reduce accessibility for children. They also limit effectiveness and educational value. Research on the link between child cognitive development and web search behavior is growing rapidly. Empirical studies show mixed effects of digital device use. Some effects are beneficial. Others are harmful. Key domains affected include language. Executive function is also influenced. Attention and memory are involved as well. Outcomes depend on several moderating factors. These include the type of content used. Parental mediation plays an important role. Socioeconomic context is also influential. Prior studies highlight these patterns consistently. (Arabi et al., 2022; Clemente-Suárez et al., 2024; Carson et al., 2015; Wu et al., 2023; Mączyńska et al., 2025).

1.1 Background and Motivation

Research shows that children interact with web search systems differently than adults. Young users often struggle to create effective queries. They also have difficulty interpreting ranked result lists and evaluating the reliability and relevance of information sources (Vanderschantz & Hinze, 2021; Downs et al., 2021; Babari et al., 2023). These challenges are not purely technical. They are rooted in developmental factors such as limited vocabulary, emerging reading skills, and evolving metacognitive abilities. Children often have incomplete or inaccurate mental models of how search engines function. Some assume that systems like Google have human-like intelligence or unlimited knowledge (Girouard-Hallam & Danovitch, 2024a; 2024b). To address these difficulties, researchers and designers have proposed child-oriented search interfaces. Examples include simplified layouts, visual relevance cues, emoji-based indicators, gamified interactions, and voice or conversational input (Aliannejadi et al., 2021; Yadav & Chakraborty, 2021; Bettencourt et al., 2024). Empirical studies show that these modifications can reduce cognitive load, increase engagement, and improve task performance. Despite these benefits, adoption remains limited. Most implementations exist only in experimental settings or educational environments. The majority of children continue to use mainstream search engines designed primarily for adults (Vanderschantz & Hinze, 2021; Allen et al., 2023).

1.2 Children as Information Seekers

Children are active and goal-oriented information seekers. Their search behaviors reflect distinct developmental trajectories. Studies consistently show that children tend to use short and underspecified queries. They rely heavily on surface level cues such as images and familiar words. They also demonstrate limited strategies for query reformulation and result comparison (Vanderschantz & Hinze, 2021; Brante et al., 2024). Reading ability, domain knowledge, and prior experience with digital tools strongly influence search success. These factors often intensify inequalities between learners with different backgrounds and skill levels (Brante et al., 2024; Monteiro et al., 2023). Beyond technical challenges, affective and social factors play a critical role in children's search experiences. Emotions such as frustration, uncertainty, and overconfidence shape how children interact with search systems and interpret results (Landoni et al., 2020). Trust is another key dimension. Children often assume that search engines provide accurate and objective information. This belief can limit critical evaluation and increase vulnerability to misinformation (Girouard-Hallam & Danovitch, 2024a). These findings emphasize that children should be treated as a distinct user group. They require tailored interaction models, appropriate scaffolding, and explicit support for the development of search literacy rather than simplified versions of adult oriented systems.

1.3 Limitations of Adult-Centered Search Engines

Mainstream search engines such as Google and Bing are designed for efficiency, scalability, and general use. They rely on complex ranking algorithms, dense result layouts, and text focused interfaces (Krayz Allah et al., 2021a; Krayz Allah et al., 2021b; Krayz Allah et al., 2021). These design choices support experienced users. They often conflict with the needs of children. High reading demands, ambiguous snippets, commercial content, and limited algorithmic transparency can overwhelm young users and reduce meaningful engagement (Allen et al., 2022; Downs et al., 2021). Spell correction and query suggestion features are intended to assist users. They frequently fail to accommodate children's spelling patterns and emerging language skills (Downs et al., 2021). Adult oriented search systems rarely embed pedagogical intent. They prioritize delivering answers rather than supporting learning processes. Children receive limited guidance on how to search effectively, evaluate sources, or reflect on information quality. As a result, children may retrieve correct information without developing transferable digital literacy skills. Recent advances in AI driven search technologies introduce new possibilities. Conversational agents and generative systems may reduce interaction barriers and support comprehension. At the same time, they raise concerns related to transparency, explainability, bias, and the potential weakening of critical thinking skills (Murgia et al., 2023; Movahed & Martin, 2025).

1.4 Scope and Contributions of the Review

Against this background, this review synthesizes evidence from recent systematic reviews, empirical studies, and design based research. It provides a comprehensive overview of web search interfaces for children. The review draws on interdisciplinary research from human computer interaction, information science, education, and developmental psychology. It examines four core areas. The first area is children's web search behaviours and challenges. The second area is the design of child friendly search tools and interface adaptations. The third area is the role of emerging technologies such as conversational agents and AI powered search systems. The fourth area is the methods used to evaluate these systems and the evidence of their effectiveness. This review brings together research that has remained fragmented across disciplines. Its goal is to clarify how well current web search interfaces meet the needs of children. It also seeks to identify persistent gaps in design and search literacy. In addition, it outlines directions for future research and technological innovation. The contributions of this review are threefold. First, it presents an integrated conceptual framework for understanding children's search interactions. Second, it critically evaluates the effectiveness and limitations of existing interface design approaches. Third, it offers evidence-based implications for designers, educators, and policymakers who aim to create developmentally appropriate, equitable, and educationally meaningful web search experiences for children.

2. Related Work and Theoretical Foundations

Research on children's web search and information seeking behavior is inherently interdisciplinary. It draws on theories and empirical evidence from human-computer interaction, information science, developmental psychology, and educational technology. This section positions the present review within these research traditions. It outlines key theoretical perspectives that explain how children search for information. It also summarizes prior work on the design and evaluation of child-oriented search systems.

2.1 Cognitive and Developmental Characteristics of Children

Children's interaction with web search interfaces is shaped by cognitive, linguistic, and socio developmental factors. Developmental theories show that abilities such as abstract reasoning, multi-step planning, and credibility evaluation emerge gradually across childhood. Compared with adults, children typically have smaller vocabularies, less consistent spelling skills, and lower metacognitive awareness. These factors directly influence how they formulate queries and interpret search results. Empirical studies consistently report that younger users struggle to translate information needs into effective keyword queries. They often rely on natural language input, incomplete phrases, or trial and error strategies (Vanderschantz & Hinze, 2021; Downs et al., 2021). Children also hold incomplete or inaccurate conceptual models of how the internet and search engines operate. Research on mental models shows that many children perceive search engines as authoritative sources rather than algorithmic systems. Some attribute human like knowledge or intentional behavior to these systems (Babari et al., 2023; Girouard Hallam & Danovitch, 2024). These misconceptions affect levels of trust and judgments of credibility. They also increase reliance on top ranked results. These findings highlight the need for search interfaces that align with children's developmental stages and support clearer conceptual understanding of how search systems function.

2.2 Information-Seeking Behavior in Childhood

Information science research shows that children's information seeking behaviors differ from those of adults. Studies in classroom and informal search contexts indicate that children often prioritize speed and surface level relevance. They frequently select the first visible result and rarely compare sources systematically (Vanderschantz & Hinze, 2021; Brante et al., 2024). Challenges in result evaluation are compounded by limited reading comprehension, unfamiliar domain vocabulary, and minimal experience in assessing source credibility. Researchers have developed a range of interaction supports to address these difficulties. These include spelling assistance (Downs et al., 2021), readability aware ranking (Allen et al., 2022), emoji based relevance cues (Aliannejadi et al., 2021), and query scaffolding tools (Bettencourt et al., 2024). Design based studies show that these interventions can improve task success and engagement. Improvements are particularly evident in guided or classroom settings. However, most implementations remain confined to prototypes or experimental systems. Evidence of sustained adoption outside controlled environments is limited. Recent studies expand this work to collaborative and socially embedded search. Children work with peers, teachers, or parents as co searchers or facilitators (Silva et al., 2021; Figueiredo & Cameron, 2024). These approaches frame search as a socially situated activity rather than an isolated cognitive task. They align with socio cultural theories of learning. At the same time, they raise questions about scalability and integration into mainstream search platforms.

2.3 Digital Literacy and Search Literacy Frameworks

Digital literacy frameworks provide a critical perspective for understanding children's interactions with web search interfaces. Digital and search literacy go beyond operational skills. They include the ability to articulate information needs, evaluate credibility, understand ranking mechanisms, and reflect on the limitations and biases of online systems. Research shows that many children do not receive explicit instruction in these skills. They often develop search abilities implicitly through repeated use of mainstream engines (Monteiro et al., 2023). Educational technology research highlights the importance of embedding literacy support directly into search interfaces. Features such as visual scaffolds, guided prompts, and feedback mechanisms can provide just in time support. These supports reinforce learning during authentic search activities. At the same time, AI powered conversational agents and chatbots introduce new literacy challenges. Issues include transparency, explain ability, and trust (Murgia et al., 2023; Movahed & Martin, 2025). Conversational search may reduce cognitive load and match children's preference for natural language interaction. However, it can obscure sources and retrieval processes. This may reinforce misconceptions if the systems are not carefully designed.

2.4 Prior Reviews on Child-Oriented Search Systems

Several reviews have examined children's interactions with digital technologies. These include studies on conceptions of the internet (Babari et al., 2023) and search behavior in educational contexts. Most existing reviews focus on specific interface features, age groups, or learning outcomes. They rarely provide an integrated analysis of search interfaces, information seeking behavior, and digital literacy. In addition, rapid advances in AI driven search and conversational systems have outpaced much of the earlier synthesis. This systematic review extends prior scholarship. It synthesizes empirical studies, design based research, and recent reviews from HCI, information science, and educational technology. The review explicitly examines how design intentions align with children's actual needs. It identifies persistent gaps in mainstream search interfaces and evaluates emerging approaches within a unified conceptual framework. This work provides a consolidated evidence base to guide the development of developmentally appropriate and literacy aware web search systems for children.

3. Methodology

3.1 Review Design

This study employed a systematic literature review methodology. The review followed the PRISMA 2020 guidelines, which provide updated recommendations for transparency, rigor, and reproducibility in evidence synthesis (Page et al., 2021). The PRISMA 2020 framework guided the review process, reporting, and study selection workflow.

The review protocol was defined before the study to ensure transparency and methodological rigor. It specified the research scope, search strategy, screening procedures, eligibility criteria, and synthesis approach. This design allowed a structured and reproducible analysis of research on web search interfaces for children.

3.2 Data Sources and Search Strategy

A comprehensive literature search was conducted across major scholarly databases. These databases indexed millions of research records, including Springer, Semantic Scholar, ScienceDirect, Scopus, PubMed, ACM Digital Library, and Web of Science. To reflect the interdisciplinary nature of children's web search, the search strategy targeted multiple key dimensions. These included children's web search behaviors, search interface usability, digital and search literacy, and related topics such as privacy, well-being, and educational context.

The following search terms represent the core concepts used in this systematic literature review. They were selected based on prevalence in prior.

- Children or child users or young users or school-aged children
- Web search or search engines or information retrieval systems or search user interfaces

The AND operator was employed to combine these key concepts and construct the primary search string used for literature retrieval:

("Web search" OR "search engines" OR "search user interface" OR "information retrieval") AND ("children" OR "child users" OR "young users" OR "school-aged children")

This search string reflects the central focus of the review and was applied primarily to article titles, abstracts, and author-specified keywords.

To ensure relevance and quality, additional inclusion and exclusion criteria were applied during the screening and selection process.

The first inclusion criterion required that studies be peer-reviewed and indexed within one or more of the following established electronic databases:

Springer, Semantic Scholar, ScienceDirect, Scopus, PubMed, ACM Digital Library, and Web of Science. The second criterion required that studies explicitly examine children’s interaction with web search systems or search interfaces. Studies focusing primarily on general web use, social media platforms, or assistive technologies for disabilities were excluded, unless they directly addressed children’s web search behaviors or interface design considerations. In the final selection stage, studies were assessed for methodological rigor, theoretical contribution, and practical relevance to interface design, usability, information-seeking behavior, digital literacy, and educational search environments. Only studies that contributed substantively to advancing the understanding or design of child-centered web search systems were included in the final review. The resulting set of queries was designed to capture foundational research, empirical studies, design-based investigations, and recent review articles relevant to child-oriented web search systems across both educational and home contexts.

3.3 Inclusion and Exclusion Criteria

Studies were included if they:

- (1) focused on children or adolescents as primary users;
- (2) examined web search interfaces, search behaviors, or search-related literacy; and
- (3) reported empirical findings, design evaluations, or systematic syntheses.
- (4) Only published papers are involved.
- (5) All the review papers are from the years 2020 to 2025.

Studies were excluded if they:

- (1) focused exclusively on adult populations;
- (2) addressed general internet use without a search-related component; or
- (3) lacked sufficient methodological detail or relevance to interface design or information-seeking.
- (4) There are no English-written papers.

3.4 Screening and Selection Process

The initial search retrieved 1,024 records. After removing duplicates and screening titles and abstracts, 678 studies were retained for further assessment. Full-text review identified 311 eligible studies. Of these, 27 high-quality and highly relevant studies were selected for inclusion in the final synthesis. Screening was conducted in multiple stages to reduce bias and ensure consistency with the predefined inclusion criteria.

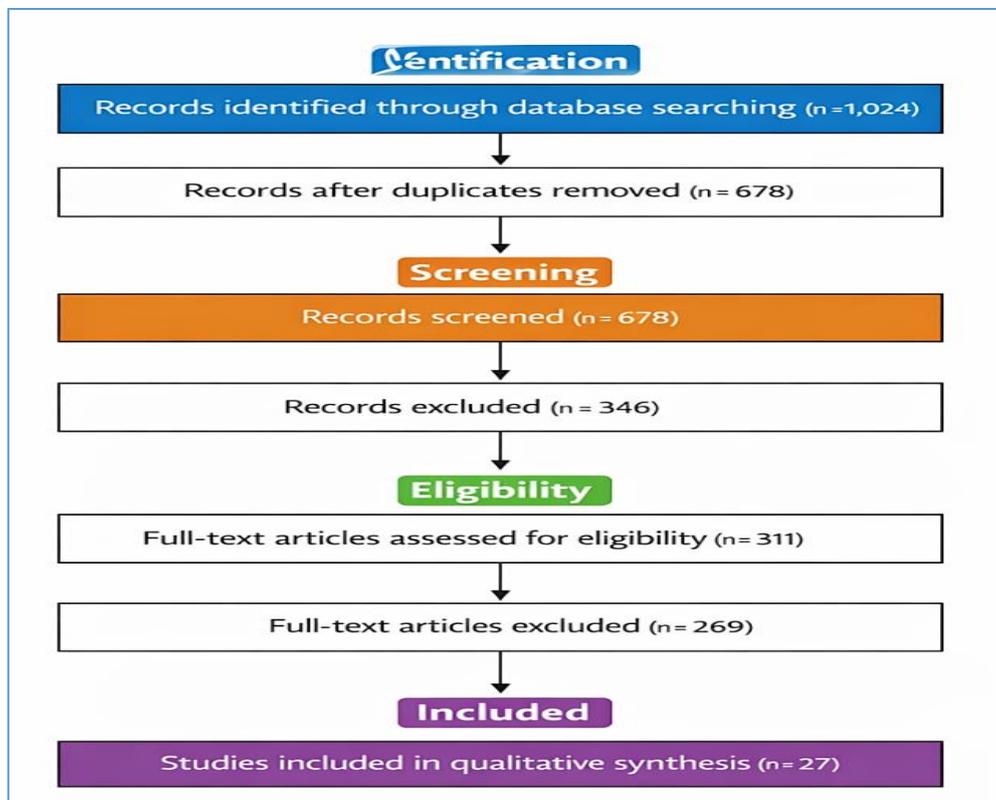


Fig. 1 PRISMA Flow Diagram: Study Selection Process

3.5 Data Extraction and Synthesis

For each included study, data were systematically extracted on study context, participant characteristics, interface features, research methods, and key findings. A narrative synthesis approach was employed to integrate evidence across diverse methodologies, enabling the identification of patterns, themes, and research gaps across studies.

3.6 Quality Assessment of Included Studies

The methodological quality of included studies was evaluated using criteria appropriate to each research design. These criteria included clarity of research questions, rigor of data collection and analysis, and transparency of reporting. The quality assessment informed the interpretation of findings. It also helped contextualize the strength and reliability of evidence across the reviewed literature.

4. Ethical considerations

This study is based solely on a review of previously published literature and did not involve human participants or data collection. Therefore, ethical approval was not required.

5. Results

Web search interfaces are a primary access point for children to engage with online information in both educational and everyday contexts. Research distinguishes between mainstream, adult-oriented search engines and child-friendly or educational search systems. Child-oriented systems aim to address developmental needs through alternative interface designs and interaction paradigms.

5.1 Mainstream Search Engines and Children's Use

Despite the availability of child-oriented alternatives, evidence shows that children primarily rely on mainstream search engines. Google is the dominant platform for both school-related and informal information seeking. These systems are designed for adult users and assume advanced reading skills, stable spelling, and understanding of ranking mechanisms. Consequently, children often face difficulties. They struggle to formulate effective queries, interpret search engine results pages, and distinguish between organic results, advertisements, and sponsored content.

Research also shows that children attribute high credibility to top-ranked results and to the search engine itself (Girouard-Hallam & Danovitch, 2024). This over-trust can lead to superficial engagement and reduced critical evaluation. Mainstream engines provide features such as autocomplete, spell correction, and voice input. However, these supports are incidental and not designed to foster learning or search literacy. Table 1 compares mainstream search engines with alternative child-friendly interfaces. It highlights strengths such as scalability and coverage, alongside limitations in developmental alignment and literacy support.

Table 1 Comparison of Web Search Interface Types for Children

Interface Type	Typical Examples	Primary Design Goals	Key Strengths	Key Limitations	Representative Studies
Mainstream Search Engines	Google, Bing	Fast, comprehensive retrieval	High coverage; familiarity; wide adoption	Adult-centered design; high literacy demands; over-trust in ranking	Vanderschantz & Hinze (2021); Girouard-Hallam & Danovitch (2024); Monteiro et al. (2023)
Child-Friendly Search Engines	Customized children's search engines	Safety; age-appropriate access	Simplified interfaces; curated content	Limited scope; low real-world uptake	Patel et al. (2020); Vanderschantz & Hinze (2021)
Educational Search Platforms	Classroom search companions; co-designed tools	Pedagogical alignment	Guided inquiry; teacher mediation	Context-bound; limited informal use	Bettencourt et al. (2024); Allen et al. (2022)
Conversational/AI-Based Systems	Chatbots; search agents	Natural language interaction	Reduced query burden; high engagement	Transparency and trust issues	Landoni et al. (2020); Movahed & Martin (2025); Murgia et al. (2023)
Collaborative Search Systems	Parent-child or peer-supported tools	Social learning	Shared sensemaking; scaffolding	Coordination and privacy challenges	Silva et al. (2021); Figueiredo & Cameron (2024)

5.2 Child-Friendly Search Engines and Educational Platforms

To address the limitations of mainstream search engines, researchers and developers have designed child-friendly search systems. These platforms scaffold children’s information-seeking processes. They often use age-appropriate language, curated content, simplified result presentations, and explicit educational goals. Examples include classroom search companions, customized children’s search engines, and co-designed applications that support query formulation and relevance judgment.

Empirical evaluations show that these systems improve engagement, task completion, and comprehension. Benefits are particularly strong when interfaces provide structured guidance or visual cues (Bettencourt et al., 2024; Allen et al., 2022). Educational platforms often integrate search activities into broader learning environments. They align tasks with curricular objectives and involve teacher mediation.

However, adoption outside controlled classroom settings is limited. Many child-friendly systems are experimental, lack ongoing maintenance, or require institutional support. This limits scalability and long-term impact compared with mainstream engines. Table 2 summarizes key interface features commonly implemented in child-oriented systems and their reported effects.

Table 2 Interface Features Supporting Children’s Information-Seeking

Interface Feature	Description	Supported Search Skills	Reported Benefits	Open Challenges	Representative Studies
Query Scaffolding	Prompts or structured input aids	Query formulation	Improved relevance; reduced frustration	Limited transfer to mainstream search	Bettencourt et al. (2024); Vanderschantz & Hinze (2021)
Visual Relevance Cues	Emojis, icons, images	Result triage	Faster relevance recognition	Risk of oversimplification	Aliannejadi et al. (2021); Aliannejadi et al. (2020)
Readability-Aware Ranking	Results adapted to reading level	Comprehension	Improved understanding	Dependence on readability metrics	Allen et al. (2022); Brante et al. (2024)
Spell Correction & Autocomplete	Child-sensitive spelling support	Query accuracy	Reduced breakdowns	Limited explanatory feedback	Downs et al. (2021)
Voice Input	Spoken queries	Accessibility; expression	High engagement; bypasses spelling	Speech ambiguity; privacy	Yadav & Chakraborty (2021); Beelen et al. (2022)
Conversational Feedback	Dialog-based guidance	Reflection; metacognition	Reduced cognitive load	Opaque reasoning	Sharma et al. (2023); Murgia et al. (2023)

5.3 Visual, Voice-Based, and Multimodal Interfaces

An important trend in child-oriented search design is the use of visual, voice-based, and multimodal interfaces. These approaches aim to reduce cognitive and linguistic barriers. Visual methods include icons, emojis, images, and color-coded relevance cues to support result interpretation and decision-making. Research shows that visual scaffolding helps children recognize relevant results more effectively than text-only presentations. Benefits are strongest for younger users and early readers (Aliannejadi et al., 2021).

Voice-based and conversational search interfaces leverage children’s familiarity with spoken language. They bypass spelling and typing challenges. Studies on voice search and spoken conversational agents report increased engagement and ease of use, especially for younger children (Yadav & Chakraborty, 2021; Beelen et al., 2022). More recent work explores multimodal systems that combine speech, text, and visual feedback. Robot-supported and AI-powered conversational agents are also being studied. These systems reduce cognitive load and support natural interaction. However, they raise concerns about transparency, trust, and the potential obscuring of information sources and retrieval processes.

Overall, the landscape of web search interfaces for children is fragmented. Mainstream platforms dominate everyday use, while child-friendly and multimodal systems show benefits but remain underutilized. This gap highlights the need for designs that integrate developmental sensitivity and literacy support into widely used search technologies.

Conversational and multimodal systems can improve engagement and reduce cognitive load. Yet, they may obscure how information is retrieved and ranked. Without careful design, they risk reinforcing misconceptions about search engines. Table 3 synthesizes how different interface types align with key developmental and literacy-related needs.

Table 3 Alignment Between Interface Types and Children’s Developmental Needs

Developmental Dimension	Mainstream Search	Child-Friendly / Educational	Multimodal & AI-Based	Supporting Evidence
Cognitive Load	High	Moderate to Low	Low (when scaffolded)	Vanderschantz & Hinze (2021); Sharma et al. (2023)
Reading & Language Demands	High	Age-adjusted	Variable	Allen et al. (2022); Yadav & Chakraborty (2021)
Support for Search Literacy	Minimal	Explicit	Emerging	Babari et al. (2023); Brante et al. (2024)
Transparency of Search Process	Low	Moderate	Often low	Girouard-Hallam & Danovitch (2024); Murgia et al. (2023)
Scalability & Adoption	Very high	Low to Moderate	Growing	Vanderschantz & Hinze (2021); Tobia & Landoni (2025)

6. Results: Children’s Web Search Behaviors and Challenges

Children’s interactions with web search interfaces are shaped by developmental factors, prior experience, and interface design. Across educational and informal contexts, research identifies behavioral patterns and challenges that distinguish children’s search practices from those of adults. This section synthesizes findings on query formulation, result evaluation, trust and credibility judgments, and children’s misconceptions about search engines.

6.1 Query Formulation and Reformulation

Query formulation is one of the most persistent challenges in children’s web search behavior. Children often struggle to translate information needs into effective keyword queries. They frequently rely on natural language phrases, incomplete expressions, or single-word inputs. Spelling errors, limited vocabulary, and difficulty identifying key concepts further constrain query effectiveness, particularly among younger users. Studies show that children are less likely than adults to engage in systematic query reformulation. They often persist with ineffective queries or abandon search tasks altogether (Vanderschantz & Hinze, 2021; Downs et al., 2021).

Design interventions such as query scaffolding, spelling support, and autocomplete features can reduce these challenges. However, children may accept system-generated suggestions without evaluating their relevance critically. This behavior can limit opportunities for developing transferable search skills. These findings highlight a tension between achieving short-term task success and supporting long-term search literacy development. Table 4 illustrates the common challenges children face when formulating and reformulating search queries, highlighting how different interface types support or hinder these processes in relation to developmental and literacy needs.

Table 4 Children’s Query Formulation and Reformulation Challenges

Challenge	Description	Interface Considerations	Key References
Limited Vocabulary & Spelling Errors	Children often misspell keywords or use incomplete queries	Spelling correction, autocomplete, query suggestions	Vanderschantz & Hinze, 2021; Downs et al., 2021
Ineffective Keyword Selection	Difficulty identifying key concepts or using concise terms	Visual query scaffolding, topic prompts, gamified query support	Bettencourt et al., 2024; Tobia & Landoni, 2025
Low Query Reformulation	Children rarely revise queries even when results are irrelevant	Adaptive suggestions, guided feedback, interactive search tutorials	Vanderschantz & Hinze, 2021; Allen et al., 2023

6.2 Result Evaluation and Ranking Interpretation

After retrieving results, children face substantial challenges in evaluating relevance and interpreting ranked lists. Studies consistently show that children focus on top-ranked results, often selecting the first link without exploring additional options or comparing sources (Aliannejadi et al., 2021; Brante et al., 2024). Visual prominence, images, and familiar branding strongly influence their choices, sometimes outweighing content relevance or quality.

Children also have a limited understanding of ranking mechanisms. They often interpret result order as a direct indicator of correctness or authority. Mainstream search interfaces rarely provide explicit cues to explain ranking decisions. Visual relevance cues and readability-aware ranking can support children’s decision-making. However, these features are rarely implemented in widely used search engines, leaving children dependent on superficial indicators. Table 5 summarizes key challenges children face when evaluating search results. It highlights issues of trust, misconceptions about search engines, and the impact on their ability to identify accurate and reliable information.

Table 5 Children’s Result Evaluation, Trust, and Misconceptions

Challenge	Description	Interface Considerations	Key References
Over-reliance on Top-ranked Results	Children focus on first few links without scanning full results	Visual relevance cues, readability-aware ranking	Aliannejadi et al., 2021; Brante et al., 2024
Difficulty Assessing Credibility	Limited ability to evaluate authorship, bias, or reliability	Credibility labels, source explanations, guided critical evaluation	Girouard-Hallam & Danovitch, 2024; Babari et al., 2023
Misconceptions about Search Engines	Belief that search engines “know” answers or retrieve from a single source	Interactive tutorials, transparent ranking explanation, AI-assisted guidance	Girouard-Hallam & Danovitch, 2024; Babari et al., 2023
Trust in System over Content	Children trust the search engine rather than individual sources	Encourage source comparison, integrate feedback prompts	Girouard-Hallam & Danovitch, 2024; Movahed & Martin, 2025

6.3 Trust, Credibility, and Source Assessment

Trust and credibility assessment is a critical challenge in children’s web search behavior. Studies show that children often place high trust in search engines, viewing them as knowledgeable or neutral arbiters of truth rather than algorithmic systems (Girouard-Hallam & Danovitch, 2024). This leads children to accept information at face value, with limited evaluation of source credibility, authorship, or potential bias.

Age influences trust patterns. Older children show greater skepticism but still struggle to apply systematic evaluation criteria. Educational interventions and guided search experiences can improve credibility assessment skills. However, these skills are often not transferred to independent search contexts.

Emerging technologies such as conversational agents and AI-powered chatbots add complexity. They may obscure source provenance and blend synthesized responses with retrieved information. This can reinforce misconceptions about reliability and reduce opportunities for critical evaluation.

6.4 Common Misconceptions About Search Engines

Many challenges in children’s web search stem from persistent misconceptions about how search engines and the internet operate. Research shows that children often hold anthropomorphic views of search engines. They may believe that systems “know” answers, “decide” what to show, or retrieve information from a single authoritative source (Babari et al., 2023; Girouard-Hallam & Danovitch, 2024).

These misconceptions influence search behavior, trust, and expectations. They can reduce motivation to cross-check information or explore alternative sources.

The findings highlight the need for transparency in search processes. Integrating conceptual explanations into interface design and educational practice can help children develop accurate mental models. Without addressing these underlying misconceptions, improvements in interface usability alone are unlikely to produce meaningful gains in search literacy or critical engagement.

7. Results: Design Features and Interaction Strategies

Designing effective child-oriented web search interfaces requires visual, motivational, instructional, and adaptive strategies. These strategies address children’s unique cognitive, linguistic, and social characteristics. Research in human-computer interaction and educational technology identifies four main categories of design approaches: visual cues and interface simplification, gamification and engagement mechanisms, scaffolding and feedback, and personalization through adaptive interfaces. The goals of these strategies are to reduce cognitive load, improve comprehension, sustain motivation, and support skill development during search tasks.

7.1 Visual Cues and Interface Simplification

Visual cues such as icons, emojis, and color-coded layouts are widely used to simplify search results and support children’s understanding of relevance and categories. Simplified interface elements, including minimal menus and large, clearly labeled buttons, reduce cognitive load, improve navigation, and increase task efficiency (Aliannejadi et al., 2020; Allen et al., 2022). Empirical studies indicate that children more accurately identify relevant results and are less likely to misinterpret content when visual scaffolding is implemented effectively. Table 6 summarizes the visual cues and interface simplification features used in search systems, highlighting how these design elements support children’s understanding, navigation, and effective interaction with search results.

Table 6 Visual Cues and Interface Simplification Features

Feature	Description	Observed Benefits	Citation
Emojis & Icons	Indicate relevance or category of results	Improved result recognition, reduced misinterpretation	Aliannejadi et al., 2021
Color-Coded Layouts	Highlight relevant vs. less relevant items	Faster visual scanning and selection	Allen et al., 2022
Simplified Menus	Minimal text, large buttons	Easier navigation, reduced cognitive load	Patel et al., 2020

7.2 Gamification and Engagement Mechanisms

Gamification adds elements such as points, badges, challenges, and progress indicators to child-oriented search interfaces. These features increase engagement and motivation. They encourage children to explore topics more deeply, sustain attention during search tasks, and improve learning outcomes (Tobia & Landoni, 2025; Bettencourt et al., 2024). Gamified interfaces are particularly effective in structured learning environments, where motivation strongly influences search success. Table 7 highlights the gamification and engagement mechanisms incorporated into search interfaces, showing how these features enhance children’s motivation, interaction, and sustained engagement during information-seeking activities.

Table 7. Gamification and Engagement Mechanisms

Gamification Element	Description	Observed Benefits	Citation
Points & Rewards	Children earn points for completing search tasks	Increased motivation and task completion	Tobia & Landoni, 2025
Challenges & Quests	Gamified exploration of topics	Encourages deeper engagement and learning	Bettencourt et al., 2024
Progress Tracking	Visual progress indicators	Supports self-regulation and task monitoring	Allen et al., 2023

7.3 Scaffolding, Guidance, and Feedback

Scaffolding strategies guide throughout the search process, supporting query formulation, result interpretation, and source evaluation. Techniques such as query suggestions, real-time spelling and grammar correction, and interactive feedback allow children to learn effective search strategies while reducing frustration and errors (Bettencourt et al., 2024; Downs et al., 2021; Landoni et al., 2020). Table 8 illustrates the scaffolding and feedback strategies employed in search interfaces, showing how these approaches guide children’s search behaviors, support learning, and help them interpret and evaluate search results effectively.

Table 8. Scaffolding and Feedback Strategies in Child-Oriented Search

Strategy	Description	Observed Benefits	Citation
Query Suggestions	Offers possible query reformulations	Reduces frustration, improves search success	Bettencourt et al., 2024
Spelling & Grammar Support	Real-time correction of input	Supports literacy, prevents query failure	Downs et al., 2021
Interactive Feedback	Highlights relevant results or errors	Helps children learn effective search strategies	Landoni et al., 2020

7.4 Personalization and Adaptive Interfaces

Recent advances in artificial intelligence and interactive systems offer new ways to support children’s web search experiences. Emerging technologies include conversational agents, AI-assisted search systems, and collaborative search platforms. These tools have the potential to address persistent challenges in query formulation, result interpretation, and user engagement.

However, they also introduce ethical, privacy, and transparency concerns. Careful design and implementation are required to ensure that these technologies support learning without compromising trust or critical evaluation. Table 9 presents the personalization and adaptive interface features implemented in child-oriented search systems, highlighting how these mechanisms tailor the search experience to individual children’s needs, preferences, and skill levels. Table 9 presents the personalization and adaptive interface features implemented in child-oriented search systems, highlighting how these mechanisms tailor the search experience to individual children’s needs, preferences, and skill levels.

Table 9. Personalization and Adaptive Interface Features

Feature	Description	Observed Benefits	Citation
Age-Based Adaptation	Interface complexity adjusted for age	Supports developmental appropriateness	Movahed & Martin, 2025
Skill-Level Adjustment	Queries and result presentation tailored to the ability	Improves search efficiency and comprehension	Sharma et al., 2023
Content Recommendations	Suggests relevant resources based on previous searches	Encourages exploration and learning	Landoni et al., 2020

8. Results: Emerging Technologies in Children’s Web Search

Recent advances in artificial intelligence and interactive systems provide new opportunities to enhance children’s web search experiences. Key technologies include conversational agents, AI-assisted search systems, and collaborative search platforms. These tools can help address persistent challenges in query formulation, result interpretation, and user engagement. At the same time, they raise concerns related to ethics, privacy, and transparency. Careful design and monitoring are needed to ensure that these technologies support learning while maintaining trust and promoting critical evaluation.

8.1 Conversational Search and Chatbots

Conversational search interfaces and chatbots allow children to interact with search systems using natural language, through text or voice. These systems reduce the cognitive burden of formulating precise keyword queries. They can provide immediate guidance or clarification during search tasks.

Research shows that children prefer conversational styles that are supportive, context-aware, and engaging. Benefits are strongest when conversational agents are combined with visual or interactive prompts (Sharma et al., 2023; Tobia & Landoni, 2025; Movahed & Martin, 2025). Conversational agents can also scaffold learning. They model effective search strategies, suggest query reformulations, and highlight relevant resources. These features help enhance children’s digital literacy and search skills.

8.2 AI-Assisted and Generative Search Systems

AI-assisted search engines and generative systems, including those based on large language models, can dynamically generate explanations, summaries, and recommended queries. These outputs can be tailored to the child’s context and skill level. Early research shows that these systems improve information accessibility, reduce frustration, and support exploratory learning (Murgia et al., 2023; Figueiredo & Cameron, 2024). Generative AI can paraphrase complex information into child-friendly language, prioritize age-appropriate content, and suggest related topics to encourage deeper engagement. Despite these benefits, challenges remain. Issues of accuracy, bias, and interpretability must be carefully managed. Ensuring safe and reliable use is critical for children’s search experiences.

8.3 Collaborative and Social Search Models

Collaborative search models involve multiple participants, such as peers, teachers, or parents, working together to find, evaluate, and interpret information. These models support learning through social scaffolding, shared problem-solving, and guided exploration (Silva et al., 2021).

Children in collaborative search environments receive both cognitive and affective support. They benefit from encouragement, discussions about relevance, and collective verification of sources. Social search features in educational platforms also foster motivation and a sense of belonging. Structured collaboration provides opportunities to develop critical evaluation and digital literacy skills (Pera et al., 2023).

8.4 Ethical, Privacy, and Transparency Considerations

Emerging technologies for children’s search offer many benefits but also raise ethical and privacy concerns. Systems must protect personal data and provide age-appropriate content filtering. They should also maintain transparency in AI-generated outputs. Children may not fully understand how algorithms shape search results. Overreliance on automated recommendations can reinforce misconceptions or bias (Monteiro et al., 2023; Babari et al., 2023).

Designers should integrate explainable AI features, clear privacy policies, and pedagogical transparency. These measures enable children to engage critically with technology while remaining informed and protected.

9. Results: Evaluation Methods and Empirical Evidence

Evaluating child-oriented web search interfaces is essential to determine their effectiveness, usability, and impact on learning outcomes. A diverse set of empirical methodologies has been employed to capture children's interactions, cognitive processes, and performance outcomes. These approaches range from direct observation and usability testing to experimental and longitudinal studies, each providing unique insights into interface design, engagement, and learning efficacy.

9.1 Usability Testing with Children

Usability testing remains the cornerstone of evaluating child-centered search systems. Researchers observe children performing realistic search tasks to identify interaction difficulties, cognitive bottlenecks, and interface design flaws (Vanderschantz & Hinze, 2021; Downs et al., 2021). Techniques often include think-aloud protocols, task completion metrics, eye-tracking, and post-task interviews. These methods provide rich qualitative and quantitative data on how children navigate search interfaces, interpret search results, and employ strategies such as query reformulation and result triage.

9.2 Experimental and Longitudinal Studies

Experimental studies in laboratory and classroom settings allow researchers to systematically manipulate interface features. They assess the effects on search performance, engagement, and task success (Tobia & Landoni, 2025; Bettencourt et al., 2024). Longitudinal studies evaluate changes over time. They reveal how repeated use of child-oriented interfaces influences skill development, digital literacy, and adoption of search strategies (Brante et al., 2024; Monteiro et al., 2023). These studies are essential for understanding the durability of learning outcomes and the developmental suitability of interface adaptations.

9.3 Learning Outcomes and Performance Metrics

Empirical evaluations often assess multiple dimensions of children's search performance. These include task completion rate, quality of query formulation, accuracy in identifying relevant results, and time on task. Beyond cognitive measures, studies increasingly examine affective outcomes such as engagement, motivation, and self-efficacy (Allen et al., 2023; Sharma et al., 2023). Assessment frameworks commonly combine behavioral observations, standardized tests, and system-logged interaction data. This combination provides a comprehensive view of both performance and learning outcomes.

9.4 Limitations of Current Evaluation Approaches

Despite progress, existing evaluation methodologies face several limitations. Sample sizes are frequently small and context-specific, limiting generalizability. Laboratory-based tasks may not capture authentic search behaviors observed in naturalistic settings, and short-term studies provide limited insight into the long-term development of search skills and literacy (Babari et al., 2023; Movahed & Martin, 2025). Furthermore, there is often insufficient consideration of socio-cultural diversity, accessibility, and individual differences in cognitive and reading abilities. These limitations highlight the need for mixed-method, longitudinal, and ecologically valid research designs to better understand the real-world effectiveness of child-oriented search interfaces.

10. Discussion: Implications for Design, Education, and Policy

This review synthesizes research on children's web search behaviors, interface design strategies, and emerging technologies. The findings offer actionable guidance for designers, educators, and policymakers.

Applying these insights can improve children's search performance and foster digital literacy. Well-designed systems can also ensure safe, equitable, and developmentally appropriate online experiences.

Future work should focus on integrating evidence-based design principles, promoting critical evaluation skills, and addressing ethical, privacy, and accessibility concerns in widely adopted search technologies.

10.1 Design Guidelines for Child-Centered Search Interfaces

Research highlights key principles for designing interfaces that meet children's cognitive, linguistic, and social needs. Effective interfaces integrate visual cues, simplified navigation, gamified engagement, scaffolding features, and adaptive personalization tailored to age and skill level (Aliannejadi et al., 2021; Bettencourt et al., 2024; Movahed & Martin, 2025).

Designers should use iterative, user-centered design approaches and involve children in co-design processes. This ensures that interfaces are intuitive, engaging, and developmentally appropriate. Attention to accessibility, readability, and clear feedback mechanisms is essential to reduce frustration and improve search outcomes.

10.2 Implications for Digital Literacy Education

Challenges in query formulation, result evaluation, trust assessment, and understanding search algorithms highlight the need for explicit digital literacy instruction (Babari et al., 2023; Brante et al., 2024).

Educational programs should teach children strategies for effective searching, critical evaluation of sources, and safe, ethical online behavior. Child-oriented search interfaces can be integrated into classroom activities to provide scaffolding while encouraging exploration, reflection, and independent problem-solving.

Educators should consider differences in developmental stages and cognitive abilities to tailor instruction. Individualized support helps optimize learning outcomes and engagement.

10.3 Recommendations for Platform Developers and Policymakers

Developers and policymakers play a key role in shaping children's online environments. Platform providers should prioritize transparency, explainable algorithms, age-appropriate content filtering, and privacy protections (Monteiro et al., 2023; Figueiredo & Cameron, 2024). Regulatory frameworks should promote child-centered design principles, enforce strong data protection, and support standards for evaluating interface effectiveness and educational impact. Collaboration among researchers, designers, educators, and policymakers is essential. Such partnerships ensure that emerging technologies and AI-driven systems are used responsibly, inclusively, and in ways that maximize benefits while minimizing risks.

11. Discussion: Research Gaps and Future Directions

Despite advances in understanding children's web search behaviors, important gaps remain. These gaps limit the effectiveness of interface design, digital literacy interventions, and the adoption of new technologies.

Further research is needed to address these limitations and inform evidence-based strategies for creating developmentally appropriate, engaging, and safe search systems for children.

11.1 Methodological Gaps

Many studies use small, context-specific samples, which limits the generalizability of their findings. Short-term research designs make it difficult to examine long-term impacts on outcomes such as search ability, critical thinking, and digital literacy in children.

Moreover, numerous studies overlook important cognitive, linguistic, and socio-cultural factors that shape children's web search behaviors (Babari et al., 2023; Movahed & Martin, 2025). Addressing these gaps is essential to produce robust and widely applicable evidence.

11.2 Underexplored User Groups and Contexts

Certain child populations remain underrepresented in research. These include younger children, children with learning disabilities, and those in under-resourced educational settings.

Naturalistic contexts, such as homes and collaborative learning environments, are often neglected (Silva et al., 2021; Pera et al., 2023). This limits understanding of children's real-world search behaviors and needs. To design inclusive and equitable search technologies, research must expand to cover diverse users and varied contexts.

11.3 Directions for AI-Enhanced Child Search Systems

Emerging AI technologies, including conversational agents, generative search systems, and adaptive personalization, offer new opportunities to improve children's search experiences.

Future research should evaluate the pedagogical impact of these systems and examine potential risks such as bias or misinformation (Murgia et al., 2023; Figueiredo & Cameron, 2024). Studies should also explore how AI can support individualized scaffolding for learning and digital literacy. Understanding how these systems interact with educational frameworks and parental involvement will be crucial for safe, effective, and responsible adoption.

11.4 Open Research Questions for Advancing the Field

Several questions remain open for future research.

1. How can search interfaces be dynamically adapted to meet individual children's skills and developmental needs?
2. What are the long-term educational outcomes of digital literacy interventions for children?
3. How do conversational AI systems and large language models affect children's information-seeking behaviors and critical thinking?

Addressing these questions will guide the design of developmentally appropriate, safe, and effective web search technologies for children.

12. Limitations of the Review

This review has several limitations that should be acknowledged. First, the selection of studies prioritized English-language publications, which may exclude relevant research in other languages and cultural contexts. Second, the heterogeneity of study designs, measurement frameworks, and age groups made direct comparisons challenging. Third, although efforts were made to include emerging technologies, some recent developments may not yet have undergone rigorous empirical evaluation. Finally, the reliance on published studies introduces the possibility of publication bias, potentially skewing the assessment of evidence strength.

13. Conclusion

Children widely engage with web search engines, including mainstream platforms like Google and Bing. Their interactions are characterized by unique challenges in query formulation, result evaluation, engagement, and safe access to content.

Evidence highlights the importance of adaptive interface design, visual and interactive enhancements, scaffolding mechanisms, and digital literacy education. These elements support effective, safe, and developmentally appropriate information-seeking behaviors.

Emerging technologies, including AI-powered search, conversational agents, and collaborative platforms, offer promising opportunities to improve search experiences. Their adoption must consider ethical, privacy, and developmental factors.

Future research should prioritize adaptive, child-centered interfaces, long-term educational outcomes, equitable access, and AI-enhanced search systems. By addressing methodological gaps, underrepresented user groups, and pedagogical integration, researchers, designers, educators, and policymakers can advance safe, engaging, and educationally meaningful web search experiences for children.

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