# Using Anti-Personas to Model Children: How to Represent User-System Mismatches

Diletta Micol Tobia
Università della Svizzera Italiana
Lugano, Switzerland
diletta.micol.tobia@usi.ch

Hrishita Chakrabarti
Web Information Systems - Software Technology
Delft University of Technology
Delft, Netherlands
h.chakrabarti@tudelft.nl

Maria Soledad Pera
Web Information Systems - Software Technology
Delft University of Technology
Delft, Netherlands
M.S.Pera@TUDelft.nl

Monica Landoni
Università della Svizzera italiana, USI
Lugano, Switzerland
monica.landoni@usi.ch

## Abstract

User models, which represent the needs of users an online information access system is meant to serve, can facilitate the design and evaluation of the system. However, these models typically rely on assumptions drawn from adult users, such as advanced literacy levels or the ability to evaluate retrieved content critically. Hence, they often overlook the distinct needs and search habits of children, despite the growing prevalence of information access systems among youngsters. In this work, we introduce a set of child anti-personas, user models representing classes of users for whom the system is not designed. To substantiate these mismatches, we investigate how primary school children's behaviors when interacting with different search tools diverge from the assumptions of typical user models. Thereafter, we identify recurring patterns of misalignment between children's behavior and system expectations and link these patterns to the risks identified by adult stakeholders involved in children's online searching. By representing children as anti-personas of contemporary search tools, this work contributes to the quest for more informed and less stereotypical user modeling when it comes to information access for underrepresented groups, such as children.

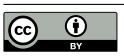
## CCS Concepts

• **Social and professional topics** → **Children**; • **Information systems** → *Information retrieval*; • **Human-centered computing** → **User models**.

## Keywords

Information Retrieval, Children, Personas, Search, User Modeling

**ACM Reference Format:**
Diletta Micol Tobia, Hrishita Chakrabarti, Maria Soledad Pera, and Monica Landoni. 2026. Using Anti-Personas to Model Children: How to Represent User-System Mismatches. In *34th ACM Conference on User Modeling, Adaptation and Personalization (UMAP '26), June 08–11, 2026, Gothenburg, Sweden.* ACM, New York, NY, USA, 10 pages. https://doi.org/10.1145/3774935.3806168




*UMAP '26, Gothenburg, Sweden*

ACM ISBN 979-8-4007-2311-7/26/06
https://doi.org/10.1145/3774935.3806168

## 1 Introduction

Online Information Access Systems **(IAS)** increasingly mediate how people acquire knowledge in everyday contexts [21, 23]. User models (**UM**), which, among other usages, capture users' goals, abilities, and preferences, can help facilitate adaptability and personalization of these systems to better serve users [57]. Traditional UM are largely grounded in assumptions drawn from mainstream users, including advanced literacy, stable information needs, and the ability to critically evaluate retrieved content [57]. However, these assumptions do not hold for all user groups, such as neurodivergent individuals, people with mental health conditions, and children, whose needs and habits differ from the mainstream.

Children increasingly rely on IAS, such as popular search engines (**SE**), to seek information for learning and leisure [74]. Due to their in-development cognitive, linguistic, and information literacy skills, their information-seeking behaviors frequently diverge from those of adult searchers [37, 58, 59, 77]. Past research has documented these differences extensively [e.g., 8, 9, 43, 44, 63], but the insights from such explorations have rarely been translated into concrete children UM. Moreover, with the increasing number of IAS in the market, these young searchers are also gradually turning more often to alternative tools for online information discovery, such as Large Language Model **(LLM)** agents (e.g., ChatGPT), voice-controlled assistants, like Siri and Alexa, and even social media platforms, including TikTok and YouTube [3]. Children's interactions with these systems remain underexplored, further amplifying the gap between children's practices and implicit UM assumptions. In this work, we bring attention to the ubiquity of IAS in youngsters' learning [43, 45] and investigate how primary school children interact with various sources of information in the classroom setting. We do so to advance understanding of how their interplay with IAS when seeking information for the classroom mismatches core assumptions underlying traditional UM, exposing them to potentially harmful content. To guide our analysis, we pose these Research Questions **(RQs)**: **RQ1**: *What information-seeking behavioral patterns and associated risks emerge when children use IAS for curriculum-based*

*inquiry tasks in the classroom context?* **RQ2**: *How can children's mismatches and associated risks be represented within user models?*

To answer these RQs, we conducted user studies with children aged 7 to 10 years old, capturing their behaviors when interacting with different sources of information while answering curriculum-related inquiries in the classroom setting. Given the central role that adult stakeholders play in children's learning in educational settings [18], we also account for adults' perspectives, namely, family members and teachers, on the potential risks that children could be exposed to when exhibiting certain behaviors.

Based on a qualitative analysis of classroom observational data and online questionnaire responses, the findings informed the development of children's anti-personas, defined as UM representations that illustrate examples of behavioral patterns of children's use of IAS that do not align with traditional assumptions. While anti-personas are typically used to represent malicious users [71], in this work, they are considered UM representing classes of users for whom IAS were not designed [4, 55], yet who increasingly rely on them [34, 42, 66]. By introducing anti-personas as a UM representation showing children's misaligned practices with IAS, the contribution of this work is twofold. First, we propose a novel strategy to build anti-personas that extends their traditional use as a static collection of malevolent user characteristics [71]. This work grounds anti-personas in observed behavioral patterns of misaligned use of IAS, triangulating them with the concerns expressed by more knowledgeable adult stakeholders. This extension aims to shift the focus from the individual user to patterns of children's misaligned usage of IAS and the risks associated with the adoption of these behaviors. Second, by embracing the new construction strategy, we provide concrete examples of children's anti-personas. Going beyond the scenario of primary school children in the classroom setting, we argue that this extended anti-personas strategy can have broader applicability to other underrepresented user groups for whom data collection is difficult or limited. In these domains of scarce data, anti-personas can be used as simulation tools to reason about system behavior, interaction mismatches, and potential risks during early stages of design and evaluation processes, thereby supporting more inclusive and risk-aware development of IAS.

## 2 Related Work

In this section, we discuss the background and related literature informing this work.

*The Evolution of User Modeling.* The process of user modeling involves defining algorithms and methods for creating reliable digital representations of users [22, 54, 62]. User modeling techniques have evolved over the years in response to technological advancements. Early approaches in the 1990s largely relied on stereotypes or collective assumptions that classified users into predefined categories based on demographic or behavioral characteristics [36, 64]. Although these models offered simplicity and scalability, they often failed to capture individual variability, leading to rigid and sometimes inaccurate modeling [35, 58]. To overcome these limitations, new research introduced decentralized architectures to improve interoperability and flexibility [48]. Decentralized architecture attempted to separate user representation from application logic, allowing multiple services to use a shared UM [48]. During the early 2000s, attention shifted toward adaptive *hypermedia systems*, where UM were leveraged to dynamically tailor the information based on users' goals and preferences [17], starting the era of early personalization [29]. As digital environments diversified, user modeling incorporated multimodal signals, combining different types of data to attain a more comprehensive understanding of user preferences [67]. Advancements in Machine Learning (**ML**) in the late 2010s, particularly neural networks, further influenced this field, enabling finer inference of user preferences and more accurate predictions of user behaviors [62]. In the context of information retrieval (**IR**), researchers have spent over three decades studying users' motivations, needs, and behaviors during information seeking, producing many UM and theories grounded in user studies and data-driven methods [e.g., 2, 26, 40, 65]. These studies led to more structured architecture for defining the system's assumptions regarding how users search for and evaluate information. Examples of these assumptions include the belief that users are able to formulate effective search queries, possess adequate vocabulary and content knowledge, and can assess the credibility of sources [e.g., 19, 57]. However, existing UM based on these assumptions largely represent a mainstream perspective, i.e., they reflect the needs and behavioral patterns of an average adult user, leaving underrepresented user groups, such as children and neurodivergent individuals—whose needs and abilities differ from the mainstream—insufficiently modeled or mis-modeled.

*User Modeling for Children.* Prior research has investigated children's information-seeking behavior to build models tailored to these young searchers [e.g., 10, 19, 46, 69]. Early child-focused UM defined characteristics or stages of children's information behavior [69]. A seminal contribution came from Kuhlthau's information search process model [38], which addressed both the emotions involved as well as the activities during adolescents' information seeking [e.g., 12, 27, 39, 50, 60, 69]. However, these models generally treated children as a homogeneous group and focused on behaviors common across young users. A notable exception was Burdick's information search styles matrix, which defined 9 categories of child users based on prominent differences in their search styles [69]. From the early 2000s, child modeling techniques began to shift focus to specific user interaction dimensions, such as query formulation skills [7], navigation and exploration strategies of adolescents [25]. A seminal work by Foss et al. [24] introduced a set of *searcher roles*, derived from observations of children's SE use in home environments, to distinguish different information-seeking strategies. While accounting for differences across children's search behavior represents progress toward more representative and nuanced child UM, they remain closely tied to the use of commercial SE. Children, however, are increasingly turning to other IAS such as LLM agents, voice-controlled assistants (e.g., Siri, Alexa), and social media platforms (e.g., YouTube, TikTok) to access online information [3]. These systems seem to bypass common challenges children face when using SE, such as query formulation, reliance on superficial link evaluation, and tendency to search for specific answers without understanding the broader context [5, 44]. By enabling fundamentally different search interactions compared to conventional SE, these systems highlight the limitation of existing

child UM, rendering them outdated and inadequate for representing children's developmental needs and behaviors in the current information-seeking landscape.

*The Concept of Anti-personas.* Cooper's concept of user personas [16] is a widely adopted design method for articulating user needs and guiding design decisions in Human Computer Interaction **(HCI)** and User Experience **(UX)** fields [52, 56, 61]. They are typically defined as fictional representations grounded in empirical user data [55, 70], representing one or more groups of target users [16]. Often used to craft UM [57], they help designers to foster empathy and support their reasoning beyond the abstract demographic data [15]. However, personas focus on the target audience for a system [71], while offering limited insight into what happens when a system is used in the wrong way. Anti-personas [71] were first introduced to address this gap by explicitly representing users for whom a system is not designed. Anti-personas have largely been used to define design boundaries, prevent scope creep, or identify misuse scenarios (anti-scenarios) [51]. In essence, anti-personas have been traditionally used in exclusionary terms, focusing on preventing access [51, 68].

In this work, we consider anti-personas more as a critical tool for examining user-system misalignment; rather than representing malicious or illegitimate users, we widen this method to represent classes of users who frequently interact with a system despite their needs not necessarily being accounted for in the system's design. From this perspective, children can be considered as anti-personas of contemporary systems: users for whom these systems were not originally designed, yet who now routinely engage with them in educational contexts [34, 74]. Child anti-personas in this case are not "undesirable users" but instead expose systematic failures of existing user modeling assumptions. By framing children's misaligned behaviors when interacting with IAS as anti-personas, we amplify the potential risks when users deviate from the core assumptions of underlying traditional UM, for instance, leading young searchers to inappropriate or developmentally unsuitable content.

## 3 Methodology

Here, we describe the data anchoring our study and the methodological approach adopted to define child anti-personas of IAS.

*Participants and Methods.* In primary school settings, children rarely search for information in isolation. Their activities are often guided or evaluated by adult stakeholders, such as educators or family members [31, 37]. As a result, adult perspectives become essential to fully capture children's search practices within their broader educational context. Accordingly, our analysis draws on qualitative data collected from Italian-speaking primary school teachers, children in grades 3-4 (ages 7-10), and members of their families. To identify recurring patterns among children's online information-seeking behaviors, we collected data from 23 primary school teachers, 17 family members (16 parents and 1 sibling), and 37 children (G=18, B=19). These perspectives allowed us to triangulate adults' reported practices and expectations with children's observed behaviors and self-reported experiences. The study received approval from the University Ethical Committee. Written informed consent was obtained from both teachers and parents of the children involved.

*Teachers and Parents' Questionnaires.* The teachers, whose primary school teaching experience ranged from 5 to 35 years, completed an online questionnaire of 37 closed-and open-ended questions. The questionnaire investigated their familiarity with online IAS, their pedagogical practices related to information seeking, and how digital devices are used in the classroom setting. On the other side, family members completed an online questionnaire of 26 closed and open-ended questions to capture their habits and strategies when searching for information with and for their children during homework activities. Together, the two questionnaires provided complementary views on how children's online search activity is scaffolded or regulated across home and school.

*Children's Activities in the Classroom.* The children participated in two curriculum-based classroom sessions designed to elicit their natural online information-seeking behaviors. The activity, conducted in pairs, was inspired by the game framework designed by Tobia and Landoni [72] to study children's search behavior across different IAS. Children were asked to answer curriculum-based questions related to four school topics, consulting different sources of information, specifically: a SE (Google), an LLM (ChatGPT-5), the help of the teacher, or a scientific/academic article. To ensure that the search tasks were pedagogically meaningful and potentially replicable across different cultural contexts, the topics selected were related to science or ancient history, subjects commonly taught in many educational systems. This activity aimed to surface differences in strategy, trust, and perceived authority across sources of information. Since the goal of this work was to observe how children reason about and select information and not to evaluate the efficiency of the interaction mechanics, all the answers were printed in advance and presented in a format visually consistent with their original representations, thereby simulating the perceived sources' affordances while ensuring a controlled and safe environment for the children. Specifically, the choice of using paper-based prototypes provided key benefits from a safety and consistency point of view. On the one hand, children were protected from encountering potentially harmful content, ensuring a controlled and ethically responsible environment. On the other hand, it ensured that all participants received comparable information, enabling systematic observation of how children interpreted and chose responses. At the end of the activity, children were asked to rate the sources of information based on their preferences and explicitly state the reasoning behind their choices. Across both sessions, we collected observations of children's information-seeking behaviors and their stated source preferences.

*The Process of Building Anti-Personas.* Traditional qualitative personas are created from empirical user data, clustered through a process of inductive or deductive coding [6] to identify recurring behaviors, needs, and goals, which are then translated into realistic user profiles with name, picture, demographics, motivations, goals, and pain points [55]. A clear example of child personas is reported in the work of Itenge-Wheeler et al. [33], where children themselves created personas representing different types of library users, capturing their interests, abilities, and learning preferences.

Anti-personas, on the other hand, illustrate users whose behaviors threaten or misalign with system assumptions, often built from the definition of the critical threats and highest-consequence [71]. We extend this method to capture children's interaction with online IAS, defining anti-personas for users whose behaviors misalign with system assumptions without being malicious. Moreover, unlike traditional anti-personas that solely rely on individual user behaviors, we also incorporate adult stakeholders' perspectives to identify the consequences or risks of those behaviors.

We ground our thematic analysis on the triangulation of teachers' and parents' questionnaire responses regarding their support practices and concerns, and children's observed behaviors and expressed preferences during the classroom activities. Starting with children's interaction data, we generate bottom-up codes through keyword-based coding of behaviors, strategies, and recurring difficulties when interacting with various sources of information. These initial codes are then clustered through affinity diagramming [49] into high-level behavioral patterns and associated risks, representing systematic mismatches between children's actions and the traditional affordances of the search tools used. We associate children's behavioral patterns with adult-reported risks, explicitly stated as concerns or difficulties from teachers' and/or families' answers. We then cluster these patterns based on similarities and identify examples of anti-persona profiles, showing distinct preferences and misleading search strategies, with explicit risks associated with their behaviors. Two researchers conducted the coding process. Disagreements were solved through discussion to reach a consensus.

## 4 Children as Anti-Personas

Below, we report the results of our analysis aimed at identifying recurring patterns observed in children's information-seeking behaviors in the classroom and relate them to associated risks emerging from concerns reported by teachers and family members. Next, we show how these relationships between behavior and risk can be summarized in three child anti-persona profiles, representing examples of systematic misalignment between youngsters' practices and the adult-centered user modeling assumptions embedded in current IAS.

### 4.1 Behavioral patterns and associated risks

We start by reflecting on the patterns captured in Table 1. These behaviors were derived primarily from classroom observations, complemented by children's reflections, while the associated risks have been triangulated with teachers' and family members' reported concerns in the online questionnaires.

The most frequently observed pattern concerns *Lexical difficulty/comprehension*. Children often encountered unfamiliar vocabulary, trying to read answers aloud, or explicitly select sources that use simpler language. This pattern is consistently associated by adults, both teachers and family members, with expressive difficulties, weak query formulation, and partial understanding of retrieved content. Several patterns reflect effort minimization in the child's evaluation of results. *First result selection/premature closure* and *Snippet/preview-based selection* capture children's tendency to engage quickly with early-ranked or summary content, often without opening or comparing the results. While snippet-based behaviors appear less frequently, teachers report repeatedly related risks, such as first-result bias and lack of search strategy. Children seem to often prioritize immediacy, choosing fast, visually rich formats to obtain answers quickly, as demonstrated by the patterns of *Speed over accuracy* and *Visual support as a shortcut*. Families and teachers associate these behaviors with impatience, frustration when answers are delayed, reduced verification, and distraction. Another frequent cluster of patterns relates to how children form their trust judgments. *Starting from prior knowledge, Familiarity or selective distrust of the platform, Trust in numbers or details* all indicate reliance on simplified heuristics to assess credibility. These behaviors align with the most frequently expressed concerns by adults, particularly regarding the credibility of sources and the methods used for evaluation. Moreover, a few patterns reflect the role of classroom dynamics when it comes to children's information-seeking. *Social influence/task division* captures the group-level decision-making practices, which can be associated, depending on the children's behavior, with the risk of task substitution expressed by parents' concerns. *Search as a playful experience* and *Perceiving the tool as "intelligent"* highlight children's tendency to frame IAS as games or authoritative agents. Additionally, *Quantity over quality* reflects children's preference for multiple results without actually comparing them, leading often to information overload as an associated risk.

Overall, children's information-seeking behaviors during classroom inquiry tasks follow recurring patterns shaped by both individual and classroom dynamics. Difficulties with comprehension, preferences for quick answers, and heuristic approaches to judge credible information contribute to risks identified by adult stakeholders, including premature stopping, reduced verification, information overload, and challenges in evaluating information.

### 4.2 Anti-personas defined

After identifying recurring behavioral patterns and associated risks, we grouped them into facets based on similarities, which informed the development of three anti-personas, shortly reported in Figure 1. Our aim was not to portray the "ideal" child, but to highlight moments where children's interaction with IAS diverges from traditional UM assumptions. These anti-personas do not represent real children; they are evidence-based constructions that synthesize recurring ways children misuse IAS during school-related search tasks. Each anti-persona integrates observed behavioral patterns, cognitive strategies, source preferences, and the predominance of errors, showing how effectively the child is able to identify correct answers. Along with the child's behavior, these anti-personas also report the associated risks identified by adult stakeholders, i.e., teachers and family members, reflecting their expectations for appropriate search practices. We describe each anti-persona through a short narrative that places the child in a realistic school-search scenario, illustrating how the specific behaviors mismatch systems' assumptions and lead to risks expressed by adults. `Alex`, `Sam`, and `Robin` each represent a distinct cluster of mismatched information-seeking behaviors and the risks identified as consequences.

*Alex the Sprinter Seeker.* `Alex` is a 9-year-old child who experiences information-seeking practices as a gaming experience, motivated more by speed and instant gratification than learning (see

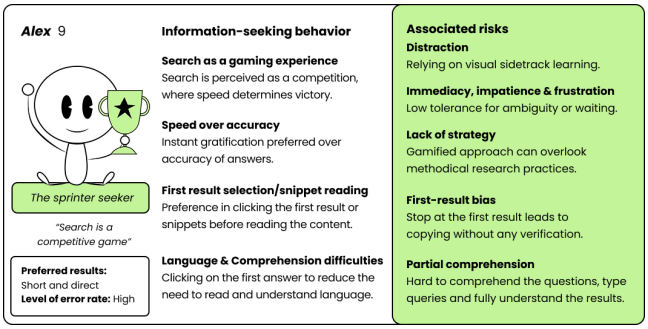
**Table 1: Children's information-seeking behavioral patterns and associated risks**

| Pattern | Type | Description | Example | Associated Risks | Risk Source |
|---|---|---|---|---|---|
| Lexical difficulty/ comprehension | Observation | Unfamiliar vocabulary or need to read aloud; search for tools using accessible language | The child does not understand the question, therefore looks for a different answer | Expressive difficulties; weak queries; partial comprehension | parents; teachers |
| First result selection/ premature closure | Observation | Rapid selection of top-ranked results | Both children within the group stopped at the first Google result. | First-result bias | teachers |
| Snippet/preview-based selection | Observation | Reliance on short summaries (SERP snippets/previews) | They tried to give the answer by reading only Google snippets. | Search method issues; lack of strategy | teachers |
| Speed over accuracy | Observation | Preference for speed or immediate formats | "I prefer ChatGPT it is faster and gives direct answers" | Immediacy, impatience, frustration | parents |
| Visual support as a shortcut | Observation | Seeking images or visual elements to obtain immediate answers | "Google makes mistakes, but it shows us images to answer." | Distraction | parents; teachers |
| Starting from prior knowledge | Cognitive strategy | Recalling previously known information before or during search | The child relies on prior knowledge of the topic from a children's book. | Source credibility issues; confirmation bias | parents; teachers |
| Familiarity or selective distrust toward platforms | Cognitive strategy | Trust in well-known brands; distrust of platforms perceived as "not for children" | "I don't trust Bing's results because it is for adults" | Source credibility issues; search method | parents; teachers |
| Trust in numbers or details | Cognitive strategy | Preference for results containing numbers | "I prefer scientific articles because scientists never tell us nonsense" | Source credibility issues; search method | parents; teachers |
| Social influence / task division | Social behavior | Group decision-making, reading aloud for alignment, division of results | Within the group, they divide the results so to compare them with each other | Full task substitution | parents |
| Search as a playful experience | Motivation | Search perceived as a game rather than a process | "I prefer using ChatGPT because it made us win by telling us more correct answers" | Search method issues; lack of strategy | teachers |
| Perceiving the tool as "intelligent" | Cognitive perception | The tool is perceived as reliable and true without valid evidence | "I preferred using ChatGPT because it was smarter than other tools" | Source credibility issues; search method | parents; teachers |
| Quantity over quality | Selection heuristic | Preference for obtaining many answers | "Google is my favorite because it has a lot stuff in it, so it's easier" | Information overload | parents; teachers |

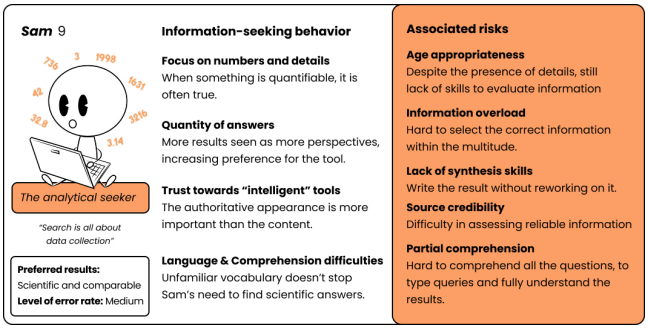
Figure 1a). For Alex, searching is about getting to an answer first. The moment results appear, Alex clicks the first snippet, image, or response, often celebrating immediately, even when the result partially addresses the question. Due to this young age, Alex has difficulty with language and comprehension. Teachers observed that Alex often reads aloud with intense concentration, carefully typing queries, yet struggles to understand the results. This makes speed a coping strategy: clicking on the first answer can reduce the need to read and understand complex language. Alex seems to strongly prefer short and direct answers, such as the ones offered by LLM-based tools like ChatGPT, and, to a lesser extent, SE snippets. These IAS are perceived as always available and ready to give the correct answer. Moreover, images are frequently used as shortcuts: when a picture seems right, it is often perceived as sufficient evidence. However, due to the difficulty in completely understanding the information shown in the results, this behavior is often associated with a high error rate in finding the correct information, driven by first-result bias and premature closure. This risk is frequently identified by teachers, followed by a lack of search strategy, partial comprehension, and weak query formulation. Moreover, Alex rarely verifies information and shows low tolerance for ambiguity or waiting. When searching online for curriculum-related activities at home, in fact, Alex's family reports impatience and frustration when answers are not clear or immediate. Together, these behavioral patterns hint at how Alex's clear attempt to reduce the overall effort can unintentionally amplify risks related to superficial understanding or exposure to unreliable content.

*Sam the Analytical Seeker.* Sam is a 9-year-old child who approaches searching as a process of data collection to gather absolute knowledge (see Figure 1b). When searching online in the classroom, Sam prefers using SE, scanning all the results in the SERP before choosing one, often drawn to numbers, statistics, or papers with an authoritative appearance. Despite spending more time searching than peers, Sam still shows a moderate error rate, oftentimes due to the presence of language exceeding primary-school comprehension levels. When presented with both child-friendly explanations and more complex articles, Sam often prefers the latter, explaining that "scientific articles don't say nonsense". Sources are trusted because they look detailed, yet Sam is rarely able to critically evaluate them, perceiving tools as "intelligent" only when displaying complex and scientific information. As explicitly stated by the family, Sam struggles to select credible information, and, among the multitude of displayed results, it is common to feel overwhelmed. According to teachers, these patterns lead Sam to show some difficulty in synthesizing information, often looking for complex results above the level of comprehension for a primary school kid. Together, these behavioral patterns hint at how Sam's analytical approach can still result in moderate error rates and misinterpretation of data.

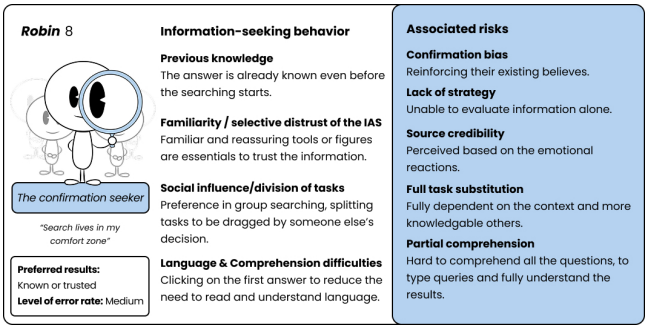
*Robin the Confirmation Seeker.* Robin is an 8-year-old kid who approaches search as a way to confirm existing knowledge (see Figure 1c). Even before starting to search, Robin already has an answer in mind, and often likes to guess before searching. When not knowing the answer, however, Robin prefers to still use familiar sources that feel safer, such as known IAS or trusted and reassuring figures, like peers and teachers. Robin still prefers using straightforward tools such as LLMs, but only because of the way IAS are perceived, classifying them more as a friend than an instrument. While LLMs are perceived as supportive, the teacher is trusted to explain things properly despite being aware that the source may make mistakes. This pattern shows a moderate error rate, particularly when incorrect information aligns with Robin's prior beliefs. Robin prefers to search in groups, frequently deferring to peers or




(a) Alex the Sprinter Seeker




(b) Sam the Analytical Seeker




(c) Robin the Confirmation Seeker

**Figure 1: Emerged Child Anti-Personas**

teachers, reading answers aloud to check for approval, and splitting tasks to reduce individual responsibility. Teachers note that this collaborative behavior can reduce Robin's critical engagement, often replaced by reassurance from others. When searching for school-related tasks at home, Robin's family shows an emotional dependence on tools. This dependence may lead to confirmation bias, as they might prefer searches that reinforce their existing understanding instead of challenging it. As a result, Robin's behavior hints at how searching within a "comfort zone" can limit exploration, often reinforcing biases, even when the child seems confident or engaged in the activity.

## 5 Discussion

Informed by the results reported in Section 4.2 on misused behavioral patterns when children interact with different sources of information for curriculum-based activities, and the associated risks expressed by adult stakeholders, we designed anti-persona profiles of primary school children using IAS in the classroom context. These profiles illustrate examples of how children navigate IAS during curriculum-related activities in the classroom setting, and how adults interpret these strategies as potential sources of risk. The introduction of this new strategy to represent child anti-personas extends the traditional persona-based approaches. Instead of focusing solely on individual user needs or system misalignment after harm has occurred, this strategy integrates children's practices with adult stakeholders' anticipatory concerns. For example, while traditional personas would highlight the need for reassurance and familiar context for describing *Robin, the Confirmation Seeker*, the anti-persona framework highlights the rise of confirmation bias and reinforcement of prior beliefs when in a context of collaborative searching. This perspective shifts the design question from *"How do we design for this child?"* to *"Where might the system fail this child?"*, offering a complementary lens for making mismatched interaction patterns more explicit.

*Towards a New Strategy for Child Anti-personas.* The typical approach of designing traditional qualitative personas starts from children's needs or goals [55]. Here, we instead deliberately focused on patterns of misuse that emerge when children interact with IAS, and on the risks that adult stakeholders associate with those behaviors. Our findings show that children's information-seeking practices are shaped by some consistent behaviors, like difficulty in lexicon comprehension, prioritization of speed over accuracy, or relying on authoritative cues, that are perceived as rational search strategies by children, yet risky behaviors from an adult's perspective. These behavioral patterns seem to function as mechanisms for children to navigate complex interfaces, but they also diverge from the expectations embedded in adults' notion of "ideal" search behavior. By anchoring the anti-personas in the behavioral-risks dichotomy, we make this mismatch more explicit.

Children tend to optimize for immediacy or reassurance, whereas adults expect them to develop search methods, increase their level of comprehension, and develop critical evaluation skills. In this context, teachers mainly highlight methodological and language proficiency issues (e.g., premature stopping, first-result bias, and limited source validation), while parents seem to be more concerned about the emotional reactions of children and their exposure to unsuitable content (e.g., distraction, frustration, and exposure to age-inappropriate content). By integrating adult stakeholders' perspectives alongside children's behaviors, this work extends the traditional construction process of anti-personas beyond the individual user's threats toward the system. Rather than identifying tasks' failure after it occurred, these anti-personas allow future researchers to anticipate how specific search strategies may lead to risks. Therefore, they function as a bridge between children's actual practices in online searching and adults' anticipatory risk assessments, supporting a reflective understanding of how certain misused behaviors in online searching may lead to possible risks, without exposing children to potential harms.

*Going Beyond Existing Child-centered User Models.* Existing representations of UM, such as qualitative personas construction, when it comes to children as users, tend to follow two main approaches.

On one hand, children are directly involved in the creation of personas, which are later refined by researchers to better reflect users' needs and goals [33]. This method allows children to become co-designers of the solution, contributing as experts of their own lives [30]. On the other hand, researchers rely on qualitative observational data to describe an ideal child user who interacts with the system as expected [55], involving children as final users rather than researchers. Unlike adult-based personas, child personas emphasize users' peculiarities based on their developmental needs rather than task achievement goals [4]. The work of Antle [4] introduces this method, primarily focusing on defining needs rather than goals, leading to the use of these child personas to understand the level of mentoring or guidance based on the developmental stage of the final user when interacting with the designed solution.

Capturing children's developmental needs is often not enough to evaluate the effectiveness of IAS when it comes to children's information-seeking behavior. Research shows that these behaviors are often shaped by their evolving cognitive development [47], limited digital knowledge [77], and different information needs [37, 58, 77]. To capture this diversity, past works attempted to cluster children's information-seeking strategies into predefined *searchers roles*, identifying patterns of interaction that children adopt depending on task type, motivation, or context [18]. These roles provide insights into how children engage with keyword search interfaces. However, despite the crucial contribution of these roles in determining the implicit strategies of children when searching online, they are focused on their interaction with traditional SE, without accounting for the growing ecosystem of IAS. Moreover, focusing on home settings rather than structured educational contexts, these roles often do not take into account the classroom dynamics, such as peer interaction or educators' scaffolding, which can affect children's information-seeking behavior.

When it comes to online searching for children in an educational context, in fact, children are often not independent searchers yet. Adults can, therefore, play a fundamental role in scaffolding, evaluating, and mediating children's experiences [41]. Teachers and more knowledgeable family members often act as facilitators of the search process, guiding children in formulating queries, assessing sources of information, or synthesizing content [11, 53], emphasizing the responsibility of adults in children's online learning. Prior work has explored this relationship by introducing *collective personas* [1, 28], which model shared goals, interactions, and influences between teachers and children [73]. While collective personas are useful for representing collaborative dynamics across different roles, based on the method of personas, they mainly focus on identifying expected or ideal forms of interaction between the represented group of users and the designed solution, often adopting a proxy approach due to the difficulties in collecting children's data [1]. These UM representation methods contribute to better capturing children's intended information-seeking behaviors when interacting with IAS. Still, often children are not intended as target users of these systems. Commercial IAS are a clear example. They are designed for mainstream users, i.e., adult population [5, 42], yet children are increasingly turning to them for information [3]. In this scenario, identifying children's information needs and adopted search strategies allows for a better understanding of their mental models without taking into account how their behaviors do not conform to expected interaction patterns. Adopting a more realistic approach by introducing child anti-personas allows for a change of perspective beyond best-case scenarios, focusing on misaligned usage of the designed solution, from non-target user groups, such as children for commercial IAS. Moreover, while collective personas are useful for representing collaborative dynamics across different roles, the two components of the child anti-personas introduced in this work allow for identifying how children's behavior can lead to risk exposure when evaluated from adult lenses.

Children are not fully able to abstract and articulate possible future risks associated with their own search strategies. At the same time, more knowledgeable others [20, 75], such as educators or family members, often struggle to anticipate children's thinking and behaviors during online search activities. By bridging these two perspectives, anti-personas can help reveal how children's strategies break systems that were not designed primarily for them, exposing them to potential risks. This opposed view highlights where children's interaction with the system is opening risky or inappropriate search paths, pointing out concrete opportunities for designers and educators to intervene to provide effective scaffolding during the learning process of online searching.

*One Method for Multiple Purposes.* UM representation tools such as personas are traditionally employed to foster empathy with users and to support the design of systems that respond to their needs and goals [55, 61]. In the case of the proposed anti-personas method, however, the focus is on providing a method with a dual purpose. From a design perspective, child anti-personas can operate as critical design probes, encouraging design experts or researchers to reflect on how interface features can reinforce risky behaviors when the user is a child. Moreover, anti-personas can help designers to anticipate how children's interaction may be misaligned with traditional IAS user assumptions, revealing possible risks without requiring children to be exposed to them. By structuring the emerged behavioral patterns into profiles rather than isolated behaviors, this framework enables designers and researchers to reason and anticipate when IAS may need to implement scaffolding practices to support children's search strategies [43]. Representing these failures enables the design of more adaptive solutions that respond to misalignment rather than treating it as a threat. From an educational perspective, this new strategy for designing child anti-personas provides educators with a lens to understand classroom behaviors that may often be interpreted as a distraction or a lack of effort. By framing these actions as resulting from the misunderstanding of information-seeking strategies, teachers can shift from addressing superficial mistakes to scaffolding interventions for a better understanding of underlying strategies. Overall, this work contributes to the design of a new construction strategy for building child anti-personas that takes into account the role of adults in children's online learning, without replacing the child's practices, but as a lens for understanding their information-seeking behaviors.

*The Importance of Representing Multiple Learners.* With the increasing use of search tools in the classroom, IAS are often turned into learning tools to support knowledge construction. In this educational context, it becomes essential to anticipate learners' needs to

provide the correct level of scaffolding [32]. Introducing the Search-as-Learning **(SAL)** paradigm within the classroom context can help to detect and predict these learning needs, emphasizing search sessions driven by a specific learning intent, while supporting children in their educational activities. While on one side, SAL practices contribute to the growth of search strategies to acquire new information, they also support the development of effective search skills [14], focusing on providing children with the correct scaffolding to effectively search [76]. Our findings hint at how children's interactions with IAS often oscillate between these two dimensions, but they frequently fail to fully support both. The three examples of child anti-personas that emerged from this work highlight how children may appear engaged in searching to learn, to achieve a specific curriculum-related task, while relying on strategies that may limit the development of effective search skills and expose them to possible risks, identified by more knowledgeable others [20, 75]. `Alex`'s clear attempt to reduce the overall effort by selecting the most immediate result can lead to possible exposure to misinformation or inappropriate content [13]. `Sam`'s analytical approach, instead, despite appearing methodical, can lead to misjudgment or lack of comprehension when not supported by appropriate scaffolding. Finally, `Robin`'s preference towards a comfortable environment can limit learning exploration, reinforcing existing biases, or unreliable trust with no evidence.

Overall, by revealing how different young learners approach online information-seeking activities, adopting specific behavioral patterns and misleading search strategies, we argue for the importance of accounting for distinct forms of scaffolding to support both learning outcomes and their acquisition of search skills. This perspective reinforces the importance of considering diverse learners' profiles when designing IAS, ensuring that the SAL paradigm does not simply privilege those children whose information-seeking behaviors align with the "ideal" user model outlined from adults' perception of efficient searchers.

## 6 Limitations & Future Work

Although adopting a dual perspective that combines children's observed behaviors when interacting with different sources of information and adults' perceptions of associated risks allows us to highlight misalignment between youngsters' practices and adults' expectations, this approach presents some limitations. From a methodological perspective, the activity with children was run through paper-based prototypes, which may have limited children's interaction with different IAS. Moreover, the analysis is primarily qualitative and therefore based on subjective interpretation of data from the researchers, which may lead to biases during the coding and clustering phases for themes and behavioral patterns definition. Incorporating both children's information-seeking practices and adults' stakeholders' perspective strengthens the analysis, yet future work could adopt a more mixed-method approach that integrates both qualitative insights and quantitative evidence, such as children's interaction log analysis or performance evaluations, to validate the recurring patterns. In order to do so, future studies should aim to simulate children's interactions with IAS in a controlled environment, to collect richer behavioral data regarding their dynamics, such as scrolling behaviors, query reformulation, or conversational exchanges, while still ensuring children's online safety. Due to the limited size and scope of the participant sample, our findings cannot be generalized to represent the full spectrum of children's information-seeking behaviors. Since our work focuses on the classroom settings, children's misuse practices could be influenced by the dynamics linked to that context. Future work should therefore expand the study to include a more diverse population across different educational settings and levels of digital exposure to explore whether and how these factors shape recurring misuse behavioral patterns and associated risks.

Despite the noted limitations, our results provide a foundation for considering child anti-personas as a novel UM representation strategy. By focusing on where and how IAS misalign with non-ideal users' behaviors, this work offers a different perspective for both researchers and educational experts when it comes to children's online information-seeking behaviors and associated risks.

## 7 Concluding Remarks

This study examines children's interactions with different sources of information in the primary school classroom, focusing on behavioral patterns that emerged from their misuse, combined with adults' perceptions of associated risks. By concentrating on moments of misuse and friction rather than ideal users who successfully achieve the search tasks, we highlight how children's search strategies, often perceived by them as effective, diverge from adults' expectations. Behaviors that seem rational for these young learners, such as prioritizing speed over accuracy, relying on familiar tools, or trusting authoritative cues, are interpreted by teachers and family members as potentially risky, leading to concerns regarding lack of comprehension, reduced verification strategies, confirmation biases, or information overload. These results highlight the importance of considering both children's perspectives as active users involved in the interaction with IAS and adults' perspectives, who actively scaffold, interpret, and evaluate children's online learning in educational contexts. To make visible misalignments in children-IAS interactions in the classroom context, we introduce three child anti-personas, `Alex`, `Sam`, and `Robin`, as examples of UM representation based on the dichotomy between these two actors. By shifting the focus from ideal users, often central to traditional methods such as child personas, roles, or collective personas, towards evidence-based representations of how system misaligned with children's actual online information-seeking practices, we provide a new strategy for researchers, designers and educators to reflect on potential risks without exposing children to it, identifying the correct form of scaffolding based on the emergent behavioral patterns. The reflections emerging from our study, in conjunction with prior work in IR, Child-Computer Interaction, and User Modeling, and consistent with the dual process of searching to learn while learning to search within the SAL paradigm, provide a foundation for designing inclusive, developmentally appropriate, and context-aware IR systems. By shifting the focus from success to identifying misalignment and from individual users to the broader ecosystem of stakeholders involved in online classroom search activities, these IAS should aim to support both the achievement of learning outcomes and the development of information-seeking skills among diverse groups of young learners.

## Acknowledgments

This work is supported by SNSF Award #[IC00I0-227887 project n.10000973 SOL]. GenAI tools were used for editing the manuscript for clarity, but the authors are fully accountable for the content.

## References

[1] Christie Anne Abel and Thomas D Grace. 2020. Designing dyadic caregiver-child personas for interactive digital media use. In *Proceedings of the Interaction Design and Children Conference* (London, United Kingdom) *(IDC '20)*. Association for Computing Machinery, New York, NY, USA, 198–204. doi:10.1145/3392063.3394391

[2] Naresh Kumar Agarwal. 2022. Integrating models and integrated models: towards a unified model of information seeking behaviour. *Information Research* 27, 1 (2022), 27–1.

[3] Anitha Anandhan, Liyana Shuib, Maizatul Akmar Ismail, and Ghulam Mujtaba. 2018. Social Media Recommender Systems: Review and Open Research Issues. *IEEE Access* 6 (2018), 15608–15628. doi:10.1109/ACCESS.2018.2810062

[4] Alissa Nicole Antle. 2006. Child-personas: fact or fiction?. In *Proceedings of the 6th Conference on Designing Interactive Systems* (University Park, PA, USA) *(DIS '06)*. Association for Computing Machinery, New York, NY, USA, 22–30. doi:10.1145/1142405.1142411

[5] Ion Madrazo Azpiazu, Nevena Dragovic, Maria Soledad Pera, and Jerry Alan Fails. 2017. Online searching and learning: YUM and other search tools for children and teachers. *Information Retrieval Journal* 20 (2017), 524–545.

[6] Theophilus Azungah. 2018. Qualitative research: deductive and inductive approaches to data analysis. *Qualitative Research Journal* 18, 4 (2018), 383–400. doi:10.1108/QRJ-D-18-00035

[7] Dania Bilal. 2000. Children's use of the Yahooligans! Web search engine: I. Cognitive, physical, and affective behaviors on fact-based search tasks. *Journal of the American Society for Information Science* 51 (2000), 646–665. doi:10.1002/asi.10145

[8] Dania Bilal. 2001. Children's use of the Yahooligans! Web search engine: II. Cognitive and physical behaviors on research tasks. *Journal of the American Society for Information science and Technology* 52, 2 (2001), 118–136.

[9] Dania Bilal. 2002. Children's use of the yahooligans! web search engine. III. cognitive and physical behaviors on fully self-generated search tasks. *J. Am. Soc. Inf. Sci. Technol.* 53, 13 (2002), 1170–1183. doi:10.1002/asi.10145

[10] Dania Bilal and Joe Kirby. 2002. Differences and similarities in information seeking: children and adults as web users. *Inf. Process. Manage.* 38, 5 (2002), 649–670. doi:10.1016/S0306-4573(01)00057-7

[11] Sondra H. Birch and Gary W. Ladd. 1997. The teacher-child relationship and children's early school adjustment. *Journal of School Psychology* 35, 1 (1997), 61–79. doi:10.1016/S0022-4405(96)00029-5

[12] Kay P Bland. 1996. CD-ROM utilization in the high school student research process. (1996).

[13] Hrishita Chakrabarti, Diletta Micol Tobia, Monica Landoni, and Maria Soledad Pera. 2025. Online Information Disorder & Children. In *Proceedings of the 5th Workshop on Reducing Online Misinformation through Credible Information Retrieval co-located the 47th European Conference on Information Retrieval (ECIR 2025) (CEUR Workshop Proceedings, Vol. 3986)*, Marco Viviani , Marinella Petrocchi, and Udo Kruschwitz (Eds.). CEUR-WS, 24–38.

[14] Kevyn Collins-Thompson, Preben Hansen, and Claudia Hauff. 2017. Search as learning (dagstuhl seminar 17092). (2017).

[15] Alan Cooper. 1999. *The Inmates are Running the Asylum*. Vieweg+Teubner Verlag, Wiesbaden, 17–17. doi:10.1007/978-3-322-99786-9_1

[16] Alan Cooper. 2004. The origin of personas. *INNOVATION-MCLEAN THEN DULLES VIRGINIA-* 23, 1 (2004), 26–29.

[17] Paul De Bra, Ad Aerts, Bart Berden, Barend Lange, Brendan Rousseau, Tomi Santic, David Smits, and Natalia Stash. 2003. AHA! The Adaptive Hypermedia Architecture. 14 (2003). doi:10.1145/900051.900068

[18] Allison Druin, Elizabeth Foss, Hilary Hutchinson, Evan Golub, and Leshell Hatley. 2010. Children's roles using keyword search interfaces at home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Atlanta, Georgia, USA) *(CHI '10)*. Association for Computing Machinery, New York, NY, USA, 413–422. doi:10.1145/1753326.1753388

[19] Sergio Duarte Torres, Ingmar Weber, and Djoerd Hiemstra. 2014. Analysis of Search and Browsing Behavior of Young Users on the Web. *ACM Trans. Web* 8, 2, Article 7 (March 2014), 54 pages. doi:10.1145/2555595

[20] Michael D Ekstrand, Maria Soledad Pera, and Katherine Landau Wright. 2023. Seeking information with a more knowledgeable other. *Interactions* 30, 1 (2023), 70–73.

[21] Adobe Express. 2025. ChatGPT as a Search Engine | Adobe. https://www.adobe.com/express/learn/blog/chatgpt-as-a-search-engine

[22] Josef Fink and Alfred Kobsa. 2000. A Review and Analysis of Commercial User Modeling Servers for Personalization on the World Wide Web. *User Model. User-Adapt. Interact.* 10 (2000), 209–249. doi:10.1023/A:1026597308943

[23] Torbjørn Flensted. 2024. How Many People Use Google? Statistics & Facts (2025). https://seo.ai/blog/how-many-people-use-google

[24] Elizabeth Foss, Allison Druin, Robin Brewer, Phillip Lo, Luis Sanchez, Evan Golub, and Hilary Hutchinson. 2012. Children's search roles at home: Implications for designers, researchers, educators, and parents. *Journal of the American Society for Information Science and Technology* 63, 3 (2012), 558–573. arXiv:https://onlinelibrary.wiley.com/doi/pdf/10.1002/asi.21700 doi:10.1002/asi.21700

[25] Elizabeth Foss, Allison Druin, Jason Yip, Whitney Ford, Evan Golub, and Hilary Hutchinson. 2013. Adolescent search roles. *Journal of the American Society for Information Science and Technology* 64, 1 (2013), 173–189. doi:10.1002/asi.22809

[26] Allen Foster. 2004. A nonlinear model of information-seeking behavior. *Journal of the American society for information science and technology* 55, 3 (2004), 228–237.

[27] LDL Friel. 1996. The information research process with low-achieving freshman using Kuhlthau's six-stage model and the interventions that facilitate the process. (1996).

[28] Alain Giboin. 2011. From individual to collective personas modeling realistic groups and communities of users (and not only realistic individual users). In *The Fourth International Conference on Advances in Computer-Human Interaction (ACHI 2011)*. 132–135.

[29] M.P. Graus. 2018. *From behavior-centered to user-centered : incorporating psychological knowledge and user feedback in personalization*. Ph. D. Dissertation. Industrial Engineering and Innovation Sciences. Proefschrift..

[30] Anja Stedjeberg Hansen. 2017. How to best communicate with and encourage children during a design process.

[31] Sandra G. Hirsh. 1999. Children's relevance criteria and information seeking on electronic resources. *Journal of the American Society for Information Science* 50, 14 (1999), 1265–1283. doi:10.1002/(SICI)1097-4571(1999)50:14<1265::AID-ASI2>3.0.CO;2-E

[32] Anett Hoppe, Peter Holtz, Yvonne Kammerer, Ran Yu, Stefan Dietze, and Ralph Ewerth. 2018. Current challenges for studying search as learning processes. In *7th Workshop on Learning & Education with Web Data (LILE2018), in conjunction with ACM Web Science*.

[33] Helvi Itenge-Wheeler, Heike Winschiers-Theophilus, Alessandro Soro, and Margot Brereton. 2018. Child designers creating personas to diversify design perspectives and concepts for their own technology enhanced library. In *Proceedings of the 17th ACM Conference on Interaction Design and Children* (Trondheim, Norway) *(IDC '18)*. Association for Computing Machinery, New York, NY, USA, 381–388. doi:10.1145/3202185.3202760

[34] Hanna Jochmann-Mannak, {Theo W.C.} Huibers, Leo Lentz, and Ted Sanders. 2010. Children searching information on the Internet: Performance on children's interfaces compared to Google. In *Towards Accessible Search Systems*, Pavel Serdyukov, Djoerd Hiemstra, and Ian Ruthven (Eds.). Association for Computing Machinery, United States, 27–35. Workshop Towards Accessible Search Systems 2010 ; Conference date: 23-07-2010 Through 23-07-2010.

[35] Alfred Kobsa. 2007. *Generic User Modeling Systems*. Springer Berlin Heidelberg, Berlin, Heidelberg, 136–154. doi:10.1007/978-3-540-72079-9_4

[36] Bruce Krulwich. 1997. Lifestyle finder: Intelligent user profiling using large-scale demographic data. *AI Magazine* 18 (1997), 37–45.

[37] Carol Kuhlthau. 1997. Learning in Digital Libraries: An Information Search Process Approach. *Library Trends* 45 (1997).

[38] Carol Collier Kuhlthau. 1988. Developing a model of the library search process: Cognitive and affective aspects. *Rq* (1988), 232–242.

[39] Carol Collier Kuhlthau. 1988. Perceptions of the information search process in libraries: a study of changes from high school through college. *Information Processing & Management* 24, 4 (1988), 419–427. doi:10.1016/0306-4573(88)90045-3

[40] Carol C Kuhlthau. 2025. *Seeking meaning: A process approach to library and information services*. Bloomsbury Publishing USA.

[41] Monica Landoni, Mohammad Aliannejadi, Theo Huibers, Emiliana Murgia, and Maria Soledad Pera. 2021. Right Way, Right Time: Towards a Better Comprehension of Young Students' Needs when Looking for Relevant Search Results. In *Proceedings of the 29th ACM Conference on User Modeling, Adaptation and Personalization* (Utrecht, Netherlands) *(UMAP '21)*. Association for Computing Machinery, New York, NY, USA, 256–261. doi:10.1145/3450613.3456843

[42] Monica Landoni, Theo Huibers, Emiliana Murgia, and Maria Soledad Pera. 2024. Good for Children, Good for All?. In *European Conference on Information Retrieval*. Springer, 302–313.

[43] Monica Landoni, Theo WC Huibers, Mohammad Aliannejadi, Emiliana Murgia, and Maria Soledad Pera. 2021. Getting to know you: Search logs and expert grading to define children's search roles in the classroom. In *CEUR workshop proceedings*, Vol. 2950. CEUR, 44–52.

[44] Monica Landoni, Davide Matteri, Emiliana Murgia, Theo Huibers, and Maria Soledad Pera. 2019. Sonny, Cerca! Evaluating the Impact of Using a Vocal Assistant to Search at School. In *Experimental IR Meets Multilinguality, Multimodality, and Interaction: 10th International Conference of the CLEF Association, CLEF 2019, Lugano, Switzerland, September 9–12, 2019, Proceedings* (Lugano,

Switzerland). Springer-Verlag, Berlin, Heidelberg, 101–113. doi:10.1007/978-3-030-28577-7_6
[45] Monica Landoni, Maria Soledad Pera, Emiliana Murgia, and Theo Huibers. 2022. Let's Learn from Children: Scaffolding to Enable Search as Learning in the Educational Environment. arXiv:2209.02338 [cs.IR] https://arxiv.org/abs/2209.02338
[46] Andrew Large, Valerie Nesset, and Jamshid Beheshti. 2008. Children as information seekers: what researchers tell us. *New Review of Children's Literature and Librarianship* 14, 2 (2008), 121–140. doi:10.1080/13614540902812631
[47] Stefanie Lindow. 2021. On searching and finding: The development of information search abilities. *Cognitive Development* 58 (2021), 101011. doi:10.1016/j.cogdev.2021.101011
[48] Andreas Lorenz. 2005. Agent-Based Ubiquitous User Modeling. 512–514. doi:10.1007/11527886_73
[49] Andres Lucero. 2015. Using Affinity Diagrams to Evaluate Interactive Prototypes. In *Human-Computer Interaction (INTERACT 2015)*, Julia Abascal, Simone Barbosa, Mirko Fetter, Tom Gross, Philippe Palanque, and Marco Winckler (Eds.). Springer International Publishing, Cham, 231–248.
[50] Joy H McGregor. 1993. *Cognitive processes and the use of information: A qualitative study of higher order thinking skills used in the research process by students in a gifted program.* The Florida State University.
[51] Caroline Moeckel. 2018. From user-centred design to security: building attacker personas for digital banking. In *Proceedings of the 10th Nordic Conference on Human-Computer Interaction* (Oslo, Norway) *(NordiCHI '18)*. Association for Computing Machinery, New York, NY, USA, 892–897. doi:10.1145/3240167.3240241
[52] Nor Haniza Mohd Khir and Marina Ismail. 2019. Review on gamification in children computer interaction (CCI) for persona modelling. *Bulletin of Electrical Engineering and Informatics* 8 (2019). doi:10.11591/eei.v8i4.1622
[53] Emiliana Murgia, Monica Landoni, {Theo W.C.} Huibers, {Jerry Alan} Fails, and {Maria Soledad} Pera. 2019. The Seven Layers of Complexity of Recommender Systems for Children in Educational Contexts. In *Proceedings of the Workshop on Recommendation in Complex Scenarios (CEUR Workshop Proceedings)*, Marijn Koolen, Toine Bogers, Bamshad Mobasher, and Alexander Tuzhilin (Eds.). Association for Computing Machinery, United States, 5–9.
[54] Fatma Nasoz and Christine Lisetti. 2007. Affective User Modeling for Adaptive Intelligent User Interfaces. 421–430. doi:10.1007/978-3-540-73110-8_45
[55] Lene Nielsen. 2013. *Personas - User Focused Design.* 1–24.
[56] Lene Nielsen, Kira Hansen, Jan Stage, and Jane Billestrup. 2015. A Template for Design Personas:. *International Journal of Sociotechnology and Knowledge Development* 7 (01 2015), 45–61. doi:10.4018/ijskd.2015010104
[57] Maria Soledad Pera, Federica Cena, Monica Landoni, Cataldo Musto, and Alain D Starke. 2024. Human Factors in User Modeling for Intelligent Systems. In *A Human-Centered Perspective of Intelligent Personalized Environments and Systems*. Springer, 3–42.
[58] Maria Soledad Pera, Theo Huibers, Emiliana Murgia, and Monica Landoni. 2025. Some Things Never Change: Overcoming Persistent Challenges in Children IR. In *Proceedings of the 48th International ACM SIGIR Conference on Research and Development in Information Retrieval*. 3107–3109.
[59] Jean Piaget. 1971. *The theory of stages in cognitive development.* McGraw-Hill, New York, NY, US.
[60] Judy M Pitts. 1994. *Personal understandings and mental models of information: A qualitative study of factors associated with the information-seeking and use of adolescents.* The Florida State University.
[61] John Pruitt and Jonathan Grudin. 2003. Personas: practice and theory. In *Proceedings of the 2003 Conference on Designing for User Experiences* (San Francisco, California) *(DUX '03)*. Association for Computing Machinery, New York, NY, USA, 1–15. doi:10.1145/997078.997089
[62] Erasmo Purificato, Ludovico Boratto, and Ernesto William De Luca. 2024. User Modeling and User Profiling: A Comprehensive Survey. arXiv:2402.09660 [cs.AI]
[63] Glenda Revelle, Allison Druin, Michele Platner, Stacy Weng, Benjamin B Bederson, Juan Pablo Hourcade, and Lisa Sherman. 2000. Young children's search strategies and construction of search queries. (2000).
[64] Elaine Rich. 1998. User Modeling via Stereotypes. *Cogn. Sci.* 3 (1998), 329–354.
[65] Soo Young Rieh, Kevyn Collins-Thompson, Preben Hansen, and Hye-Jung Lee. 2016. Towards searching as a learning process: A review of current perspectives and future directions. *Journal of Information Science* 42, 1 (2016), 19–34.
[66] Ian Rowlands, David Nicholas, Peter Williams, Paul Huntington, Maggie Fieldhouse, Barrie Gunter, Richard Withey, Hamid R Jamali, Tom Dobrowolski, and Carol Tenopir. 2008. The Google generation: the information behaviour of the researcher of the future. In *Aslib proceedings*, Vol. 60. Emerald Group Publishing Limited, 290–310.
[67] Hataichanok Saevanee, Nathan Clarke, Steven Furnell, and Valerio Biscione. 2015. Continuous user authentication using multi-modal biometrics. *Computers & Security* 53 (2015), 234–246. doi:10.1016/j.cose.2015.06.001
[68] Benjamin Schooley and Tonia San Nicolas-Rocca. 2025. From Persona Non Grata to Persona Imperitus: Modeling Personas to Design Usable and Secure Software Applications. In *HCI for Cybersecurity, Privacy and Trust*, Abbas Moallem (Ed.). Springer Nature Switzerland, Cham, 223–241.
[69] Andrew K. Shenton and Pat Dixon. 2003. Models of young people's information seeking. *Journal of Librarianship and Information Science* 35, 1 (2003), 5–22. doi:10.1177/096100060303500102
[70] Gavin Sim, Abhishek Shrivastava, Matthew Horton, Simran Agarwal, Pampana Sai Haasini, Chandini Sushma Kondeti, and Lorna McKnight. 2019. Child-generated personas to aid design across cultures. In *IFIP Conference on Human-Computer Interaction*. Springer, 112–131.
[71] Adam Steele and Xiaoping Jia. 2008. Adversary Centered Design: Threat Modeling Using Anti-Scenarios, Anti-Use Cases and Anti-Personas.. In *IKE*. 367–370.
[72] Diletta Micol Tobia and Monica Landoni. 2025. Quest for knowledge: Design of an interactive game to trace children's search experience. In *Proceedings of the 24th Interaction Design and Children*. Association for Computing Machinery, New York, NY, USA, 932–937. doi:10.1145/3713043.3731509
[73] Sveva Valguarnera and Monica Landoni. 2021. Designing Collective Teacher-Children Personas in Preschool: A Methodological Approach. In *Proceedings of the 20th Annual ACM Interaction Design and Children Conference* (Athens, Greece) *(IDC '21)*. Association for Computing Machinery, New York, NY, USA, 488–492. doi:10.1145/3459990.3465186
[74] Nicholas Vanderschantz and Annika Hinze. 2019. "Computer what's your favourite colour?" children's information-seeking strategies in the classroom. *Proceedings of the Association for Information Science and Technology* 56, 1 (2019), 265–275. arXiv:https://asistdl.onlinelibrary.wiley.com/doi/pdf/10.1002/pra2.21 doi:10.1002/pra2.21
[75] Lev S Vygotsky. 1978. *Mind in society: The development of higher psychological processes*. Vol. 86. Harvard university press.
[76] Aída Walqui. 2006. Scaffolding Instruction for English Language Learners: A Conceptual Framework. *International Journal of Bilingual Education and Bilingualism* 9, 2 (2006), 159–180. doi:10.1080/13670050608668639
[77] Virginia A. Walter. 1994. The Information Needs of Children. In *Advances in Librarianship*. Emerald Group Publishing Limited. arXiv:https://www.emerald.com/book/chapter-pdf/9122169/s0065-2830_1994_0000018006.pdf doi:10.1108/S0065-2830(1994)0000018006