



Exploring AI in Education: Child-Computer Interaction in the Global South

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Recent artificial intelligence (AI) advancements promise to enhance children's education through well-planned interventions. However, designing AI interventions for the Global South is challenging due to limited literature on children's interactions with AI-based educational tools. This survey article identified 18 studies from 2014 to 2025 that explicitly focus on child-computer interaction when integrating AI into education in the Global South. Our synthesized review uncovers three primary themes: enhancing learning through AI-driven tools, addressing barriers like privacy concerns and digital literacy gaps, and designing strategies for effective AI implementation. Key insights reveal AI's potential to enrich children's learning through personalized experiences, voice assistants, and educational games. Yet, challenges such as limited technology access, privacy risks, and cultural barriers require targeted solutions to ensure AI benefits all students. We conclude by proposing design strategies for AI integration that involve co-designing with children, enhancing digital literacy, and creating child-friendly interfaces.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**; • **Social and professional topics** → *Children*; • **General and reference** → **Surveys and overviews**;

Additional Key Words and Phrases: Children, CCI, child computer interaction, global south

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1 Introduction

In 2022, 244 million children remain out of school, particularly in the Global South, hindering their educational development [20]. Despite progress toward ensuring inclusive and equitable quality education by 2030, it is estimated that over 300 million children will still need more basic literacy and numeracy skills [62]. Most countries in the Global South lack resources to train and hire well-equipped teachers, leading to high student-to-teacher ratios, which has hindered individualized attention from teachers [39]. An opportunity with the expansion of digital tools and AI in the Global South [5, 24, 74] is the integration of technology into the education system, which has the potential to improve educational outcomes through well-planned interventions [51].

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Recent research spotlights AI's transformative potential in education [5, 24, 74], with UNESCO advocating its use for personalized student support, especially in remote areas [20]. AI applications enhance learning by providing personalized experiences and supporting game-based learning [10, 41]. Tools like **Tangible User Interfaces (TUIs)** are integrated to facilitate embodied learning activities [11]. These technologies track student progress, allowing for tailored educational content that motivates and enhances learning at an individual pace [47, 52]. AI also assists teachers with administrative tasks, such as grading and feedback [10]. Additionally, AI promotes inclusive education through tools like SiLearn for sign language learning and LetterReflex for addressing letter reversals [27, 36]. However, developing countries face barriers to fully utilizing ICT in education [30]. UNESCO suggests child-centered AI guidelines to ensure a safe and secure learning environment [63].

Previous research on AI in education within the Global South has mainly focused on understanding how children use technology and designing interventions to improve educational outcomes. However, these efforts have prioritized availability and usability, while children's opportunities and challenges in AI contexts have been less explored. Although some scholars have specifically examined the opportunities and challenges for educational technology in the Global South [47, 52, 63], most prior work offers only fragmented insights [30]. Motivated by these observations, our synthesis situates itself in the context of COMPASS and ICTD. We aim at understanding the opportunities and challenges for child-computer interaction and AI in education within developing regions.

Our literature search yielded 18 articles focused on integrating AI into education in the Global South. All 18 articles in our review were published between 2014 and 2025, reflecting the emerging nature of this field. Our dataset shows that India had the highest number of studies, followed by Malaysia and Tanzania. The studies primarily address the application of AI to educational contexts, targeting diverse age groups of children. We then analyzed these 18 articles to understand the factors shaping the design and implementation of AI systems in these regions.

Our main findings highlight three critical themes in integrating AI into education within developing countries. First, AI holds the potential to enhance learning experiences through tools like voice assistants, educational games, and interactive robots, fostering personal growth, engagement, and personalized learning. Second, the integration of AI faces considerable challenges, including technological limitations, gaps in digital literacy, cultural differences, and the risks associated with anthropomorphism in AI. Third, we identify practical strategies to overcome these challenges, such as co-designing with children, improving digital literacy, and tailoring AI interventions to meet the diverse educational needs of different regions. We conclude by discussing enhancing children's rights for AI by focusing on children's participation, privacy protection, and resource provisioning.

Definition of "AI" and "Child-Computer-Interaction"

UNICEF [63] defines **Artificial Intelligence (AI)** as machine-based systems that, based on human-defined objectives, make decisions impacting real or virtual environments. These systems interact with and adapt to their surroundings, often autonomously, using machine learning methods to recognize data patterns and process inputs such as text, voice, or images. The effectiveness of AI relies on high-quality data and well-designed algorithms that minimize bias and ensure fairness.

Child-Computer Interaction (CCI) involves studying and designing interactive systems specifically created for children, emphasizing how they interact with and comprehend technology. It adapts principles from **human-computer interaction (HCI)** to accommodate the developmental stages and abilities of children [17]. The primary aim is at developing technology that

fosters learning, creativity, and growth while addressing children's unique needs and behaviors and considering the effects of these interactions on their learning and social development [25, 50].

Contrasting AI Integration in Schools Across Regions

As AI-driven educational technologies continue to evolve, their integration into primary education varies significantly across different regions. Recent UNESCO reports highlight significant disparities in ICT infrastructure across regions [20]. For instance, in Sub-Saharan Africa, where electricity supply is often unreliable, mobile phones are a more viable alternative to computers for digital learning [33]. Even when the necessary infrastructure is available, skilled personnel for deployment and management are often lacking [24]. While the digitalization of education in developing countries is progressing, the absence of consistent strategies risks deepening existing patterns of inequality and exclusion [33]. Thus, it is vital to acknowledge these limitations while designing interventions involving AI for education in the Global South.

In developed countries, the primary challenge in integrating AI into education lies not in infrastructure but in responsible implementation and meaningful use. Laws on AI research have helped set a foundation for bringing AI into education, making progress more structured and effective. For instance, the second article of the National AI Initiative Act in the United States mandates national support for AI studies in formal and non-formal education [26]. Similarly, the European Union's proposed AI Act imposes strict obligations on AI systems used in education and vocational training [18]. In Finland, schools leverage the ViLLE platform for exam and assignment analytics [34], while **Learning Management Systems (LMS)** and interactive whiteboards have been introduced into classrooms [44]. However, these technologies are not yet being used as primary methods of instruction. Notably, children in developed countries are already exposed to AI systems and frequently interact with smart devices like iPads and Smart TVs, and so on.- without always recognizing their engagement with AI [19]. Developed countries face different challenges in integrating AI into education.

AI and EdTech research continue to be dominated by institutions in the Global North, often overlooking local policies, languages, and practices in the Global South [6, 24, 66]. For instance, AIED tools frequently rely on models trained in English, making them less effective in non-English contexts [13]. This dynamic often leads to market gains for corporations in the Global North while extracting economic value from developing countries [53]. However, there has been a significant increase in AI research originating from the Global South in recent years, indicating positive progress [59]. There have been efforts to establish data centers and AI research labs in developing regions. Yet, these positions often require technical expertise that local populations may lack, resulting in underrepresentation at both leadership and workforce levels [9].

To ensure equitable AI integration, interventions can consider a regional focus rather than adopting a universal framework [2]. While the Global North and South divide remains significant, constructive partnerships can foster the beneficial exchange of AI and pedagogical expertise across cultural boundaries [16]. However, such collaborations must prioritize the empowerment of local communities, enabling them to influence decision-making based on their unique realities [16].

2 Research Questions

We aimed at exploring how AI technologies improve children's experience in education technologies in the Global South. Through our work, we address the following research questions:

- **RQ1:** What are the (a) opportunities and (b) barriers for AI-based interventions for education and child-computer interaction in the Global South?

Table 1. Keywords used in the Search Term

Category	Keywords
(A) CCI	Child computer interaction, CCI
(B) Education	Child education, Primary schools
(C) AI	Artificial intelligence, AI
(D) Global South	Africa, Developing countries, Global south, India, Kenya, Latin America, LMIC, rural, Southeast Asia
Search Term	(A) AND (B) AND (C) AND (D)

Our search yielded 18 articles on integrating AI into education in the Global South.

– **RQ2:** What are some design strategies for AI-based interventions to enhance children’s experience?

3 Methodology

We conducted a literature review to answer our research questions. Our methods were similar to prior scholars in HCI4D literature [45, 67]. The following section provides a detailed outline of our methodology, including the identified search terms, parameters for filtering, and the analysis conducted on the retrieved articles.

Search Methodology

We used a search strategy similar to those in previous research [45, 67] to identify relevant articles. Our focus was on studies exploring child education in developing countries and the role of AI in improving educational outcomes. We specifically targeted child-centered studies that presented the perspectives of the children themselves. We limited our search to articles published since 2014 to ensure we captured recent advancements.

We employed four categories of keywords to ensure a comprehensive collection of relevant articles (see Table 1). The first category focused on education, with keywords like “child education” and “primary schools,” reflecting our interest in K-12 education. The second category defined the type of intervention, specifically “artificial intelligence.” The third category ensured that the articles were child-centric, using “child-computer interaction.” The fourth category filtered for studies based in developing countries, using terms such as “Africa,” “developing countries,” “global south,” “India,” “Kenya,” “Latin America,” “LMIC,” “rural,” and “Southeast Asia.”

We combined these categories using the AND operator between them and the OR operator within each category. This comprehensive search strategy resulted in a total of 210 research articles.

Filtering Operations

We performed several filtering steps to ensure the relevance and quality of the articles in our review. First, we excluded articles where the search terms appeared only in the references. We also removed fifteen articles that were unavailable in English and fourteen due to access issues. Books and review articles were also excluded.

After this initial screening, we carefully examined the 78 remaining articles by reading abstracts, assessing the purpose, findings, and contributions, and skimming the main text. Articles focused on teachers rather than students were filtered out, as were those from developed countries or not centered on AI interventions for improving child education.

Following this rigorous process, we finalized a selection of 18 articles. (see Table 2).

Table 2. Final Dataset for Thematic Analysis Consisted of 18 Articles

SNo.	Title	Author	Year	Publication Venue
1	Analyzing Preschoolers Requirements to the Integration of Game-Based Learning in Tanzania [46]	Catherine A Ongoro	2017	Journal of Information Engineering and Applications, Vol.7, No.8
2	I made my game: A framework for the design of digital games by children [4]	Adriana Gomes Alves	2017	Ph.D. Dissertation, Universidade do Vale do Itajaí
3	Design and Perception of a Social Robot to Promote Hand Washing among Children in a Rural Indian School [49]	Amol Deshmukh, Shanker Ramesh, Sooraj K Babu, Parameswari Anitha, Rao R Bhavani	2019	28th IEEE International Symposium on Robot and Human Interactive Communication
4	Using Google voice search to support informal learning in four to ten year old children [71]	Savita Yadav, Pinaki Chakraborty	2021	Education and Information Technologies, Volume 27, Issue 3
5	Remote Learning Amidst the Pandemic: Measuring the Relationships of Internet Usage and Cybersecurity Awareness of Primary School Students in Malaysia [28]	Norliza Katuk, Mohd Hasbullah, Adi Affandi Ahmad, Suhaidi Hassan, Mustaffa Ahmad, Jazzannul Azriq Aripin	2022	SSRN Electronic Journal
6	CodeJr : Comprehensive Programming Application for Children [43]	C J Muthuthanthirige, Uthpala Samarakoon, Nelum Amarasena	2022	4th International Conference on Advancements in Computing (ICAC)
7	“Hey, Alexa” “Hey, Siri”, “OK Google”” exploring teenagers’ interaction with artificial intelligence (AI)-enabled voice assistants during the COVID-19 pandemic [40]	Devadas Menon, K Shilpa	2023	International Journal of Child-Computer Interaction 38
8	Student Performance Prediction with Eye-Gaze Data in Embodied Educational Context [11]	Neila Chettaoui, Ayman Atia, Med Salim Bouhlel	2023	Education and Information Technologies 28
9	Inclusive Child-centered AI: Employing design futuring for Inclusive design of inclusive AI by and with children in Finland and India [57]	Sumita Sharma, Netta Iivari, Leena Ventä-Olkkonen, Heidi Hartikainen, Marianne Kinnula	2023	CHI 2023 Workshop on Child-centred AI Design: Definition, Operation and Considerations
10	Sense-Making of Digital Game Technologies (DGT): Positive Instances of Children-Led Engagement With Chess [60]	Malola Prasath, Thittanimuttam Sundaramadhavan, Luis Blasco De La Cruz, Astrid Barbier, Sharon Whatley, Muthu Kumar Narayan, Delgerzaya Bayaraa, Tamer Karaketin, Mustaffa Megrahi, Humberto Enrique Gutiérrez Rivas	2023	Proceedings of the 17th European Conference on Games Based Learning 17, 1

(Continued)

Table 2. Continued

SNo.	Title	Author	Year	Publication Venue
11	Helpful or Harmful? Exploring the Efficacy of Large Language Models for Online Grooming Prevention [48]	Ellie Prosser, Matthew Edwards	2024	Proceedings of the 2024 European Interdisciplinary Cybersecurity Conference (Xanthi, Greece), Association for Computing Machinery New York
12	Young children's conceptions of computing in an African setting [37]	Mayowa Oyedoyin, Ismaila Temitayo Sanusi, Musa Adekunle Ayanwale	2024	Computer Science Education 0, 0
13	Developing Local Games for Enhancing Numeracy Skills in Primary Schools in Tanzania: A Participatory Approach [41]	Joel S. Mtebe, Christina Raphael Isingo	2024	East African Journal of Science, Technology and Innovation 5(2)
14	The Influence of a Robotics Program on Students' Attitudes Toward Effective Communication [55]	Sabariah Sharif, Thiagarar Muniandy, Muralindran Mariappan	2024	European Journal of Educational Research 13, 3
15	Exploring and Co-Designing Emerging Technologies to Enhance the Reading Experience of Namibian Children [69]	Helvi Itege	2024	Ph. D. Dissertation. Queensland University of Technology.
16	Design and evaluation of a gesture interactive alphabet learning digital-game [58]	Tadiboyina, Venkateswara Rao and Deepak, Bbvl and Bisht, Dhananjay Singh	2024	Education and Information Technologies, Vol. 29
17	Promoting criticality with design futuring with young children [56]	Sumita Sharma, Noura Howell, Leena Ventä-Olkkonen, Netta Iivari, Grace Eden, Heidi Hartikainen, Marianne Kinnula, Eva Durall Gazulla, Michael Nitsche, Jussi Okkonen, Supratim Pait, Elisa Rubegni, Wouter SluisThiescheffer, Lonneke van der Velden, and Uttishta Sreerama Varanasi	2024	Nordic Conference on Human-Computer Interaction (NordiCHI 2024)
18	Effects of feedback dynamics and mixed gamification on cognitive underachievement in school [23]	Holguin-Alvarez, Jhon and Cruz-Montero, Juana and Ruiz-Salazar	2025	Contemporary Educational Technology, 17(1)

Data Analysis

We developed a rubric to extract key information to analyze our final set of 18 articles. This included keywords, the article's purpose (main goal), research methodology, findings, contributions, and whether the study focused on children. We also recorded the number of child participants, the study's duration, the location, and the age groups involved.

We carefully reviewed each article to complete the rubric and created summaries. Following this, we conducted a thematic analysis as described by Braun and Clark [7]. This process involved the following steps: first, we thoroughly read the entire dataset multiple times to identify initial

Table 3. Area-wise Distribution of Articles

Country	Number of Research Articles
India	6
Not mentioned	3
Malaysia	2
Tanzania	2
Brazil	1
Nigeria	1
South Asia	1
Peru	1
Namibia	1

ideas for codes. In the second step, we generated the initial codes, which were then grouped into preliminary themes. After reviewing and refining these themes, we developed clear names and definitions for each. Finally, all codes were organized under the identified themes, and the results were reported (for information about themes, see Table in Appendix A).

4 Dataset

This analysis examined 18 research articles published since 2014. These studies targeted various age groups of children in the Global South and employed various research methodologies. Below is a brief overview of how these articles are distributed across these parameters

Geographic Areas Covered in the Study

We describe the countries where the studies were conducted. For studies that covered multiple neighboring countries, we reported the broader region, such as South Asia, as the place of study. Our analysis reveals that India has the highest number of studies, followed by Malaysia and Tanzania. Some articles did not specify a region. Some of these involved the study of co-located peer learners [60]. In contrast, some omitted the locations of the intervention from their details, and others involved online LLM models, which were not limited to a specific region [48] (see Table 3).

Year of publication

The graph (see Figure 1) illustrates the trend in the number of research articles published from 2017 to 2025. While the initial years (2017-2019) saw relatively low and fluctuating publication numbers, there has been a noticeable upward trend since 2020. This increase is particularly evident in 2022 and 2024, where the number of published articles reached 4 and 5, respectively. The trend indicates growing attention to the topic within the academic community.

Age Demographics of Children Studied

Table 4 illustrates the distribution of research articles across various age groups¹ of children ranging from 3 to 15 years old. The data reveals that most studies focus on children aged 7 to 10, with six articles each indicating more research interest in this age range. Age groups 5-6 and 12 also receive attention, with five articles each. Conversely, younger children (ages 3-4) and older children (ages

¹Table 4 categorizes the reviewed articles by age group: 3–4, 5–8, 9–12, and 13–15 years. Some studies span multiple age groups (e.g., ages 3–7) and are therefore counted in more than one category. As a result, the total number of entries in the table exceeds the total number of unique articles reviewed.

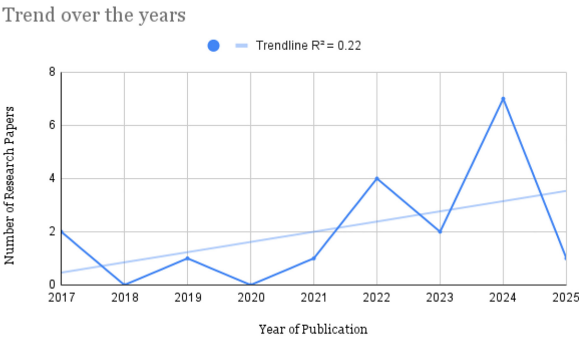


Fig. 1. Research articles published over the years.

Table 4. Target Age Groups of Children

Age group (in years)	Number of Research Articles
3 - 4	2
5 - 8	10
9 - 12	11
13 - 15	3

14-15) are less studied, with only one or two articles each. This suggests that AI-driven educational interventions inclination to target children in primary education’s early to middle stages.

Research Methodologies Utilized

The articles used a variety of research methodologies (see Table 5), with experimental design, interviews, and participatory design particularly prominent. The interviews are the most common, and they are used in four studies, often in semi-structured formats. The experimental design approach is used in four studies. Two of these involved a pretest-posttest approach to measure learning gains. While two others included intervention and control groups as well. Participatory design approaches involving student input in design processes were used in three studies. Online surveys appeared in two studies, utilizing platforms like Google Forms. Single studies employed the qualitative draw-and-talk technique, workshops, in-vivo observational methods, and non-participant observation.

Interviews offer flexibility in responses, which likely accounts for their preference over surveys and questionnaires for obtaining feedback. The experimental design approach allows comparison of learning outcomes by measuring changes in participant performance before and after the intervention. The participatory design approach emphasizes the importance of including children in the design process [4, 37, 41, 46, 69]. Additionally, it was observed that drawings can play a significant role in understanding children’s perceptions, which are otherwise difficult to convey using words [37].

Findings

4.1 RQ1a: Opportunities: Leveraging AI for Enriched Learning, Personalization, and Social Development

Integrating AI into education can yield benefits beyond traditional learning outcomes. AI’s impact extends to improving student behavior [49, 55, 60], emotional well-being [55], and health [49],

Table 5. Methodologies Used

Methodology	Description
Interview	Interviews included both personal and group formats, with most being semi-structured and some conducted online [40, 46, 49, 71].
Participatory design approach	Participatory design approaches involved a randomly selected group of students who participated in regular meetings to provide input throughout the design process, particularly in developing games [4, 41, 69].
Survey	Survey-based methods involved platforms like Google Forms, where questionnaires with yes/no, objective, and subjective questions were distributed [28, 43].
Qualitative draw-and-talk technique	In the qualitative draw-and-talk technique, children were given article and pencils to draw their conceptions of computers, the internet, code, and AI. Following the drawing activity, they were interviewed to discuss their creations [37].
Workshop	Workshops involved about 30 children in design activities and discussions [56, 57].
Experimental Design	This approach utilized a pretest-posttest structure, which in some cases included control and intervention groups. It was employed to evaluate learning outcomes by comparing participants' performance before and after the intervention [11, 23, 55, 58].
In-vivo observational methodology	In-vivo observational methodologies were employed to understand digital immersion in the case studies [60].
Non-participant observation	Non-participant observation involved the authors testing various large language models (LLMs) for response quality by asking various questions and assessing the models' security [48].

ultimately creating a more supportive learning environment. By utilizing innovative tools such as voice assistants, smart speakers, educational games, and interactive robots, developers can design engaging learning experiences and support the overall development of children.

4.1.1 Improving Learning Through Technology Integration. Using educational technology in the classroom can improve student access to instruction and reduce feelings of social and academic isolation by introducing them to a comprehensive academic curriculum and diverse educational programs [55]. Eye gaze tracking and facial expression tracking can also be used to evaluate children's emotions. Combining these with learning traces and behavior attributes can help predict students' learning outcomes [11, 43]. In one of the research articles, the researchers evaluated the effectiveness of their approach by utilizing eye-tracking and facial expression-tracking services through a webcam [43]. While the children may be unable to learn from voice search by themselves, it was found that using adult assistance, Google voice search could supplement in-person teaching [71]. One of the studies involving teenage students in India [40], however, highlighted diverse perspectives on the academic support provided by voice assistants. While some children

Methodologies Employed

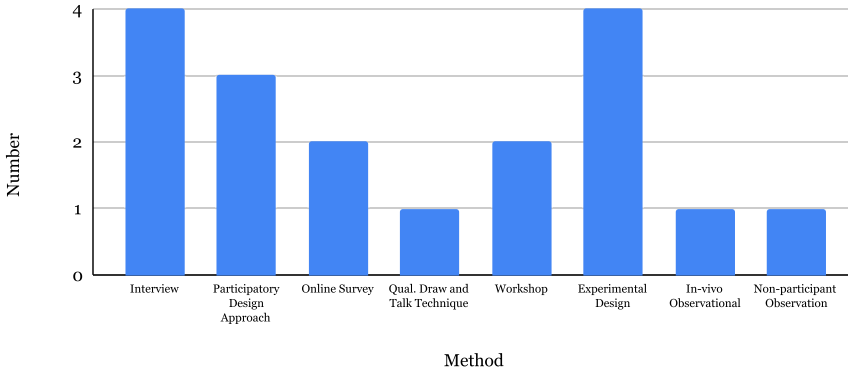


Fig. 2. Research methodologies used.

recognized its positive impact on enhancing class participation, others did not perceive any improvement in their academic performance.

Educational tools like numerical skills games, tangible learning activities, and robotics programs can enhance children's education. Mixed gamification, which combines extrinsic motivation (rewards) and cooperative activity, has been shown to improve engagement and learning [23]. In Tanzania, a numerical skills game showed significant improvement in post-test scores, rising from 53.89% in the pretest to 91.55% [41]. Tangible learning activities can also support participants' knowledge-building and enhance students' performance. One of the activities required participants to identify internal organs by manipulating tangible objects equipped with fiducial markers on an interactive tabletop. These objects were tracked by a camera system that provided audiovisual feedback during the process [11]. Programs such as robotics that incorporate problem-solving, experimentation, and inquiry skills were found to help students learn scientific and mathematical principles while improving their communication and interaction abilities in a study held in Malaysia [55]. In one study, when children were asked to imagine futures as students, they envisioned robot teachers supporting their learning in the absence of human teachers, thus highlighting AI's potential to address teacher absenteeism in developing countries [56]. Overall, integrating these technologies can foster enhanced educational experiences and equip students with essential skills for their academic and social development, thus allowing these tools to supplement education.

4.1.2 Personalization to Enhance Learning and Motivation. AI-based personalized learning systems provide learners with specific and targeted learning content and assessments. The student can thus experience improved learning, as the e-learning system can customize content delivery according to the strengths and weaknesses of the learner [42]. For example, in one of the studies involving a comprehensive programming application developed for children, AI and Natural Language Processing techniques were utilized to intelligently group children with similar interests and identify the underperforming children to provide additional support [43]. Underperforming students were provided an "Intelligent Guide" to encourage and motivate learning according to their respective levels. The Guide further detected reasons behind the children's shortcomings and provided a step-by-step plan to rebuild their confidence [43].

Some of the articles also introduce the idea of using eye-tracking for personalization. The system proposed how eye-gaze tracking can assess a learner's attention and focus during a task [11, 43]. Additionally, Eye tracking has been found to correlate with learning outcomes. In an experimental

setup utilizing a tangible learning interface, where participants were tasked with identifying internal organs, it was found that medium and underperforming students spent more time fixating on irrelevant areas. This suggested off-task behavior, likely stemming from confusion during the task [11]. In contrast, high achievers exhibited more fixations in key areas, indicating a deliberate approach to building knowledge using tangible object monitoring and cognitive strategies.

4.1.3 Enhancing Self-learning and Complementing Academic Learning. AI applications can be used as a tool for self-learning. Prior work suggests that children use the internet and voice search technology to browse for educational and homework-related information, study, and watch videos [28, 71]. In a study involving semi-structured interviews with high school students in India, participants reported that AI-enabled voice assistants and smart speakers, such as Alexa, helped them obtain quick results and additional information, enhancing their classroom participation [40]. For younger children, such voice assistants can be especially helpful during language acquisition as one can learn new words and their pronunciation through smart speakers [40].

Students learn skills such as teamwork and leadership from extra-curricular activities while decreasing the likelihood of different problem behaviors [3]. These skills have the potential to complement academic learning. In research studies involving students from India and Malaysia, it was revealed that children use technology for various activities like learning to cook, listening to music, playing online games, and interacting on social media [28, 40]. In an online learning system for Indian children, it was found that those without prior exposure to chess could develop consistent chess etiquette when a problem-solving exercise was implemented using the “Learn-Immerse-Value-Engage” paradigm [60]. This can help nurture higher-order thinking skills.

4.1.4 Improving Behavioral and Social Skills. Improving behavior and attitudes can result in positive social interaction and enhance children’s ability to navigate social settings. For example, a social robot, Pepe, was deployed in a primary school in India to encourage proper handwashing behavior among children [49]. When integrated with technology such as robotics programs, it was found that school instructional approaches fostered encouragement, open discussions, constructive disagreements, and collaborative sharing among students [55]. Additionally, a study conducted in Malaysian schools revealed that the robotics program significantly improved students’ attitudes toward effective communication in the experimental group compared to the control group [55]. Digital gaming technologies can offer the social imagination for children to progressively nurture higher-order thinking through hands-on engagements [60].

4.1.5 Engaging Learning Through Enjoyment. AI applications designed for children feature child-friendly interfaces and often require minimal effort to achieve desired outcomes, making them enjoyable and motivating for young learners [40]. For example, in a study on school children in India, preference for using voice search was seen due to the enjoyment of receiving audio responses, eliminating the need for typing and spelling, thus offering greater convenience [71]. Digital storytelling can boost reading habits and vocabulary while providing entertainment and joy. It was observed in one of the research studies held in Namibia that a digital story interspersed with physical puzzle stations further enhances student engagement [69]. Studies have also demonstrated that children are highly engaged by robots in educational settings, often attributing human characteristics such as gender, ethics, and lifelike qualities to them [49, 69]. In one such study in Namibia, children were introduced to a reading technology tool in the form of a movie, and it was observed that they were captivated by the talking robots [69]. In another study in India, teachers reported that game-based learning sessions were highly engaging and led to significant improvements in student performance [58]. Incorporating music elements in gamification further enhances sensory preparation and engagement [23].

4.2 RQ1b: Barriers in Integrating AI in Educational Context

While AI has numerous advantages and can enhance learning experiences, significant barriers are associated with integrating AI into the education curriculum, particularly in developing regions where technological disparities and cultural nuances complicate this integration. Understanding these barriers is crucial for educators and policymakers to create an inclusive and effective educational environment that can harness the full potential of AI.

4.2.1 Privacy and Security Implications of AI Integration in Classrooms. Integrating the internet and AI into classrooms exposes learners to various risks, including cyberbullying, trolling, and flaming. These technologies can impact students' behavior negatively, disrupt their emotional well-being, and even cause damage to their devices if students cannot discern appropriate and inappropriate content [28]. While teachers may recognize the benefits of game-based learning, some still remain cautious about fully relying on digital tools for education [58]. A study conducted in Malaysian primary schools revealed that while many students were knowledgeable about online privacy, phishing, and economic risks, their understanding of stranger danger, password management, digital competency, and content-related risks was only moderate to low [28]. Children also have contradictory views regarding the confidentiality of AI. For instance, a study on smart speakers in India revealed that while children did not perceive their interactions with these devices as private, closed-door conversations, they nonetheless regarded the speakers as safe [40]. This inconsistency stems from the privacy paradox where they trust the measures of the smart speaker despite knowing the potential privacy risks due to the social norms and perceived convenience.

Large Language Models (LLMs) present significant security risks, especially regarding online grooming. Research has shown that LLMs can behave like adults in conversations, potentially dangerous as children may take their advice seriously [48]. Furthermore, the quality of responses tends to worsen when the user identifies as a child, leading to harmful guidance. For instance, some LLMs have *advised children to ensure their parents were gone before inviting guests* or told them *it's rude to change their mind about an adult visiting* [48]. Although closed-source models are typically more polished than open-source ones, harmful behaviors remain a significant concern. The behavior of closed-source is particularly critical in contexts involving children, who may lack the awareness to identify and mitigate these risks.

4.2.2 Digital and AI Literacy Gaps. As of 2022, only one in four individuals in low-income countries had access to the internet [70], indicating that a significant portion of the population has internet access issues. These technological barriers limit the use of AI-based applications and hinder data collection efforts [40, 41]. For example, a study in a primary school in India found that none of the children had ever interacted with a robot [49]. Similarly, a study in Namibia revealed that learners struggled to connect with researchers due to unreliable internet connections and lack of access to technology [69].

Children in developing countries have limited access to technology. While some are familiar with the internet and computers, their comprehension of AI is often superficial and riddled with misconceptions [37]. For instance, a study in Nigeria found many children believe that computers are smarter than humans. Due to their limited exposure to modern technology, many viewed computers as akin to televisions or as devices restricted to just a screen and keyboard [37]. Children often lack the essential digital literacy skills to use these tools effectively. For instance, in a study where preschoolers in Tanzania were asked to illustrate their concepts for a game-based interface, the drawings revealed their limited understanding of technology [46].

Children often misconstrue AI technologies as human-like entities, attributing human characteristics like gender to them [49]. This anthropomorphism leads children to believe these technologies

will abide by ethics and “be good” and “do no harm” [56, 57]. For example, children’s conversations with voice assistants may lead them to share their personal stories [40, 49]. In one study in India, a child acknowledged viewing Alexa as a friend and engaging in conversations with it during lockdown [40]. Similarly, children were reported to have shared stories about their homes with a robot that was installed to encourage proper handwashing behavior in schools in India [49]. In another study, children imagined forming close, supportive friendships with robots and believed that a robot could cheer up a depressed person [56]. Alternatively, the voice assistant/LLMs may provide harmful advice (when hallucinating or through incorrect prompting [48]).

4.2.3 Bias and Recognition Issues in AI Systems. Despite the significant advancements in AI, AI models are trained on datasets from Western contexts; hence, they may propagate existing social, gender, and racial biases [57]. Moreover, smart speakers like Alexa and Siri can get inadvertently activated by words similar to their trigger names [40]. Another considerable challenge in applying AI to improve child education is that AI models often fail to interpret child voices correctly. For example, in one study in Namibia, when children’s voices were being recorded by the computer, the system struggled to capture their voices accurately [69]. A child’s inaccurate pronunciation or wrong sentence formation and the different pitch also lead to difficulties in voice search and delayed answers or irrelevant answers in another study in India [71].

4.2.4 Role of Income, Language, and Cultural Barriers. A study conducted in Nigeria observed that children from low-income families had limited exposure to technology and required more fundamental knowledge of the internet [37]. In Namibia, researchers found that many did not possess personal digital devices and instead relied on sharing devices owned by family members [69]. In developing regions, the libraries aren’t well equipped, and there is a lack of reading culture at home, which leads to similar behaviors in the children [69]. Language barriers add further complications as standard technical terms may not have equivalent translations in the local languages. For example, during interviews conducted with children in Nigeria in their regional language, it became evident that language barriers significantly impeded their ability to understand and explain concepts related to artificial intelligence, the internet, and coding [37]. Some learners may not be comfortable expressing themselves in English due to their limited proficiency, as was found in a study with Namibian students [69], thus hindering their use of smart speakers and voice search technologies. Teachers and students in government primary schools in India are often found to struggle with English [58].

Culture plays a crucial role in shaping technology adoption in the Global South. For example, in a study conducted at a rural primary school in India, students preferred designing a robot based on a cat rather than a dog, reflecting religious beliefs that consider dogs unclean [49]. To successfully integrate AI interventions into local classrooms, it is essential to address challenges such as low literacy levels, cultural barriers, and communication difficulties [41].

4.3 RQ2: Strategies to Enhance Utility and Experience of AI Interventions for Children

Successful integration of artificial intelligence into the educational system in developing countries requires well-planned strategies that address diverse needs and tackle potential challenges. This section explores various approaches to effectively incorporate AI in education while ensuring that the technology aligns with the student’s needs, empowers the teachers and parents, and respects the cultural and religious boundaries to create an inclusive and secure learning environment.

4.3.1 Tailoring AI Interfaces to Children’s Preferences. To effectively integrate AI-based applications into classrooms, interfaces can be tailored to children’s needs [40]. Displaying essential options prominently on the screen helps children access them more easily. For example, in a study

involving Tanzanian preschoolers, the children expressed a preference for having options such as *Quick* and *Start* buttons visible on the screen at all times [46]. Studies indicate that children prefer voice searches, smart speakers, and voice assistants over text-based applications [69, 71]. This preference may be due to fast responses that require minimal effort [40], reluctance to type long sentences [43], or limited reading and writing skills [71]. Voice-based technologies can be more supportive of children by recognizing their voices [71] and maintaining engaging conversations while imparting valuable knowledge. For example, it was found that storytelling effectively maintained an engaging conversation with the child while simultaneously imparting programming principles [43].

Interventions can be designed to be attractive and engaging to the young audience [49]. Adding interactive elements like animations, cartoons, voice-mimicking, and sound effects can enhance the experience. Still, they shall be used judiciously to avoid distracting from the core content [46, 69]. Children often have low patience and skip over texts, focusing only on graphical representations [71]. Developing applications involving full-body engagement and various tasks and activities can help reduce boredom during the learning process [46, 69].

While these features make an application engaging and interesting, child safety remains a major concern. A potential solution to prevent LLMs from giving harmful advice to children is to include prompts encouraging them to seek a second opinion from a trusted adult [48]. In Tanzanian schools, preschoolers' inputs suggested game timers to prevent addiction and ensure equal participation in multiplayer games [46].

4.3.2 Co-designing Technology with Children. Involving children in the design process can foster creativity and ensure that designs reflect the child's perspective [4, 37, 46]. Co-designing with children allows children to express what excites or bores them and how they interact with technology—unlike traditional methods that may not fully consider the user's interests [4, 69]. A participatory design approach in Brazil noted that it is crucial to use authoring tools that are simple and accessible to children's knowledge levels [4]. Additionally, in a study in Tanzania, researchers found that involving children in the design process fosters a sense of belonging [46].

When children are not involved in the design process, there can be cultural and linguistic diversity misalignments, a lack of alignment with local curricula, and a disconnect between designers and the target audience [41]. Developers often rely on input from teachers and parents regarding children's needs. Still, this approach may overlook children's nuances as observed during a participatory design approach in Tanzania [41]. Another study in Tanzania observed that children's interaction with digital technology differs from adults due to their naturally curious nature [46]. They often discover playful and enjoyable elements that designers may not have anticipated or integrated into the design [46, 69]. For example, during the testing of a Spin the Bottle game prototype in Namibia, when the bottle landed between two students, the children devised their tie-breaking methods, such as playing rock-paper-scissors or giving the turn to the student with the fewest turns [69].

4.3.3 Boosting Engagement through Game-based Learning. Our analysis shows that integrating studies with puzzle activities or games boosts children's engagement and motivation, as they are drawn to the competition and the sense of accomplishment that comes with completing tasks [4, 43, 69]. Digital games tend to have strong appeal among children [58]. During the testing of game prototypes with Tanzanian preschoolers, it was reported that incorporating game mechanics such as a points system to track progress increased both motivation and fun [46]. Multiplayer games were particularly useful in another study in Namibia, as children enjoyed their peers' involvement, responding positively to hearing their answers and observing their actions [69]. Collaborative games enrich communication, creativity, interaction, and participation [69]. A study

conducted in Namibia observed that personalized elements, such as using the child's name for the hero's character in the story, helped children identify more closely with the narrative [69]. Another study in India found that **Gesture Interactive Game-Based Learning (GIGL)** was more effective than traditional methods for teaching alphabets, as the multimodal engagement boosted student motivation [58]. Mixed gamification techniques have also been shown to be as effective as virtual teaching tools alone [23].

4.3.4 Influence of Teachers, Peers, and Parents in Technology Use. Peers play a significant role in introducing new technology to children [40]. Their involvement in multiplayer games boosted the learners' morale and motivation in an intervention in Namibian schools [69]. Children are heavily influenced by parents, guardians, and other adults [37]. Younger children, in particular, need guidance from caregivers to navigate technology effectively [40, 71]. For example, a study in India observed that younger children required assistance from caregivers to formulate appropriate queries for Google Voice Search and to evaluate the accuracy of the results [71]. A Nigerian study found that even though children may be introduced to computers at school, they often learn practical usage at home, making parental support crucial [37]. Parents can encourage using digital technology and provide technical assistance to their children [40]. Parents can also help children choose age-appropriate apps and occasionally co-use them [71]. Increasing parental awareness about AI and internet use and incorporating cyber parenting programs can enhance parents' digital literacy [28].

4.3.5 Meeting Diverse Needs Through Contextualized Design. Additionally, when designing digital game technology tools for children, it is important to incorporate "fairness by design" to ensure inclusivity. During a game-based approach in Namibia, it was found that multiplayer games should be inclusive of all players [69]. Developers can tailor interventions to the local context to best meet the needs of their target audience by aligning technology with local curricula. For instance, in Tanzania, one study developed digital adaptations of traditional local games, aligning them with the curriculum with the assistance of teachers and students. This approach successfully enhanced children's numerical skills [41].

Even within the same geographical area, children of different age groups have varying needs [71]. For example, teenagers can focus on a particular task for longer periods compared to younger children [43]. In a study in India, young children (ages 4-6) were found to require adult assistance for executing search queries, while older children (ages 9-10) were capable of managing these tasks on their own [71].

4.3.6 Integrating AI and Digital Literacy into School Curricula. Research shows that developing countries face challenges such as insufficient learning resources, unqualified teachers, and a lack of permanent technical support to integrate AI technology into classrooms [37, 63]. Therefore, teachers need to be trained in AI and digital literacy to raise awareness about how the internet can aid children's learning [71].

Our analysis showed that integrating digital literacy into the school curriculum is essential for familiarizing students with mobile and web-based software applications [37, 46, 71]. Furthermore, school curricula can be updated to include emerging technologies to ensure students fully benefit from these advancements. A qualitative "draw and talk" research study conducted in Nigeria with children aged 5 to 8 indicated that the educational curriculum's lack of programming content contributed to disparities in children's computational knowledge [37]. Lastly, privacy and security can be embedded in the education system [28]. Prior work found that providing technical demonstrations and fostering peer support are practical steps toward achieving this goal [28].

5 Discussion

This section summarizes our findings and provides opportunities for future research. Specifically, we aim at enhancing the conversations around children's rightful participation in AI contexts. As the UN report describes [63]. *Children are less able to understand the implications of AI technology fully and often do not have the opportunities [...] to communicate their opinions, or the right advocates to support them..* We discuss important aspects of supporting children's rights through providing resources, protection from AI harms, and equitable participation in AI integration.

5.1 Provisioning AI for Enhanced Student Learning

AI in educational technology provides essential tools, resources, and opportunities for enhancing student learning and development. By introducing students to comprehensive academic curricula and diverse educational programs, technology reduces social and academic isolation and improves access to instruction [55]. Advanced tools like eye gaze tracking and facial expression recognition can provide valuable insights into student emotions and behaviors, enabling educators to tailor their teaching approaches to improve learning outcomes [11, 43]. Combined with learning traces and behavioral analysis, these technologies can predict how well students are performing to provide feedback to teachers [43]. Voice-based technologies also offer significant educational value; voice search can complement classroom learning, providing quick and convenient access to information [14, 71].

In addition to enhancing traditional learning, educational technologies such as games, tangible activities, and robotics provide interactive learning experiences that enrich students' education. For instance, well-designed educational games have led to a significant increase in test scores and support skill development [41]. Tangible learning tools, where students physically engage with objects to understand concepts, have also improved student performance and knowledge retention [11]. Robotics programs incorporating problem-solving and inquiry-based learning further enhance student engagement by promoting scientific and mathematical thinking while improving communication and teamwork skills [55]. Therefore, future work can consider providing these technologies in the classroom to create a rich learning environment that supports students' academic growth and social development.

Generative AI (GenAI) offers transformative potential for education, but its integration must be carefully managed to ensure positive outcomes. When used effectively, GenAI can personalize learning content, serve as a virtual tutor, assist teachers with automated grading, enhance accessibility, and support language learning through tools like grammar correction and conversation simulations [54, 73, 75]. However, UNESCO warns that unregulated or excessive use of GenAI can undermine academic integrity and reduce student motivation [54, 75]. Despite its rapid growth, there is a notable lack of research on GenAI's role in K–12 education, highlighting an urgent need to better understand both its risks and its potential in primary and secondary school settings [72].

5.2 Protecting Students While Promoting Privacy and Digital Literacy

Integrating AI into educational settings brings opportunities and challenges, especially regarding protecting students' privacy and security. As classrooms become more connected, students are exposed to risks such as cyberbullying, privacy breaches, and exposure to harmful content [28]. Furthermore, students' trust in AI devices such as smart speakers can lead to a privacy paradox. For example, children often do not perceive their interactions with these devices as private, yet they feel safe using them due to perceived convenience and social norms [40]. This gap between perceived and actual risks highlights the need for privacy protections and digital literacy education

in classroom curricula, ensuring students can safely interact with AI tools without compromising their well-being.

In addition to privacy and security risks, the lack of digital literacy presents a significant barrier to equitable AI access and usage in schools. Many students, particularly in low-income and rural regions, have limited exposure to advanced technology, leading to misconceptions about AI and its applications. In Nigeria, for instance, children viewed AI as a simple tool akin to television due to their lack of access to digital resources [37]. Cultural and language barriers further complicate this issue, as technical terms may not have equivalent translations, making it harder for students to engage with AI technologies [69]. To bridge this gap, future work must prioritize the integration of digital literacy and privacy into curricula. This will ensure that students from diverse backgrounds can safely and effectively benefit from AI-driven learning while being protected from its associated risks.

5.3 Participation in AI Design: Engaging Children, Parents, and Educators

The active involvement of children, educators, parents, family members [35] and peers [61] plays a critical role in AI's successful integration and development in educational settings. Teachers and parents are essential for guiding children through digital tools and AI, as younger learners often require adult assistance to navigate complex technologies [71]. Parental involvement (or equivalent caregivers such as older brothers or sisters [35]) is particularly influential, as children often gain practical technological skills at home, where caregivers can encourage digital use and provide technical assistance [37]. Increasing parents' and teachers' awareness about AI and promoting cyber parenting programs can also enhance children's safe and productive engagement with digital tools. Moreover, peers influence technology adoption, particularly in multiplayer gaming environments, where collaborative tasks can boost children's motivation and participation. In prior work, peer interactions in multiplayer games enriched the learning experience by fostering collaboration and communication [61, 69].

Empowering children by involving them in the co-design of digital tools fosters creativity and ensures that the technology reflects their interests and needs. Participatory design approaches allow children to directly influence the development process, providing insights that might be overlooked. For example, in a Tanzanian study, children's input during the design process fostered a sense of belonging and ownership over the technology while also revealing playful elements that the developers had not anticipated [46]. In Namibia, children demonstrated creative tie-breaking methods during a game prototype test, showcasing their natural curiosity and ability to find enjoyable ways to interact with technology [69]. When children are excluded from the design process, there is often a misalignment between the technology and the local curriculum or cultural context, which can diminish the tool's effectiveness in the classroom. Future work can actively involve children, educators, and parents in the design of AI to address students' educational and cultural needs.

Collaborative Partnerships for AI-Driven Education: Bridging Governments, Developers, and NGOs

The lack of coordinated, context-aware strategies for AI in education poses a significant barrier to sustainable integration in the Global South. Unlike countries in the Global North—where centralized bodies often guide AI adoption with attention to the socio-technical landscape—many Global South nations take a fragmented approach, frequently overlooking the social, economic, and cultural realities of local communities [22]. This mismatch can lead to ineffective or unsustainable EdTech interventions. Establishing strong, inclusive partnerships between AI developers, educators, governments, and NGOs is therefore essential to ensure that AI tools are aligned with local needs and can deliver meaningful educational impact.

Governments and NGOs are essential to successfully integrating AI into education, especially in the Global South. One strategy is for governments to offer scholarships and grants across both public and private sectors to support AI adoption in education [64]. NGOs also play a significant role—in fact, according to CUE’s Global Catalog of EdTech innovations, they represent the largest share of implemented educational interventions, ahead of even the private sector [68]. While NGOs often fund universities and start-ups to build AI solutions for social impact, they frequently lack in-house AI expertise [22]. This skills gap creates a promising opportunity for collaboration between NGOs and AI developers. Some successful examples of such partnerships include the iMlango project in Kenya—a multi-stakeholder effort that delivers personalized educational content in rural and semi-urban areas [22, 32]—and the Siyafunda Community Technology Centres in South Africa, which offer digital literacy programs that complement formal schooling and improve employability [65].

Strategic investments and cross-sector collaboration are essential to advancing AI in education, especially in developing regions. Increasing funding for AI research institutions and promoting knowledge-sharing through conferences and collaborative platforms can enhance resource availability and drive innovation [22, 64]. These efforts lay the groundwork for collaborative ecosystems, but sustaining them requires active involvement from both the public and private sectors. Public-private partnerships have proven particularly effective in financing and delivering educational content in the Global South [21, 53]; for example, Microsoft’s 4Afrika initiative addresses systemic challenges in Sub-Saharan Africa by supporting digital growth in education, healthcare, and finance [38]. These initiatives highlight the promise of coordinated efforts, but long-term success depends on the public sector’s role in establishing platforms for ongoing cooperation, mediating disputes, and facilitating dialogue among stakeholders [29]. Building on this foundation, intra-group, and inter-institutional collaborations can help cluster AI-related projects—minimizing duplication, enabling specialization, and fostering complementary knowledge creation [22].

6 Limitations

Although we aimed at conducting a systematic literature review, the limited number of articles that met our search criteria resulted in a more synthesized review of the available research [12]. We acknowledge that a similar literature review in COMPASS, which employed the same methodology, found only a limited number of articles (16) related to XAI [45]. Although there are likely additional articles from the Global South that do not explicitly reference “child-computer interaction” [35, 61] or “AI” (such as LLMs or chatbots [8]), we believe that they are out of scope for our research question but could offer insights for related research questions (education technology research for children in the Global South). Industry products like Google’s Read Along [1] or Khan Academy [31] might also provide valuable insights into broader research questions (deployments for children in ICTD). In future work, we plan to interview industry and academic experts involved in projects with children in the Global South, similar to the method followed by Dell and Kumar [15].

7 Conclusion

This article presented a thematic literature analysis on integrating artificial intelligence into child education in the Global South, highlighting key insights and challenges. By examining 18 articles focusing on child-computer interaction when integrating AI into education, we identified three prominent themes: AI’s potential to enhance learning experiences and personal growth, the obstacles in incorporating AI into the classrooms, and the strategies to enhance children’s user experience. We discuss the three core aspects of rightful AI integration for children’s education: provisioning, protection, and participation. We highlight the importance of provisioning AI technologies to enhance learning while addressing privacy and security challenges through digital

literacy education. We report involving children, educators, and parents in AI design to ensure culturally and educationally relevant solutions. Together, these approaches improve student engagement and safety in AI-driven learning environments.

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A Thematic Analysis - Final Themes and Their Descriptions

We identified three major themes from our analysis of 18 research articles. The following table (see Table 6) provides a comprehensive record of the themes, their subthemes, and a concise description of each theme.

Table 6. Final Themes and Descriptions

Themes	Subthemes	Description
Leveraging Artificial Intelligence for Enriched Learning, Personal Growth, and Engagement	Acts as an adjunct to traditional education Facilitates personalized knowledge acquisition Enables rapid information retrieval and promotes self-learning Effective for recreational and extracurricular activities Instrumental in fostering behavioral changes Utilizing technology for hedonic pleasure	This theme explores how AI enriches children’s learning in developing countries, enhancing academic education and recreational activities alike. It highlights the potential of AI in delivering personalized knowledge, providing quick information, and promoting positive behavioral changes.
Barriers in Integrating AI in Educational Curricula	Anthropomorphizing AI and Its Potential Risks for Children Inherent Constraints and Limitations of the AI Technology Digital Divide and Technological Obstacles in Developing Nations Challenges in Technology and AI Literacy Among Children Privacy and Security Concerns with AI Integration in Educational Settings Influence of Linguistic, Economic, and Cultural Barriers on AI Integration Limited Empathy and Human Connection in AI Education Tools	The theme highlights the challenges researchers face during implementing AI technology, gathering children’s feedback, and developing effective educational tools. It includes barriers such as technological limitations, privacy concerns, and cultural divides.
Strategies to Enhance Efficiency and User Experience of AI Interventions for Children	Empowering Children through Collaborative Design in Digital Technology Development Enhancing Engagement and Motivation in Children through Game-Based Learning Influence of Teachers, Peers, and Parents in Technology Adoption and Digital Literacy Incorporating Digital Literacy and Cybersecurity into Educational Curricula Creating Child-Centric AI Interfaces for Effective Classroom Integration Contextualizing AI Interventions to Meet Diverse Educational Needs	The theme delves into design solutions identified by researchers via interactions with children or other experimental methodologies. It emphasizes enhancing AI interventions’ efficiency and user experience, incorporating digital literacy and cybersecurity, and tailoring AI to local needs to meet diverse educational requirements.

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