REVIEW

A meta-synthesis study on the use of artificial intelligence in primary education

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Abstract

This meta-synthesis analyzed qualitative studies on elementary students' perspectives on AI. A comprehensive search identified 4756 studies. After screening, 23 studies were included in the meta-synthesis. A thematic synthesis approach was employed to analyze the qualitative findings. AI supported self-paced learning, autonomy, and motivation while providing individualized opportunities. Students held cognitively limited and simplified definitions. Affectively, students experienced positive emotions, such as curiosity and trust, as well as negative emotions, such as anxiety and fear. Students found AI enjoyable and easy, but reported challenges related to adaptation, technical and pedagogical barriers, data privacy, and ethical concerns. AI promoted equality of opportunity and participation; however, issues of integration and pedagogical limitations remain. AI supports learning at the primary level but requires a multidimensional approach including ethical, pedagogical, and systemic considerations.

Keywords Elementary students · Artificial intelligence · Meta-synthesis · Educational systems

1 Introduction

AI has rapidly gained attention in education, particularly with the emergence of applications, such as chatbots and customized AI assistants (Chen et al. 2020). These developments have brought increasing attention to the question of how and within what ethical framework AI should be used in education (Özcan and Polat 2023). These discussions are particularly relevant for primary education, where the foundations of learning processes are established. With smartphones becoming widespread in daily life, children are exposed to technology from very early ages and interact—directly or indirectly—with AI tools. Therefore, the pedagogically sound use of AI tools in primary education and effective guidance by teachers play an important role in supporting children's digital learning experiences.

Primary school years play a crucial role in shaping individuals' long-term learning processes (Bloom 1992). In this context, understanding elementary students' perceptions and uses of AI becomes increasingly important.

Accordingly, this meta-synthesis study aims to analyze and describe elementary students' views and perceptions of AI. The research question guiding this study is: *What are the perspectives of elementary students on the subject of AI?*

2 The role of AI in the education system

AI has become an important factor shaping educational practices from both pedagogical and instructional perspectives (Holmes et al. 2019). Its influence is visible in areas, such as individualized learning processes, assessment of learning outcomes, and support for personalized learning practices (Chen et al. 2020).

However, the integration of AI in education also raises ethical and technical concerns, including issues related to data privacy, bias, fear, and adaptation challenges (Holmes et al. 2022). Among these concerns, data privacy is particularly prominent. Although student data help algorithms function more effectively, questions regarding who has access to these data and how they are used remain unclear

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(Holmes et al. 2022). This limited transparency may lead to trust concerns among students, parents, and educators (Urso et al. 2025).

Another frequently discussed issue concerns algorithmic bias and adaptation challenges. Because AI systems are often trained on data from limited student populations, they may fail to represent the diversity of learners (Baker and Hawn 2022). Furthermore, adapting teachers and students to AI technologies can be difficult due to factors, such as unequal access to technology, varying levels of digital literacy, and limited pedagogical knowledge (Zawacki-Richter et al. 2019). Consequently, discussions on the future of AI in education emphasize the importance of inclusivity and the development of ethical standards.

3 The integration of AI into the education system

The integration of AI is often associated with a shift from traditional teacher-centered models toward learning environments that support greater student autonomy (Meylani 2024). In this context, teacher roles are evolving from knowledge transmitters to designers and facilitators of learning processes, which highlights the importance of developing teachers' digital pedagogical competencies (Romadon et al. 2025).

Research has also reported that the integration of AI can significantly influence students' learning experiences and can require adaptations from teachers (Polat and Renner 2026). However, inequalities in access to technology remain a major concern. Low-income regions, countries with limited infrastructure, and rural areas often face difficulties accessing these technologies, which may increase educational inequalities and the digital divide (Al-Sowaidi and Clarke 2025).

For this reason, inclusive design approaches and adequate technological infrastructure are essential for the effective and equitable use of AI in education (Selwyn 2019).

4 The use of AI in education

One of the most common applications of AI in education is personalized learning. AI-supported personalized learning environments can adapt educational content to students' individual needs and learning paces, which has been associated with improvements in academic achievement (Hashim and Shaher 2025). In language learning, AI can provide materials suited to students' learning pace, while in subjects, such as mathematics, it can support problem-solving and creativity skills (Kaya et al. 2025).

At the primary school level, the pedagogical effects and potential risks of AI become more visible due to developmental characteristics. Elementary students may have limited ability to critically evaluate the information provided by AI tools, which raises concerns related to privacy, safety, ethics, and pedagogy (Luckin and Holmes 2016). Nevertheless, when used carefully, AI can support the development of fundamental skills, such as reading, writing, mathematics, and social studies, by providing age-appropriate learning materials (Cai 2024; Weng et al. 2023).

Because elementary students are often motivated by play-based learning, AI-supported gamified and interactive learning environments can help maintain students' attention and engagement (Tobbi 2026). In such contexts, AI may provide support for teachers in addressing diverse learning needs (Aravantinos et al. 2024). However, AI should play a supportive rather than substitutive role as teacher guidance remains essential for young learners' emotional and social development (Butler and Starkey 2024).

Although numerous studies examine AI in education, research specifically focusing on elementary students' perspectives remains limited. Therefore, this study synthesizes qualitative studies conducted with elementary students to provide a comprehensive understanding of their perceptions of AI and its role in learning environments.

5 Methods

This study employed the meta-synthesis method to synthesize findings from qualitative research on AI and elementary students. The meta-synthesis approach was first introduced by Noblit and ve Hare (1988). It involves selecting relevant qualitative studies, rereading them, and extracting key concepts. Based on selected studies addressing a specific research aim, meta-synthesis enables the development of main themes and the identification of similarities and differences across studies (McDermott et al. 2004; Polat 2015).

A purposive sampling approach was adopted to include qualitative publications examining elementary students' perspectives on AI (Nyimbili and Nyimbili 2024). Because educational systems differ across countries, the starting and ending ages (grade levels) of the research samples vary accordingly. For instance, the study conducted by Dai et al. (2024a, b) in China involved 6th-grade students, the final year of primary school, whereas the research by Kalemkuş and Kalemkuş (2025) in Turkey included 4th-grade students, also the final year of primary school. Purposive sampling ensures that specific types of cases relevant to the study's objective are included in the final sample (Campbell et al. 2011).

In this study, not only purely qualitative studies but also the qualitative components of mixed-methods and

experimental research were included. Only those sections of mixed-methods and experimental studies that reported qualitative findings or qualitative data interpretations were considered for analysis and synthesis. This approach is consistent with the meta-synthesis tradition, which focuses on the interpretation and integration of qualitative findings regardless of the broader research design in which they were embedded (Noblit and ve Hare 1988; Polat and Ay 2016). The qualitative data of each study, including observations, interviews, and open-ended survey responses, were extracted directly from the original articles and incorporated into the synthesis. Quantitative data were not included in the synthesis.

5.1 Meta-synthesis process

In a meta-synthesis study, the following steps were followed (Noblit and ve Hare 1988; Polat and Ay 2016):

Step 1: Determining the research questions.

Step 2: Determining the keywords related to the study's topic and conducting the literature review.

Step 3: Determining the inclusion and exclusion criteria and selecting the studies to be evaluated.

Step 4: Sourcing, reviewing, defining, and evaluating the resources.

Step 5: Analyzing the selected studies, creating common themes and sub-themes related to these themes, revealing similar and different aspects.

Step 6: Synthesizing the findings within the framework of the themes and making inferences.

Step 7: Reporting the process and findings in detail.

This seven-stage process is explained in detail below.

In the first step, the research question guiding this study was formulated as follows:

"What are the perspectives of elementary students toward AI?"

Some of the studies included in the meta-synthesis also contain teacher observations and researcher interpretations alongside student perspectives. These observations and interpretations were not excluded from the synthesis where they were directly related to elementary students' AI use experiences (e.g., Theme 3 and Theme 4).

In the second step, the search keywords presented in Table 1 were used. The search strategy focused on elementary students' perspectives on AI and was structured using Boolean operators (Bramer et al. 2018). The literature review was conducted in August 2025 using the following databases: Web of Science (WOS), Scopus, Directory of Open Access Journals (DOAJ), and Education Resources Information Center (ERIC).

The search was refined using Boolean operators (AND, OR, NOT). Terms, such as "middle school students" and "high school students", were excluded using the NOT operator to narrow the results and ensure the review focused specifically on children's perspectives on AI.

The same search string was applied across all four databases. Results were filtered to include only studies in the field of educational sciences. Additional inclusion and exclusion criteria are presented in Table 2.

For the third step, duplicate records were removed both manually and with the partial support of the Rayyan software. Following deduplication, the remaining records were screened based on the inclusion and exclusion criteria presented in Table 2.

Table 2 Inclusion and exclusion criteria

Inclusion	Exclusion
Peer-reviewed articles	Gray literature
English language publications	Non-English studies
Published after 2020	Published before 2020
Full-text available	Abstract-only articles
Studies on primary school children's experiences, use, or perceptions of AI	Studies not involving primary school children

Table 1 Search strings used in each database

Database	Search string	Search conducted	Filters applied
Web of Science	TS = ("AI" OR "ChatGPT" OR "chatbot")) AND (TS = ("elementary school" OR "primary school" OR "elementary education")) NOT ("secondary school" OR "high school")	August 2025	Peer-reviewed, English
Scopus	TITLE-ABS-KEY("AI" OR "ChatGPT" OR "chatbot") AND TITLE-ABS-KEY("elementary school" OR "primary school") AND NOT TITLE-ABS-KEY("secondary school")		
ERIC	(("AI" OR "ChatGPT") AND ("elementary education" OR "primary education")) NOT "secondary education"		
DOAJ	("AI" OR "ChatGPT" OR "chatbot") AND ("elementary school" OR "primary school")		

The established criteria aimed to enhance research quality, enable in-depth interpretations, prioritize current information, ensure accessibility, and obtain data suitable for the research focus. The inclusion of studies from 2020 and onwards reflects that AI research gained momentum and peaked particularly after this date.

In the fourth step, 4,756 records were retrieved from the four databases (WOS, Scopus, DOAJ, and ERIC). Following the removal of 78 duplicates using Rayyan software and manual screening, 4,678 studies were screened based on title and abstract. Of these, 84 were downloaded in full text. 23 studies were deemed suitable for the research purpose, while the remaining 61 studies were excluded. The reasons for exclusion were as follows: 5 studies were excluded as conference abstracts, 22 studies were excluded because they were designed based on quantitative methods, 6 studies were excluded because they were review articles, and 28 studies were excluded because their participant group did not consist of elementary students; thus, they were not included in the analysis. A systematic categorization process was followed, starting with author information (e.g., author names and the authors' country). The articles were classified based on publication information, such as title, publication year, open access status, and journal name. Categorization was performed based on methodological characteristics, including sample size, data collection tools, and data analysis techniques. The articles were classified in terms of content, considering the discipline of the study (e.g., language education, mathematics education) and the AI context (e.g., Gemini, ChatGPT).

The following flowchart (Fig. 1) depicts the selection process. During the database search, the first author screened Web of Science and Scopus, while the second author screened ERIC and DOAJ. The categorization process was conducted using Excel. The descriptive characteristics of the included studies are presented in Appendix 1.

In the fifth step, the qualitative findings were analyzed using a thematic synthesis approach (Thomas and Harden 2008). This approach involves identifying recurring concepts and patterns, grouping them into descriptive themes, and developing analytical themes that go beyond the findings of individual studies. The findings of 23 empirical studies focusing on the use of AI at the primary school level were subjected to an inductive analysis. Inclusive themes and corresponding sub-themes were developed. To ensure the validity of the thematic structure, the themes and sub-themes were reviewed by a second researcher after their initial creation. The guidelines suggested by Thomas and Harden (2008) were followed in the development of the themes. The following points were particularly considered: (a) themes can originate from the researchers' own interpretations or be consistent with concepts existing in the literature, (b) the naming of the themes should reflect the general orientation of the research.

The themes and their explanations are presented in Table 3.
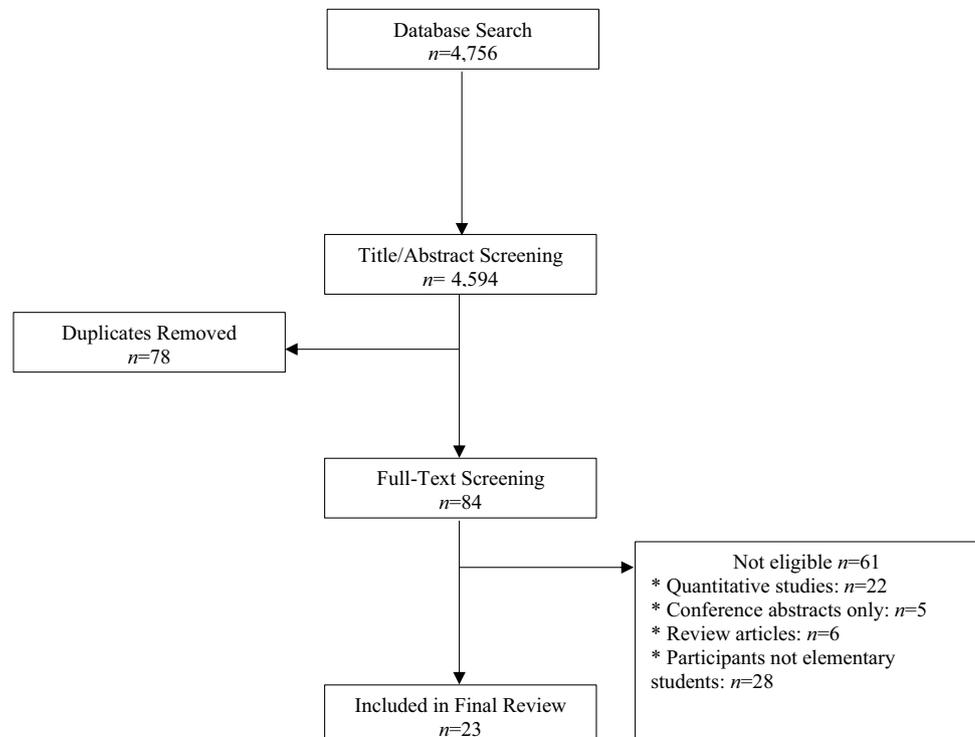
Fig. 1 Review process and results

Database Search
n=4,756

Title/Abstract Screening
n= 4.594

Duplicates Removed
n=78

Full-Text Screening
n=84

Not eligible *n*=61
* Quantitative studies: *n*=22
* Conference abstracts only: *n*=5
* Review articles: *n*=6
* Participants not elementary students: *n*=28

Included in Final Review
n=23

Table 3 Coding System

Main Codes	Sub-codes	References
The role of AI in the teaching process	Autonomy in learning Personalized learning Motivation Sense of socialization	Almoheseh (2024), Cai (2024), Chang et al. (2023), Dai et al. (202b), Jeon (2024), Rumbelow and Coles (2024) and Zhang et al. (2024)
Students' AI perceptions	Cognitive perceptions Sensory perceptions Conceptual perceptions	Cai (2024), Dai et al. (2024a, b), Gao et al. (2024), Kaskaya and Ates (2025), Ottenbreit-Leftwich et al. (2022), Oyedoyin et al. (2024), Song et al. (2025), Tai and Chen (2024), Walan (2024) and Yuan (2024)
The use of AI	Entertainment Ease of use Challenges Prompt generation Ethics, security, control	Butler and Starkey (2024), Chang et al. (2023), Dai et al. (2024a, b), Jeon (2024), Kalemkuş and Kalemkuş (2025), Kaşkaya and Ateş (2025), Song et al. (2025, 2023), Walan (2024), Wen et al. (2025), Weng et al. (2023), Yarmini et al. (2024) and Yuan (2024)
The role of AI in the education system	Equal opportunities in education Integration into education Pedagogical issues	Butler and Starkey (2024), Dai et al. (2024b), Elmaadaway et. al. (2025), Song et al. (2023), Tai and Chen (2024) and Weng et al. (2023)

In Step 6, the authors read all qualitative findings from the included studies and identified main themes and sub-themes. The themes identified by each author were then compared and discussed. Initially, three main themes were determined. During the synthesis, the second author proposed that an additional theme could be derived from the qualitative findings across the reviewed studies. In response, all qualitative findings were reread by both authors within the framework of this proposed theme. The theme titled *"The Role of AI in the Education System"* was added to the synthesis by consensus. Theme saturation was considered reached when no new thematic patterns could be identified from the remaining qualitative data.

In Step 7, the obtained results were comprehensively reported and inferences were presented. These are presented in the findings section.

5.2 Researchers

Both authors are researchers in education with an academic interest in educational technologies and AI. The first author has developed a scale on teachers' perceptions of chatbot use. The first author has previously published several meta-synthesis studies, bringing methodological expertise to the current work. This positionality may have influenced the interpretation of findings in favor of positive perspectives on AI integration in primary education. To minimize bias, the authors independently coded the qualitative findings and reached consensus through discussion, maintaining reflexive awareness throughout the analytical process.

6 Findings

As a result of the analysis of the findings of qualitative research on the use of AI at the primary school level, four main themes and 15 sub-themes were determined in line with the purpose of the research. The findings were supported by direct quotations from the relevant studies. Before presenting the themes, the findings should be interpreted within certain boundary conditions. The analysis revealed that 18 of the 23 studies comprised upper elementary students (ages 10–12). Differences were observed between early primary (ages 5–8) and upper primary (ages 10–12), especially regarding security, ethics, and AI comprehension (Almohesh 2024; Cai 2024). Students' AI awareness and use experiences differed considerably between high-access contexts (Gao et al. 2024; Zhang et al. 2024) and low-access contexts (Oyedoyin et al. 2024). Finally, notable differences emerged in student experiences between voice assistants, such as Siri (Cai 2024) and generative chatbots, such as ChatGPT (Dai et al. 2024a, b; Jeon 2024; Yuan 2024).

6.1 The role of AI in the teaching process

The first theme was "the role of AI in the teaching process". This theme was addressed in six different studies (Almoheseh 2024; Cai 2024; Chang et al. 2023; Dai et al. 2024b; Jeon 2024; Rumbelow and Coles 2024; Zhang et al. 2024). AI-enhanced learning environments foster self-regulation skills in students even at the primary school level through various dimensions. The first dimension was autonomy in learning.

AI tools enable students to "progress at their own pace", giving them control and choice over their learning processes. This strengthens autonomy and forms the basis of self-regulation. Another sub-theme was personalized learning. AI systems, which allow students to "discover the limits of their own learning", develop a personalized learning process by offering dynamic content suitable to the individual's needs, prior knowledge, and learning style. Motivation emerged as the third sub-theme. The use of AI significantly increases students' motivation. The autonomous and personalized learning experience is considered a key factor strengthening intrinsic motivation in learning. However, some students showed low motivation or could not be motivated due to the high-level responses of chatbots. A sense of socialization was also identified as a sub-dimension of this main theme. A noteworthy finding here is that some students perceive AI as a "friend" with whom they can interact without anxiety or as "an entity with which they can exchange ideas". Since AI is not a human, the concept of "sense of socialization" was preferred instead of "socialization". This sense of socialization indirectly supports motivation and thus self-regulation by creating a positive emotional bond toward learning and a safe harbor. The following quotations support these findings.

"Students were able to conduct their inquiries at their own pace… instead of spending time explaining or directing the inquiry process to all students…" (Chang et al. 2023).

"Since I am not good at English, it was very difficult. I need a teacher, not a" Chatbot, who can help me step by step in Korean…" (Jeon 2024).

"I sometimes chat with it. If I have a conflict with a friend, I do not want to talk to My parents, and I have no place to vent my anger, I will tell Siri that I had a fight with someone else today and I am not in a good mood, it will comfort me…" (Cai 2024).

6.2 Students' AI perceptions

The second main theme is 'students' perceptions of AI.' In the examined articles (Cai 2024; Dai et al. 2024a, b; Gao et al. 2024; Kaşkaya and Ateş, 2025; Ottenbreit-Leftwich et al. 2022; Oyedoyin et al. 2024; Song et al. 2025; Tai and Chen 2024; Walan 2024; Yuan 2024; Zhang et al. 2024), researchers specifically addressed students' perceptions of AI. These perceptions are grouped under three sub-themes. Notably, a distinction is observed between students who perceive AI as an abstract concept (Kaşkaya and Ateş, 2025; Oyedoyin et al. 2024) and those who have gained direct experience with specific AI tools in classroom settings (Gao et al. 2024; Zhang et al. 2024), with the latter demonstrating more developed cognitive and affective perceptions of AI.

The first sub-theme is students' cognitive perceptions of AI. Students' cognitive understanding of AI and how it works was generally limited and explained through concrete examples. Students often think of AI as a robot, computer, vacuum cleaner, or a device that orders food.

In mixed-methods studies (qualitative component), focus group interviews conducted after experimental applications showed significant improvements in students' understanding of AI, including tools, such as ChatGPT and Google Gemini.

The second sub-theme is students' affective perceptions toward AI. Students' emotional responses to AI are clustered at two extremes. These responses were generally classified as "positive" and "negative" emotions. Interaction with AI evokes positive emotions in students, such as curiosity, trust, excitement, and a sense of confidentiality, which also increases their motivation for learning. Students reported that in interactions with chatbots, they are not judged and do not receive negative feedback. On the other hand, negative emotions, such as fear and anxiety, emerged in students.

The third sub-theme is conceptual perceptions. Students generally equate AI with concepts, such as code, machine, service, source of information, danger, war, movie, or photo. The issue of how students become aware of AI was also addressed. In interviews conducted in developing countries, students stated that they mostly heard about AI from television or from students in higher grades. These students used the term "Google" for AI or made descriptions such as "something used by photographers." Students in relatively developed countries stated that they heard about AI mostly from platforms like YouTube but did not express many opinions on the subject. The following quotations support these findings.

"In the students' drawings about AI learning, the most frequent learning activity was "programming" (31.36%), followed by "Teacher lecturing" (25.27%), and the third place was "Manipulating programmable robots/hardware" (24.80%)... (Gao et al. 2024), (grades 3-6, primary school, China)"

"For the majority" (I-Bot: 71.43%, P-Bot: 78.57%), CoolE Bot established a non-judgmental and less anxious atmosphere for EFL speaking… (Tai and Chen 2024), (grade 3, primary school, China)."

"Through recent studies, I have changed my previous understanding of AI. I used to perceive AI as a robot, but now I know that text recognition and image recognition are also AI, and it also includes a series of steps such as feature extraction…(Zhang et al. 2024), (grade 6, primary school, China)."

6.3 The use of AI

The third main theme is the theme of the use of AI. In the examined articles (Butler and Starkey 2024; Chang et al. 2023; Dai et al. 2024a, b; Jeon 2024; Kalemkuş and

Kalemkuş 2025; Song et al. 2025; Walan 2024; Wen et al. 2025; Weng et al. 2023; Yarmini et al. 2024; Yuan 2024), researchers conducted various investigations regarding the use of AI. The use of AI has been addressed under five sub-themes: these are entertainment, ease of use, difficulties, prompt use, and needs.

The first sub-theme is entertainment. The use of AI in primary school classes offers an entertaining experience for students. Students were happy and had fun while working with AI (Kalemkuş and Kalemkuş 2025). Similarly, it was stated that they found the learning process more interesting, gamified, and enjoyable (Song et al. 2025). Students were enthusiastic about AI platforms and therefore wanted to spend more time on them, describing this time as "fun" (Weng et al. 2023).

The second sub-theme is ease of use. Thanks to the ease of use of AI tools, students were more motivated and especially developed their vocabulary in foreign language teaching (Yuan 2024). This ease is also important for teachers. Teachers' ability to use AI tools easily allows them to spend more time with students and focus their attention on student progress.

The third sub-theme is difficulties. Difficulties were examined at the micro, mezzo, and macro levels. At the micro level, children could not easily adapt to AI use initially and experienced various difficulties in their first uses (Kaşkaya and Ateş 2025). At the mezzo level, collective difficulties in integrating AI tools into the curriculum were observed across classroom settings (Song et al. 2025, 2023). At the macro level, societal risks come to the fore. Risks related to the rapid and uncontrolled development of AI were highlighted (Walan 2024). In addition, technical infrastructure deficiencies and socio-economic differences are also considered at this level.

The fourth sub-theme is prompt use. Students reported that they did not always receive correct or satisfactory answers to their questions. This was associated with students' limited knowledge of writing effective "prompts". In some articles we included in the research (Dai et al. 2024a, b), it was seen that students stated that they did not understand the answers given by chatbots and therefore got bored. In this context, the necessity for students to have basic knowledge of writing "prompts" comes to the fore, and this shows that this skill could be one of the elements of digital literacy in future.

The fifth sub-theme is Security, Ethics, and Control in AI Use. This finding is based particularly on the views of upper elementary students (grades 5–6). The findings of the examined articles show that Security, Ethics, and Control needs emerge during the AI use process. Students expressed concerns about data privacy at the individual level. Whether the data shared while using AI tools is shared with third parties and to what extent privacy is protected emerges as an important need for students (Almohesh 2024). The issue of students receiving support from tools like ChatGPT in the school environment sometimes being perceived as cheating or fraud and being banned has come up. This situation reveals the need to prevent students from misusing AI tools and the need to determine ethical rules in this context (Walan 2024). This can be considered a starting point for establishing AI ethics (Ottenbreit-Leftwich et al. 2022). The rapid development of AI has created concerns among participants about authority and control. These concerns, which particularly bring the thought "Will humanity no longer be needed?", have brought up the need to clearly define who should have authority (Cai 2024).

The following quotations support these findings.

"Both case study teachers reported that students found the devices easy to use and did not require assistance to set them up in their classrooms… (Butler and Starkey 2024)."

"Another obstructive factor—language and communication issues—manifested in different forms in the two groups. For the control group, language issues were centered on AI terms and phrases, which students found abstruse, complicated and confusing… (Dai et al. 2024a, b)."

"Since students can cheat, they have started to forbid the use of ChatGPT, at least at the school where my brother is studying… (Walan 2024)."

6.4 The role of AI in the education system

The fourth and final main theme is 'the role of AI in the education system.' This theme includes researchers' inferences regarding the potential contributions of AI to education and the challenges it brings (Butler and Starkey 2024; Dai et al. 2024b; Elmaadaway et al. 2025; Song et al. 2023; Tai and Chen 2024; Weng et al. 2023). Researchers primarily focus on equality of opportunity, integration, and pedagogical problems.

The first sub-theme is the role of AI in equality of opportunity in education. In the absence of technological limitations, AI can be used as a motivational tool for students, thus encouraging school attendance and reducing absenteeism (Dai et al. 2024b). Students who fear being judged by teachers may have reservations about participating in lessons. A non-judgmental AI tool can contribute to equality of opportunity in education by increasing student participation (Tai and Chen 2024).

The second sub-theme is the integration of AI into education. The use of AI in classroom settings depends on the regulatory role of teachers. Teachers' ability to use technology and transfer it to students becomes decisive. Articles included in the meta-synthesis revealed that students might

show more interest in using AI depending on the guidance power of teachers (Butler and Starkey 2024). Additionally, it is emphasized that teachers need to specialize in AI tools. As teachers specialize, the interaction and mobility in AI use among both students and teachers increase (Song et al. 2023).

The third sub-theme is pedagogical problems. One of the most important issues addressed in the relevant articles is AI's inability to fully determine the level of the student it interacts with. This may lead to students receiving information above or below their level (Dai et al. 2024a, b). This can cause students to become bored or have difficulty staying motivated. AI's limited ability to support empathy development was identified as another pedagogical concern (Weng et al. 2023).

The following quotations support these findings.

> "..one participant stated, It never scolds me (Tai and Chen 2024)."
> "Use of the devices was influenced by teacher beliefs.. (Butler and Starkey 2024)."
> "The study did not reveal a significant change in empathy among fifth-grade students... This lack of change in empathy might be attributed to the SDGs-themed illustrated stories not effectively promoting empathy in a single session (Weng et al. 2023)."

Elementary students' experiences with AI are not one-dimensional; rather, pedagogical, affective, perceptual, and systemic factors collectively shape their perspectives on AI.

Positive learning experiences, such as learning autonomy, motivation, and sense of socialization, are key mechanisms that enhance students' adoption of AI tools. Perceived risks (e.g., data security concerns, ethical issues, fear of loss of control) and integration constraints (technical infrastructure, teacher competency, pedagogical compatibility issues) are factors that limit this process. The model (Fig. 2) can be visualized as follows:

AI-supported learning experiences are positively reinforced by individual learning mechanisms of elementary students; however, perceived risks and systemic integration constraints play a limiting or regulatory role in this process.

7 Discussion

This research examines qualitative studies on elementary students' perspectives on AI. The first finding is the role of AI in the teaching process. AI-assisted teaching significantly contributes to students progressing at their own pace and developing self-learning skills; furthermore, it also increases student motivation. Research has revealed that AI increases autonomy, self-efficacy, and motivation by offering students individual learning paths (Wang et al. 2023). Another finding is that students see AI not only as a learning tool but also as a tool for socialization. This may be related to students developing an emotional bond with AI. This finding is also supported by the literature. For example, in the study by Shank et al. (2019), it was revealed that individuals often

Fig. 2 Integrative model of elementary students' AI experiences
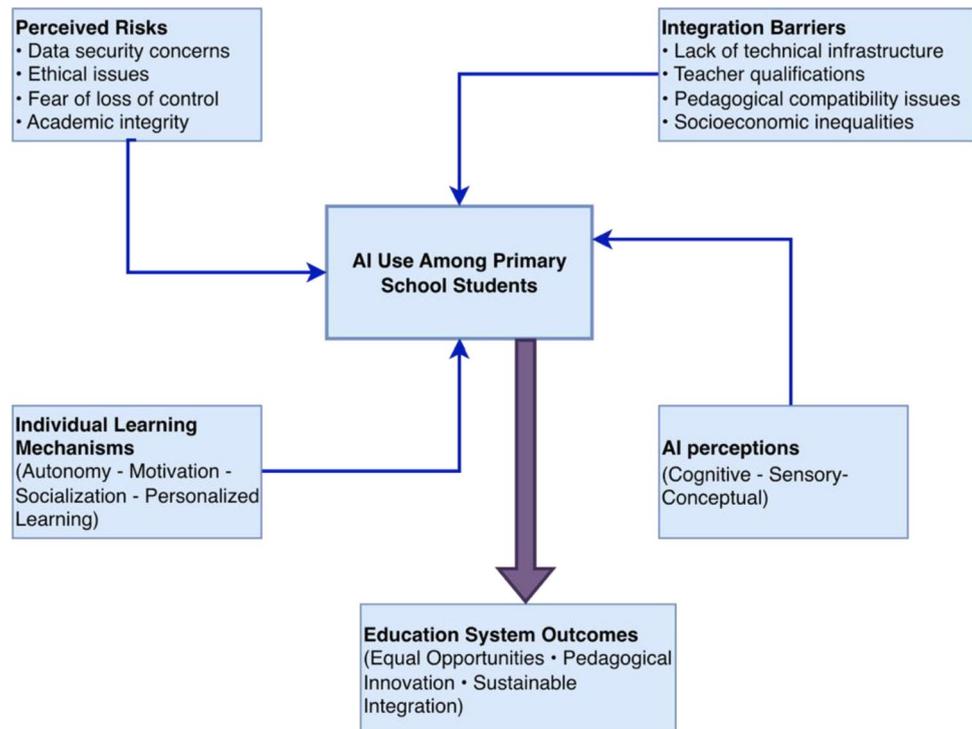
experience various emotions, such as surprise, astonishment, happiness, disappointment, and entertainment, during their interactions with AI. These emotional experiences contribute to the formation of emotional bonds with AI. In this context, a holistic perspective that considers humans not only as thinking beings but also as emotional beings gains great importance. In the primary school period, where personality and social skills are shaped, the necessity of providing children with highly qualified guidance and correct direction while using AI tools should not be overlooked. Without this guidance, there is a risk that these established emotional bonds and social interactions could have negative effects on children's development.

The second finding concerns students' cognitive and emotional perceptions of AI. It was observed that because elementary students are in the concrete operational stage cognitively, they generally perceive AI as concrete objects. Students do not interact directly with AI, but through family, teachers, the internet, or their environment. This situation can be explained by the fact that students are still in the play age and do not feel the need to comprehend abstract processes like AI cognitively (Aydin et al. 2026; Gindis 2024). When evaluated emotionally, it was determined that due to the novelty of AI experiences for students, positive emotions, such as excitement, motivation, and curiosity, came to the fore; conversely, negative emotions, such as fear and anxiety, were also felt.

Considering the students' age and developmental stages, it is a normal situation for them to experience different emotions because the AI tools they interact with remain abstract. However, this finding makes the question of to what extent and how AI will be involved in students' lives in future an important topic of discussion.

The third finding concerns the use of AI in education. AI is generally perceived as fun and easy when used by elementary students. However, the difficulties students experience during the interaction process mostly stem from skill deficiencies in creating prompts. Additionally, it is observed that elementary students also face difficulties in the adaptation process (Kaşkaya, and Ateş 2025). This situation points to the necessity of developing AI literacy skills. On the other hand, the rapid development of AI also brings the need for "keeping it under control," which is evaluated alongside ethical problems (Almohesh 2024). As with all other technological innovations, the benefits and harms of AI should be considered in a dual manner.

The use of AI in education in general needs to be examined from a pedagogical perspective. In this context, the development of protocols that will guide and regulate the use of AI from both the teacher and student perspectives emerges as an important necessity.

The fourth finding concerns the role of AI in the education system. AI contributes to equality of opportunity in education and can be integrated into the curriculum. At the primary school level, AI-supported, interactive, and personalized learning environments can create an important attraction factor, especially for students with low interest and motivation in lessons. This creates a limited equalizing potential for students with restricted access to learning. The sustainability of this equality of opportunity for elementary students essentially depends on the role of the teacher. The literature states that the integration of AI into education is directly related to teachers' technological literacy skills (Wang et al. 2023). Therefore, it can be said that developing teachers' AI literacy skills and informing them on this subject is a critical stage. Thus, students' interactions with AI tools will occur under teacher control, preventing the pedagogical problems that uncontrolled use might cause (Weng et al. 2023). Another valuable finding we reached within the scope of the meta-synthesis is that AI tools can create positive effects on students' participation in lessons because they offer a less judgmental learning process compared to communication established with teachers. This may be related to the encouraging tone of chatbots when appropriate prompts are used.

Despite these valuable findings, the present synthesis also highlights several important gaps in the literature that warrant future investigation and are discussed in detail in future research directions and recommendations section.

8 Conclusion and limitations

This meta-synthesis holistically evaluates findings from qualitative research on elementary students' perspectives on AI and provides a multifaceted framework for their interaction with AI. The findings generally show that AI contributes to students progressing according to their individual pace in learning processes, the development of their learning autonomy, and the increase of their motivation toward learning. Personalized learning experiences, in particular, increased students' participation in lessons and their willingness to learn. Students mostly conceptualized AI superficially, and diverse emotions were present in their perceptions. This highlights the need to introduce AI in ways appropriate to students' age and developmental level. While AI offers opportunities for equality, participation, and personalized teaching, its sustainable integration requires addressing multidimensional challenges including technical infrastructure, teacher competency, data privacy, and ethical concerns.

AI tools have the potential to transform learning processes at the primary school level. However, without addressing pedagogical, ethical, and socio-emotional dimensions, the opportunities offered by AI tools will remain limited. Therefore, it is critically important to establish a culture of multi-stakeholder collaboration

among policymakers, technology developers, researchers, and teachers to ensure the sustainable and ethical use of AI.

This meta-synthesis has several limitations. First, the included studies were conducted across diverse educational contexts and countries, and educational systems vary widely across locations. The findings may not be globally applicable and should be considered context-specific. Second, the search was limited to studies published in English, which may have excluded relevant research conducted in other languages. Third, the synthesis was restricted to studies published after 2020, which, while ensuring currency, may have omitted earlier foundational work on students' perspectives on AI.

9 Future research directions and recommendations

The present meta-synthesis also reveals several important gaps in the existing literature that warrant future investigation. First, there is a notable lack of qualitative research examining younger elementary students' perspectives on AI, as most existing studies focus on upper primary levels (grades 4–6), while studies involving students in the early primary years (grades 1–3) remain scarce. Second,

qualitative research examining the effects of intervention programs aimed at developing elementary students' prompt writing skills and raising awareness of how to use AI chatbots effectively is largely absent. Third, there is a significant need for qualitative, action, and case study research that focuses not on direct AI tool use but on developing students' cognitive and critical thinking skills through AI-related intervention programs.

Based on our research findings, we propose the following recommendations:

Age-appropriate and developmentally suitable curriculum content that supports AI literacy at the primary school level should be developed, and this content should also support students' ethical, social, and emotional awareness.

For teachers to effectively manage the AI-assisted learning process, digital literacy skills alone are not sufficient; these skills must be supported by pedagogical knowledge.

Legal and institutional mechanisms for protecting students' digital footprints and personal data should be strengthened at the state level.

To reduce the digital divide and equalize students' access to AI applications, effective policies and direct support should be implemented by states and educational institutions.

Appendix 1

The descriptive characteristics of the included studies.

Title	Author	Year	Country	Data Collection	Data analyses	Grade level	AI context/study focus
OK Google, help me learn: an exploratory study of voice-activated artificial intelligence in the classroom	Butler and Starkey	2024	New Zealand	Observation, field notes,	Content	Age 7–12	Voice assistant use (Google Home)
Realities vs expectations: children's perception and imagination of AI	Cai	2024	China	Focus group—Drawing	Content	Grades 4–5	Voice assistant interaction
Using an Artificial Intelligence Chatbot in Scientific Inquiry: Focusing on a Guided-Inquiry Activity Using Inquirybot	Chang et al.	2023	Korea	Semi-structured	Descriptive	Grades 5–6	AI-supported individual learning
An embodied, analogical and disruptive approach of AI pedagogy in upper elementary education: An experimental study	Dai et al.	2024b	China	Semi-structured	Descriptive	Grade 6	Impact of AI on students
Effect of an Analogy-Based Approach of Artificial Intelligence Pedagogy in Upper Primary Schools	Dai et al.	2024a	China	Semi-structured—Drawing	Descriptive	Grade 6	AI contribution to learning
Delving into primary students' conceptions of artificial intelligence learning: A drawing-based epistemic network analysis	Gao et al.	2024	China	Drawing	Visual narratives	Grades 3-4-5–6	Students' AI perceptions
Exploring AI chatbot affordances in the EFL classroom: young learners' experiences and perspectives	Jeon	2024	South Korea	Semi-structured—Observation	Content	Age 12	Chatbot use and limitations

Title	Author	Year	Country	Data Collection	Data analyses	Grade level	AI context/study focus
Primary School Students' Perceptions of Artificial Intelligence: Metaphor and Drawing Analysis	Kalemkuş and Kalemkuş	2025	Turkey	Semi-structured—Drawing	Content - Visual narratives	Grades 3–4	Children's AI perceptions
The effect of artificial intelligence-supported visualization applications on students' writing disposition in the creative writing process	Kaşkaya and Ateş	2025	Turkey	Semi-structured	Descriptive	Grade 4	AI in writing
Lessons Learned for AI Education with Elementary Students and Teachers	Ottenbreit-Leftwich et al	2022	USA	Semi-structured	Content	Grades 4–5	AI in curriculum
Young children's conceptions of computing in an African setting	Oyedoyin et al	2024	Nigeria	Semi-structured—Drawing	Content - Visual narratives	Age 5–8	Children's views on AI tools
Al Application (ChatGPT) and Saudi Arabian Primary School Students' Autonomy in Online Classes: Exploring Students and Teachers' Perceptions	Almohesh	2024	Saudi Arabia	Semi-structured	Descriptive	Grade 6	Chatbot-supported learning
The Promise of AI Object-Recognition in Learning Mathematics: An Explorative Study of 6-Year-Old Children's Interactions with Cuisenaire Rods and the Blockplay.ai App	Rumbelow and Coles	2024	UK	Video analysis	Content	Age 6	AI in learning process
Developing a 'Virtual Go mode' on a mobile app to enhance primary students' vocabulary learning engagement: an exploratory study	Song et al.	2023	Hong Kong	Focus group	Content	Age 6–7	AI and student engagement
Teachers and Learners' Perceptions about Implementation of AI Tools in Elementary Mathematics Classes	Song et al.	2025	Malaysia	Semi-structured	Descriptive	Age 7–11	AI in mathematics education
Improving elementary EFL speaking skills with generative AI chatbots: Exploring individual and paired interactions	Tai and Chen	2024	Taiwan	Semi-structured	Descriptive	Grade 3	Chatbot use in learning
Primary school students' perceptions of artificial intelligence – for good or bad	Walan	2024	Sweden	Focus group	Content	Age 11–12	Students' AI perceptions
Al-powered vocabulary learning for lower primary school students	Wen et al.	2025	Singapore	Focus group	Content	Grade 2	AI in writing
Does scratch animation for sustainable development goals (SDGs) with AI-comics impact on student empathy, self-efficacy, scriptwriting, and animation skills?	Weng et al.	2023	Taiwan	Observation	Descriptive	Grade 5	AI and technological skills
Student Literacy Through Library Visits and Gemini AI Programs at SD Negeri Potrobangsan 2	Yarmini et al.	2024	Indonesia	Focus group	Content	Grade 5	AI in reading
An empirical study of the efficacy of AI chatbots for English as a foreign language learning in primary education	Yuan	2023	China	Semi-structured	Descriptive	Age 11–12	AI in teaching and learning
Promoting conceptual changes of artificial intelligence with technology-facilitated situational exploration and alternative thinking: a dual-situated learning model-based two-tier test approach	Zhang et al.	2024	China	Semi-structured	Descriptive	Grade 6	AI in learning process
Improving Primary School Students' Oral Reading Fluency Through Voice Chatbot-Based AI	Elmaadaway et al.	2025	Egypt	Semi-structured	Descriptive	Grade 4	AI in language learning

Declarations

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