frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 02 October 2025
DOI 10.3389/feduc.2025.1688092

OPEN ACCESS

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RECEIVED 18 August 2025
ACCEPTED 17 September 2025
PUBLISHED 02 October 2025

CITATION
Granström M and Oppi P (2025) Student engagement with AI tools in learning: evidence from a large-scale Estonian survey. *Front. Educ.* 10:1688092. doi: 10.3389/feduc.2025.1688092

Student engagement with AI tools in learning: evidence from a large-scale Estonian survey

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The rapid advancement and proliferation of generative artificial intelligence (AI) tools such as ChatGPT are reshaping the educational landscape, with students integrating these technologies into learning practices faster than curricula and institutional policies can adapt. This study presents the results of a large-scale national survey conducted in Estonia in 2024, involving 15,631 students from grades 6 to 12, to map the prevalence, purposes, and perceptions of AI use among school-aged learners. Estonia provides a unique context as one of the first countries in Europe to formally introduce AI literacy into its national curriculum. The study examined (1) the extent and purposes of AI tool usage, and (2) how students' attitudes toward AI's usefulness, risks, and ethical implications differ across educational levels. Results show that most students have already used at least one AI tool, primarily for completing school assignments such as homework and essay writing. While upper secondary students reported greater awareness of both benefits and risks and higher engagement with AI, lower secondary students showed less exposure and may need more structured support. The findings suggest a potential implementation gap: students' practices are evolving ahead of pedagogical frameworks, which could be associated with uncritical use and challenges for metacognitive engagement. The study highlights the urgent need for pedagogically grounded, age-appropriate AI integration strategies and emphasizes the importance of future research to examine AI's associations with learning outcomes, motivation, and critical thinking. These findings provide a foundational baseline for future policy and practice as AI education becomes institutionalized.

KEYWORDS

artificial intelligence, student learning, digital competence, educational technology, ChatGPT

Introduction

In recent years, the rapid development and dissemination of artificial intelligence (AI) tools have significantly transformed the educational landscape. As generative AI technologies such as ChatGPT have entered mainstream use (Crawford et al., 2024; Kalota, 2024), students have increasingly integrated these tools into their everyday learning practices, often faster than schools and curricula can adapt (Amoozadeh et al., 2024; Malik et al., 2023). While discussions around AI in education often focus on teacher preparedness (Galindo-Domínguez et al., 2024; Lozano and Blanco Fontao, 2023) and ethical concerns (Cukurova and Miao, 2024; Grassini, 2023), there is still limited empirical research on how students themselves use AI tools in the context of formal schooling, especially among school-aged learners.

This study wishes to fill this gap by presenting the findings of a large-scale national survey of lower and upper secondary school students in Estonia. Estonia represents a particularly relevant and pioneering case: it is among the first countries in Europe to formally

incorporate AI literacy into its national education strategy (Teadusministeerium, 2025). In 2024, Estonia launched targeted initiatives to integrate AI education into the school curriculum, both in terms of teaching students how AI works and fostering ethical and responsible use of such tools in learning contexts. Given this strategic development, it is crucial to understand the baseline: how many students already use AI, which tools they use, for what purposes, and how they perceive the benefits and risks associated with these technologies.

Previous studies have shown that AI-based tools can support learning in a variety of ways: enhancing personalization (Pikhart, 2020), boosting writing skills and self-efficacy (Chaudhry et al., 2023; Hapsari and Wu, 2022), and promoting metacognitive processes such as self-regulation and reflection (Liao et al., 2024; Mannuru et al., 2023). At the same time, growing concerns have been raised about the reliability of AI-generated content, risks of misinformation, ethical use, overreliance, and the erosion of students' critical thinking skills (Crawford et al., 2024; Cukurova and Miao, 2024; Foroughi et al., 2024; Rospigliosi, 2023). These tensions underscore the need to map student behavior before further institutionalizing AI use in schools.

Granström and Oppi (2025) recent study, conducted among Estonian teachers, explored their readiness to use AI tools in education and how useful they perceive these tools to be. The findings revealed that 53.2% of teachers reported using AI tools, while 46.8% had not. Teachers who used AI tools rated their readiness (e.g., knowledge, access to resources, support from school leadership) and the perceived usefulness of AI (e.g., support for individualized instruction) significantly higher than those who had not. Moreover, readiness and perceived usefulness emerged as the strongest predictors of AI adoption, whereas teaching experience had no significant effect. It is therefore important to move forward with mapping students' AI toolboxes. This article presents the results of a national survey conducted in Estonia in spring 2024, involving over 15,000 students from grades 6 to 12. By focusing on the student perspective, this study responds to urgent calls for inclusive and evidence-based policymaking in the age of AI (Farrokhnia et al., 2023; Lo, 2023). Understanding how students engage with AI is critical for shaping future curricula and ensuring that AI integration supports equity, engagement, and deep learning. Building on this context, this study aims to examine whether and how students in Estonia have used AI tools in their learning so far, prior to the significant shift toward formally integrating AI into the national education system.

Theoretical overview

Understanding AI and its evolution in education

AI encompasses technologies enabling machines to mimic human cognitive functions such as learning and problem-solving (Malik et al., 2023). It refers to computer systems capable of carrying out human-like processes, including learning, adaptation, synthesis, self-correction, and using data for complex tasks (Grájeda et al., 2024). AI has emerged as a pivotal force in education, signaling a shift toward more responsive and adaptive learning environments, optimizing language acquisition and instruction to suit individual needs (Malik et al., 2023).

The advancement of generative AI (Gen-AI), capable of creating new content like text, images, code, simulations, and video, has significantly impacted various sectors, including education (Kalota, 2024). OpenAI's ChatGPT, launched in November 2022, is a prominent example of Gen-AI, leveraging a large language model (LLM) based on transformer architecture to generate human-like text and facilitate automated conversations (Crawford et al., 2024; Farrokhnia et al., 2023; Grájeda et al., 2024; Grassini, 2023; Kalota, 2024).

The proliferation of AI has undeniably prompted extensive discussions regarding its profound influence on learning and teaching in education (Crawford et al., 2024; Grassini, 2023). This transformative surge of AI in education marks a significant shift toward more responsive and adaptive learning environments, aiming to optimize instruction to suit the nuanced needs of individual learners and educators (Crawford et al., 2024; Malik et al., 2023).

The overall sentiment leans toward a balanced approach, where AI collaborates with human authors and educators rather than substituting them entirely. While AI is viewed as a helpful assistant for identifying writing issues and providing content suggestions, maintaining human control, creativity, and critical analysis in the learning process is continuously underscored (Crawford et al., 2024; Cukurova and Miao, 2024). The issue of trust in AI remains complex, with students exhibiting varying levels of trust and transparency regarding AI systems' behavior (Amoozadeh et al., 2024; Grassini, 2023). Moreover, the potential for AI to negatively impact students' social interactions, leading to increased loneliness and a weakened sense of belonging, is a growing concern, suggesting that substituting human support with AI support may have unintended adverse social outcomes (Crawford et al., 2024; Yan et al., 2024). Consequently, schools are urged to develop clear policies, guidelines, and adapt assessment methods to balance technological innovation with educational ethics and integrity, ensuring responsible and effective AI integration (Cukurova and Miao, 2024; Eden et al., 2024). As AI technology advances rapidly, it is anticipated to play an increasing role in supporting students in their academic endeavors, necessitating ongoing adaptation and thoughtful implementation within educational paradigms.

Benefits, challenges, and concerns of AI in education

Benefits of artificial intelligence in education

AI technologies offer extensive benefits, primarily by facilitating personalized and adaptive learning experiences. AI-powered systems can analyze vast amounts of student data and preferences to tailor instruction, content, pace, and difficulty levels to individual needs, promoting greater engagement, motivation, and achievement (Eden et al., 2024; Malik et al., 2023). For instance, AI can provide customized recommendations to improve student success and offer real-time feedback that mimics human instructors, boosting confidence and persistence (Eden et al., 2024). Studies show positive impacts on students' English writing competence, self-efficacy, and self-regulated learning, while significantly reducing cognitive load (Hapsari and Wu, 2022). AI can also foster learning autonomy and reflective thinking among students (Mannuru et al., 2023). The ability of AI to adapt to individual learning styles and progress, along with providing tailored

pedagogical approaches, underscores its transformative potential in redefining educational experiences (Eden et al., 2024; Malik et al., 2023).

AI also significantly enhances academic writing and information access. Students widely acknowledge the benefits of AI-powered writing tools for grammar checks, plagiarism detection, language translation, and generating essay outlines and content (Malik et al., 2023). These tools have improved writing proficiency and self-efficacy, offering timely feedback (Chaudhry et al., 2023). AI-driven language translation technologies broaden academic information access and refine writing quality, transcending linguistic barriers and fostering multicultural understanding (Chaudhry et al., 2023). AI's ability to simplify complex information and produce text in different languages can particularly benefit those with inadequate literacy skills or who speak lesser-known languages. Furthermore, AI can facilitate complex learning, such as language acquisition and critical thinking, by providing customized instruction and feedback. It can stimulate critical thinking by challenging students with tailored questions and providing opportunities to improve argumentation skills through low-stakes practices (Cukurova and Miao, 2024; Luckin et al., 2022; Pratama et al., 2023).

Challenges and concerns of artificial intelligence in education

Despite the many advantages, the integration of AI in education is fraught with challenges and concerns, particularly regarding accuracy, ethical implications, and the potential impact on fundamental human skills (Cukurova and Miao, 2024). A primary concern is the accuracy and reliability of AI-generated content (Grassini, 2023; Pratama et al., 2023; Rospigliosi, 2023). AI models like ChatGPT, trained on large corpora of data, may generate incorrect, imprecise, or even fake information, and their knowledge can be limited or outdated (Malik et al., 2023). This risk is amplified if the training data is biased, leading to perpetuating discrimination and unfair outcomes, especially for diverse populations. Nearly half of students (48.2%) expressed concern about incorrect or imprecise AI answers (Grassini, 2023). Also, one concern raised in the ethical and developmental discourse is that generative AI tools may inadvertently hinder the development of students' independent problem-solving abilities. If students no longer need to mentally construct the steps toward a solution because the AI provides these, they may miss crucial opportunities for forming new cognitive connections that underpin deep learning and higher-order thinking (Crawford et al., 2024; Luckin et al., 2022). This implies a risk that future generations might become less practiced in formulating even the reasoning process, not just the answers.

Another significant challenge is the impact on creativity and critical thinking. Students worry about potential limitations on critical thinking skills when relying on AI, and the possibility of over-reliance on technology (Crawford et al., 2024; Malik et al., 2023). If students primarily use AI to solve problems, their cognitive reasoning may decline (Crawford et al., 2024). While AI can process data efficiently, it may lack the nuanced understanding and creativity inherent in human cognition, underscoring the need for a balanced approach. Ethical considerations include data privacy and security, intellectual property, and the potential for unintentional plagiarism (Eden et al., 2024). The opaqueness of AI decision-making processes further complicates ethical oversight. The digital divide is another significant concern, as disparities in access to AI tools, technology, and internet connectivity can exacerbate educational inequalities (Holmes and Tuomi, 2022). The impersonal nature of AI and the potential for reduced human interaction pose a social and psychological challenge (Crawford et al., 2024; Grájeda et al., 2024). Some students may perceive AI systems as emotionless and less engaged than interactions with a human teacher. Excessive use of AI designed for academic support may inadvertently lead to social withdrawal, isolation, or a diminished sense of belonging, as students might substitute human interactions for AI convenience (Crawford et al., 2024; Liao et al., 2024; Yan et al., 2024). This can negatively affect student achievement when social support, psychological wellbeing, loneliness, and sense of belonging are considered (Crawford et al., 2024).

Learner-centered perspectives on AI use

While much of the current discourse on AI in education emphasizes technological affordances, understanding students' engagement with AI tools requires a deeper consideration of learning as a cognitive and socio-cultural process. The self-regulated learning (SRL) theory highlights the importance of goal setting, strategic planning, self-monitoring, and reflection in successful learning (Zimmerman, 2002). AI tools such as ChatGPT can support these phases—by helping generate ideas or clarify concepts—but may also bypass them by offering ready-made answers. Whether such tools enhance or hinder SRL depends on how learners use them. According to Bandura and Cervone (1986), social cognitive theory, agency, and self-efficacy are central to the learner's capacity to regulate their behavior and learning environment. Investigating students' use of AI tools thus sheds light on technological uptake and the learner's strategic and motivational orientation.

The European digital competence framework DigComp provides a complementary lens (Carretero et al., 2017), which defines digital competence as encompassing technical skill and information literacy, communication, content creation, safety, and problem-solving. DigComp emphasizes the ability to critically evaluate digital content and act responsibly and creatively within digital environments. AI tools pose new challenges—such as distinguishing between accurate and fabricated outputs, or understanding ethical implications of AI-assisted work—making students' digital judgment a crucial component of meaningful AI integration.

Moreover, from a sociocultural perspective, tools are not neutral instruments but mediate human cognition and development (Vygotsky, 1997). Integrating AI into everyday learning may shift students' roles from active constructors of knowledge to passive recipients of algorithmic output—unless accompanied by critical awareness and reflective practice. In this sense, learner agency must be reaffirmed and supported through both pedagogical design and digital literacy education (Sanusi et al., 2024). These perspectives suggest that analyzing how and why students use AI tools provides valuable insight into their self-directed learning processes and digital maturity.

Previous studies

Currently, AI usage has been studied more extensively among university students and less so among school students; therefore, it is

valuable to analyze findings from higher education, as these can offer insights and allow for certain inferences about how school students might be using AI. For instance, Strzelecki (2024) and Bhullar et al. (2024) synthesized students' acceptance and concerns about ChatGPT, while Sublime and Renna (2024) reported widespread adoption of large language models across student populations. Likewise, Stojanov et al. (2024) applied latent profile analysis to examine university students' reliance on ChatGPT, identifying distinct usage profiles. These findings reinforce the need to investigate school-aged learners, whose engagement remains less studied.

A study by Malik et al. (2023) involving 245 undergraduate students in Indonesia found that students generally had a positive attitude toward AI-powered writing tools. Most respondents were familiar with these tools, with nearly 60% agreeing they were aware of them. Many students reported using AI specifically for grammar and spelling checks, plagiarism detection, and language translation. For example, over half used AI to check grammar and spelling, while more than 60% relied on it to detect plagiarism or translate text. Importantly, most students saw AI not as a replacement for human authors but as a helpful assistant—particularly for identifying language issues and offering content suggestions.

Empirical evidence suggests that university students are actively adopting AI tools, particularly generative AI systems such as ChatGPT, to support a variety of academic tasks. A nationwide survey in Germany involving over 6,300 students found that nearly two-thirds had used AI-based tools, mainly for clarifying concepts and understanding subject matter (von Garrel and Mayer, 2023). Similarly, Dai (2025) reported that 59.8% of engineering students used generative AI tools during design projects to generate ideas, bridge skill gaps, or facilitate discussions. However, a notable portion (40.2%) chose not to adopt generative AI, citing misalignment with their goals, a lack of technical skill, or concerns about trust and effectiveness.

Trust has emerged as a critical factor influencing student adoption. Amoozadeh et al. (2024) found that students exhibit varying levels of trust in AI, which correlates with their willingness to use these tools for programming tasks. The study emphasized that both overtrust and undertrust can undermine the effective use of AI in learning.

Grassini (2023) surveyed 601 university students from various disciplines to explore their views on using AI and ChatGPT in education. Overall, students were optimistic: over two-thirds saw AI as applicable for learning, particularly understanding complex topics and saving time on assignments. The average rating for ChatGPT's usefulness was moderately high (M = 3.84 out of 5). At the same time, many students voiced concerns. More than half worried about the reliability of AI-generated content, its potential to weaken critical thinking, and the risk of academic dishonesty. The average concern level was slightly lower (M = 3.45), indicating mixed feelings. Male students viewed AI more positively than female students, and prior experience with tools like ChatGPT was linked to greater acceptance and fewer concerns. This suggests familiarity may reduce skepticism and increase confidence in using AI for educational purposes.

In their study, Lozano and Blanco Fontao (2023) investigated the perceptions of Primary Education students at the University of León (n = 81, *M* age = 19.7) regarding the use of ChatGPT in education, analyzing responses from a dual perspective: as current students and as future teachers. The findings revealed that prior to a classroom activity involving ChatGPT, 76% of students were unfamiliar with the tool, indicating a generally low level of initial awareness. However, after engaging with ChatGPT in an educational context, students reported highly positive perceptions. A large majority found it easy to use (87%), time-saving (77%), and supportive of personalized learning (85%), with 95% expressing surprise at its potential. The main benefits identified were faster task completion and support material generation, while concerns included reduced capacity for critical thinking and an increased risk of plagiarism. While 94% acknowledged the importance of understanding the content generated by ChatGPT, only 54% felt they understood how the tool worked. As future teachers, students broadly did not perceive ChatGPT as a threat; 71% believed it could be helpful in their teaching practice, and 78% anticipated it would require changes in how student tasks are approached. Furthermore, 96% emphasized the need to understand AI tools to prevent plagiarism and ensure ethical use.

One of the recent surveys conducted in Estonia as part of the EU Kids Online network (Kalmus, 2025) sheds light on how school-aged students engage with generative AI tools. The study involved 2,481 students from grades 3 to 9, and found that two-thirds of respondents (66%) had used generative AI in the past month. The most common uses were summarizing or explaining longer texts (35.8%), writing essays or stories for schoolwork (29.2%), and obtaining recommendations for activities or media content (26.1%). Among users, the primary motivations for using AI included saving time (61.7%), simplifying tasks (58.3%), and filling information gaps not found elsewhere (49.5%). A notable portion (33.8%) also admitted to using AI to get better grades, while nearly a quarter (24.5%) used it so that tasks would be completed for them. In contrast, non-users cited disinterest (47.4%) and lack of necessity (44.3%) as key reasons for avoiding AI, with fewer expressing ethical concerns (8.4%) or privacy worries (6.9%).

In follow-up interviews with 13–17-year-olds (n = 16), students described generative AI as a helpful, human-like tool capable of generating content in response to prompts. While technical understanding was often shallow, most participants were confident in their ability to use AI tools, and some showed awareness of how to assess outputs and refine their prompts critically. Interestingly, many students perceived adults as less competent in using AI, echoing a generational divide shaped by public discourse.

In addition, perspectives from media ecology and new literacies research help to situate students' AI use within broader transformations in digital learning environments. Digital platforms do not merely deliver content; they structure participation, visibility, and feedback in ways that shape motivation and literacy practices (Lankshear and Knobel, 2011). Features such as visible peer presence in video calls, threaded discussion spaces, or the immediacy of automated feedback influence how students perceive agency, collaboration, and the value of digital tools. As recent syntheses emphasize, platform affordances and social presence should therefore be seen as central factors in understanding students' attitudes toward AI-supported learning (Adiguzel et al., 2023; Lo, 2020).

The current study

This study aims to provide a comprehensive baseline overview of how students in Estonia are currently engaging with AI tools in their learning. In recent years, the rapid development and adoption of generative AI technologies, particularly large language models, have

significantly reshaped how students approach educational tasks (Crawford et al., 2024; Grassini, 2023; Kalota, 2024). Estonia represents a particularly timely and important context for such an investigation. It is among the first countries in Europe to formally integrate AI education into its national curriculum, starting from the 2025 academic year (Teadusministeerium, 2025). Given this policy development, this study serves as a national mapping exercise that captures the "starting point" before AI education becomes institutionalized in schools.

The following research questions and hypotheses were formulated:

First, do students use AI applications? Which ones do they use, and for what purposes? It was hypothesized (H1) that most students have used at least one AI application (von Garrel and Mayer, 2023; Kalmus, 2025). We also predicted (H2) that students primarily use AI tools for completing school assignments, especially homework. Prior studies have found this to be one of the most common use cases (Malik et al., 2023; Grassini, 2023).

Second, how do students' attitudes toward AI tools' use, usefulness, and risks in learning differ across educational levels (lower secondary vs. upper secondary)?

Methodology

Sample

A total of 15,631 lower and upper secondary school students participated in the survey, including 9,400 (60.1%) lower secondary students and 6,231 (39.9%) upper secondary students. The distribution of respondents across grade levels was as follows: Grade 6–2,397 students (15.3%), Grade 7–2,362 students (15.1%), Grade 8–2,361 students (15.1%), Grade 9–2,280 students (14.6%), Grade 10–2,602 students (16.6%), Grade 11–1928 students (12.3%), and Grade 12–1701 students (10.9%). Of the respondents, 8,247 (52.8%) identified as female and 6,287 (44.0%) as male, while 513 students (3.3%) selected "other/prefer not to say" (see Table 1). Respondents were distributed across three school types: 5965 students (38.2%) from basic schools, 5,076 (32.5%) from combined upper secondary schools, and 4,590 (29.4%) from state-run upper secondary schools.

Sample flow and representativeness. According to the Estonian Ministry of Education and Research, there were 510 general education schools in the 2023/2024 academic year. Excluding primary schools without grades 6–12 and adult schools, approximately 500 schools were eligible for participation. Of these, 96 schools registered and 91 ultimately completed the survey: 52 basic schools, 20 combined schools, and 19 state-run upper secondary schools. Within these schools, 12,367 students were enrolled in grades 6–9 and 8,455 students in grades 10–12. Of these, 9,400 lower secondary students (76.0%) and 6,231 upper secondary students (73.7%) participated. Overall, the final sample represented about three-quarters of the eligible student population in the participating schools. At the national level, Estonia has approximately 165,000 students in general education, meaning that our sample covers roughly 10% of the full school-aged population. Comparison with national statistics indicated that the sample distributions by grade, gender, and school type were broadly consistent with national enrollment patterns.

TABLE 1 Sample size by gender.

Gender	Lower secondary (grades 6–9)	Upper secondary (grades 10–12)	Total
Female	4,714	3,533	8,247
Male	4,339	2,532	6,871
Other/prefer not to say	347	166	513
Total	9,400	6,231	15,631

Procedure

The study was conducted in the autumn of 2024 by the Academy of Educational Leadership at Tallinn University, which organizes an annual nationwide school survey. All general education schools in Estonia were invited to participate by sending personalized invitations and registration forms to the principals of every school. Schools could also register via the university's website. Each participating school received a unique survey link. Data were collected using the Qualtrics platform, and completing the survey took approximately 30 min. Students were asked to respond to nine thematic sections in total, including those that are the focus of this article.

Approval for this study was granted by the Institutional Ethics Committee of Tallinn University, Estonia (application no. 6–5/43, decision no. 36 of 14 December 2023). The survey was conducted between January and February 2024 with full adherence to the approved ethical guidelines. All schools in Estonia were eligible to participate. Personalized invitations were sent to schools previously involved in the survey as well as to those engaged in Tallinn University's educational programs, while other schools could register voluntarily through the university website. The survey was administered during regular school hours. The teacher whose lesson coincided with the administration of the survey was present to oversee logistics, but did not influence student responses. Average completion time was 25–30 min. In line with the Ethics Committee decision, schools acted as intermediaries in obtaining parental consent. Each school received an official information letter prepared by the research team, which they forwarded to parents. Parents who did not wish their child to participate could notify the school, and such students were excluded from the survey. This procedure represented a passive parental consent model. On the day of the survey, all students received information about the purpose of the study, the voluntary nature of participation, and their right to withdraw at any time without negative consequences. Student assent was obtained directly before beginning the questionnaire. Participation was anonymous. Students who did not wish to participate were excused from answering. No identifying information such as names, contact details, or school IDs was collected. Teachers were instructed to emphasize voluntariness and to provide only technical support if needed.

Survey responses were deidentified at the point of collection. Data were downloaded by a single researcher and stored on a secure server with restricted access. Files shared within the research team were encrypted, and access required authentication through Estonian ID card credentials. During administration, teachers were instructed to ensure a quiet and safe environment, to remind students that participation was voluntary, and to avoid influencing responses. If students encountered difficulties in understanding an item, teachers were instructed to advise them simply to "answer in the way that feels most accurate to you."

Measures

Students were first asked whether they use AI tools to support their learning. Those who responded affirmatively were then asked to specify which AI tools they use. In addition to selecting from a predefined list of popular applications, students also had the option to name other tools not listed. A "none of the above" response option was also available. Six statements were developed to assess students' perceptions of AI usage in learning, partially adapted from Lozano and Blanco Fontao (2023). The selected items were chosen to provide a broad overview of students' current experiences and attitudes toward educational uses of AI. The statements included: (1) Some teachers have encouraged us to use AI tools for schoolwork, (2) AI applications are effective learning tools, (3) Some teachers have introduced us to the risks associated with AI use, (4) Because of AI, I no longer need to memorize facts, (5) Using AI makes learning easier and (6) The answers provided by AI are not trustworthy. Students responded to these statements using a 5-point (1-not agree…0.5- strongly agree) Likert-type scale. The original wording of the items in Estonian, together with English translations, is provided in Appendix B. Two of the six attitude statements were negatively worded, namely "The answers provided by AI are not trustworthy" and "Because of AI, I no longer need to memorize facts." In order to ensure consistent interpretation across all items, both were reverse-coded prior to analysis, such that higher scores uniformly indicated more positive perceptions of AI use in learning.

Data analysis

Analyses of all grades did not reveal any significant differences, so subsequent analyses were conducted comparing the levels of basic school (grades 6–9) and upper secondary school (grades 10–12). Descriptive statistics were used to answer the first research question, whether AI tools are used, which ones are used, and for what purposes students use them. Students were given a list of the most popular AI tools, and they could also name AI tools that were not on the list. All open-ended responses were analyzed using inductive open coding. Two coders jointly developed the coding scheme by collaboratively coding an initial subsample of 100 responses, after which the remaining responses were coded independently. A total of 100 responses were included in the interrater reliability check. Interrater reliability was very good, with Cohen's Kappa = 0.864 ($p < 0.001$), 95% CI [0.564, 0.932]. Percentages reported in the results are calculated relative to AI users only. Example responses included "I use AI to translate text into English" (Translation), "I use AI to generate pictures for presentations" (Image generation), and "I use AI to check my homework" (Checking assignments).

Descriptive statistics were used to address the second research question, and the Mann–Whitney *U* test was applied to examine differences between the two educational levels. This non-parametric test was selected due to the non-normal distribution of the data. Effect sizes were calculated using the rank-biserial correlation (rrb), which is appropriate for ordinal outcomes and pairwise comparisons. Thresholds for interpreting effect sizes followed common guidelines: values below 0.10 indicate a negligible effect, values between 0.10 and 0.30 represent a small effect, values between 0.30 and 0.50 indicate a medium effect, and values above 0.50 suggest a large effect (Cohen, 1988).

Results

The use of AI tools by students

The results showed that 74.2% of lower secondary school (basic school) students reported using AI tools in their learning, while 25.7% indicated not. Among upper secondary school students (gymnasium), 90.2% reported using AI tools for learning purposes, whereas 9.3% stated that they had not utilized AI tools in their studies. Table 2 presents the most frequently used AI tools for learning as reported by students. In addition to the predefined options, students were allowed to list other tools they use. Among the tools mentioned in the open-ended "Other" section, Snap AI was the most frequently cited, with 265 mentions. My AI followed this, reported 51 times, and DALL·E, which was named by 10 students.

Table 2 presents students' reported purposes for using AI tools across two educational levels: basic school (grades 6–9) and upper secondary school (grades 10–12). The most frequently reported uses among both groups were for answering homework questions and generating ideas, with over 3,600 responses in each group. These were followed by fact-checking, particularly prominent among basic school students (n = 3,547), while upper secondary students used AI more often for summarizing specific topics (n = 2,902). In addition to the predefined categories, students were invited to describe other ways they use AI tools for learning. Among basic school students, notable uses included image generation, translation tasks, and developing reaction speed. Students also mentioned checking assignments. Among upper secondary school students, image generation was the most frequently mentioned additional use. Other responses indicated using AI for creative tasks, such as producing visuals for presentations or projects (Table 3).

Educational level differences in student attitudes toward AI tools

Students' evaluations of AI-related statements were compared across lower (Grades 6–9) and upper (Grades 10–12) secondary levels using Mann–Whitney U tests. Upper secondary students reported significantly higher mean scores for the statement "Some teachers have encouraged us to use AI tools for schoolwork" (M = 3.83, SD = 1.83) compared to lower secondary students (M = 3.34, SD = 1.78), $U = 2.39 \times 10^7$, $p < 0.001$, rrb = −0.154, which represents

TABLE 2 Mainly used AI tools.

	Count	%
ChatGPT	10,830	69.30%
Google Brad	736	4.70%
Chatsonic	266	1.70%
Claude	293	1.90%
Other	3,390	21.70%

TABLE 3 For what AI tools are used.

Category	Lower secondary school (*n*)	%	Upper secondary school (*n*)	%
For generating/coming up with ideas	3,405	24.20%	4,186	30.10%
For answering homework questions	3,603	25.60%	3,615	26.00%
For summarizing specific topics	2,258	16.10%	2,902	20.90%
For fact-checking	3,547	25.20%	2,585	18.60%
For other purposes (write in the box)	1,240	8.80%	619	4.50%

One student could mark several answers.

a small effect size. Similarly, for the statement "AI applications are effective learning tools," upper secondary students (M = 4.41, SD = 1.43) reported higher agreement than lower secondary students (M = 4.12, SD = 1.51), $U = 2.51 \times 10^7$, $p < 0.001$, rrb = −0.114, also reflecting a small effect. The pattern was repeated for risk-related items. Upper secondary students (M = 4.40, SD = 1.70) were more likely to agree with the statement "Some teachers have introduced us to the risks associated with AI use" than lower secondary students (M = 3.85, SD = 1.80), $U = 2.33 \times 10^7$, $p < 0.001$, rrb = −0.177, again indicating a small effect. Likewise, in response to "The answers provided by AI are not trustworthy," upper secondary students (M = 4.49, SD = 1.20) expressed stronger agreement than lower secondary students (M = 4.17, SD = 1.38), $U = 2.46 \times 10^7$, $p < 0.001$, rrb = −0.130, with a small effect size. A notable exception to this trend emerged for the statement "Because of AI, I no longer need to memorize facts." In this case, lower secondary students (M = 2.65, SD = 1.48) reported significantly higher agreement compared to upper secondary students (M = 2.41, SD = 1.41), $U = 3.10 \times 10^7$, $p < 0.001$, rrb = 0.095. Although statistically significant, the effect size was small. Finally, both groups largely agreed with the statement "Using AI makes learning easier," with upper secondary students (M = 4.49, SD = 1.53) showing slightly higher agreement than lower secondary students (M = 4.36, SD = 1.60), $U = 2.68 \times 10^7$, $p < 0.001$, rrb = −0.053. However, this difference was negligible in magnitude.

Discussion

This study aimed to provide a comprehensive baseline overview of how students in Estonia engaged with AI tools in their learning, with a particular focus on the types of tools used, the purposes of use, and differences in attitudes across educational levels. Overall, the results suggest that AI is already a significant part of many students' learning environments. Students reported using various tools and assessed the advantages and risks of AI relatively adequately at both school levels.

The use of AI tools by students

The findings of this study reveal that a large majority of students in Estonia had already integrated AI tools into their learning; 74.2% of lower secondary and 90.2% of upper secondary students reported using AI tools to support their studies. This widespread uptake confirms earlier predictions that generative AI would become part of students' academic routines (Crawford et al., 2024; Kalota, 2024) and aligns with previous study findings indicating high levels of AI engagement among students (Kalmus, 2025). The most commonly used tool across both levels was ChatGPT, with nearly 70% of all students indicating they had used it. Other tools, such as Google Bard, Claude etc., were mentioned far less frequently. In open-ended responses, students also listed Snap AI and My AI, though a much smaller proportion cited these. This points to a clear dominance of ChatGPT and suggests that student familiarity and accessibility are central factors shaping usage patterns.

Regarding usage purposes, students most frequently employed AI tools to answer homework questions and generate ideas. These functions were similarly popular across both lower and upper secondary students. However, more nuanced patterns emerged in secondary uses: lower secondary students were likelier to use AI for fact-checking. In contrast, upper secondary students reported higher use for summarizing specific topics and creating visuals for presentations. These differences suggest that older students may be leveraging AI tools for more cognitively demanding and productive tasks, consistent with their curriculum and developmental stage. These findings resonate with theoretical perspectives on self-regulated learning and digital competence. According to SRL theory, students who strategically engage with tools to plan, monitor, and reflect on their learning are more likely to experience academic success (Zimmerman, 2002). The observed differences between school levels may indicate that upper secondary students are more likely to integrate AI into self-regulatory learning routines—for example, by using AI to organize information or create content for complex tasks. On the other hand, younger students appear to use AI more often to seek specific factual inputs, potentially reflecting earlier stages of digital and academic development.

Educational level differences in student attitudes toward AI tools

The study identified consistent and statistically significant differences between lower and upper secondary school students' attitudes toward using AI tools in education. Although mostly minor in effect size, these differences reveal important developmental and pedagogical distinctions that should be considered when integrating AI literacy into the curriculum.

Upper secondary students were more likely to agree with two key statements: "Some teachers have encouraged us to use AI tools for schoolwork," and "Some teachers have introduced us to the risks associated with AI use." These findings suggest that AI-related guidance—both in terms of encouragement and critical

awareness—is more prevalent at the upper secondary level. As students move through the educational system, they encounter various academic demands. They are likelier to engage with teachers who feel confident and prepared to support AI integration. These patterns align with theoretical and empirical work on digital competence and self-regulated learning. From a developmental standpoint, learner agency and digital self-efficacy tend to increase with age and experience (Bandura and Cervone, 1986; Zimmerman, 2002), while the DigComp framework (Carretero et al., 2017) emphasizes that effective digital competence combines both technical ability and ethical awareness. Encouragingly, upper secondary students in this study appear to have been exposed to both dimensions, as they reported more frequent teacher-initiated discussion about AI risks and a stronger belief in AI's learning benefits. These findings also resonate with earlier results from a national survey of Estonian teachers, which found that readiness and perceived usefulness were the strongest predictors of AI adoption in schools (Granström and Oppi, 2025). Teachers who reported greater confidence in their knowledge and saw AI as helpful in enhancing teaching were significantly more likely to introduce such tools in their classrooms. The fact that upper secondary students in the present study more often perceived teacher support and risk education suggests that they may be learning in environments where teacher readiness is already comparatively high. This reinforces the importance of addressing teacher competence and institutional support as foundational elements for student-facing AI literacy. The greater emphasis on encouragement and caution at the upper secondary level may reflect broader system-level dynamics, where schools with more mature digital cultures are beginning to model responsible AI use. These environments not only promote experimentation with emerging technologies but also create space for dialogue about ethical implications, helping students develop the critical judgment necessary for lifelong digital citizenship.

Upper secondary students were also more likely to view AI as a practical learning tool. This perception may result from more successful and meaningful integration of AI into complex tasks such as essay writing, project work, or exam preparation. From a self-regulated learning perspective, these students may further develop the metacognitive strategies necessary to use AI purposefully, for planning, organizing, and refining academic outputs (Liao et al., 2024; Mannuru et al., 2023). Their positive appraisal suggests they perceive AI as a tool that supports, rather than substitutes, human thinking.

Interestingly, both groups largely agreed that "using AI makes learning easier," although upper secondary students expressed this more strongly. This reflects a generally positive user experience and reinforces findings from prior studies in higher education contexts, where AI was reported to boost efficiency and confidence (Grassini, 2023; Malik et al., 2023). From the standpoint of educational design, this perceived ease of use may be leveraged to engage students in deeper learning—if accompanied by instruction that promotes active learning and reflection. A noteworthy divergence appeared in the item "the answers provided by AI are not trustworthy." Upper secondary students were more likely to agree with this statement than their younger peers, suggesting a more critical stance toward the reliability of AI-generated content. This supports earlier findings that students' trust in AI tools is context-sensitive and develops over time (Amoozadeh et al., 2024). A healthy skepticism can be seen as an indicator of digital maturity and a prerequisite for meaningful engagement with AI.

Finally, the only item where lower secondary students reported stronger agreement was "because of AI, I no longer need to memorize facts." In this case, their higher mean score reflected more vigorous disagreement. This suggests that younger students are less likely to see AI as a replacement for foundational knowledge, possibly due to their earlier stage of cognitive development and more frequent emphasis on rote learning in their curriculum. From Vygotsky's (1997) perspective, these students are still acquiring basic tools of thinking and may not yet see AI as a partner in cognitive offloading. This may be pedagogically advantageous, as premature overreliance on AI can interfere with the development of core conceptual understanding (Crawford et al., 2024).

Together, these findings indicate that upper secondary students demonstrate not only higher engagement with AI but also greater awareness of its benefits and limitations. They appear better positioned to navigate the trade-offs between efficiency, trust, and autonomy that AI tools introduce into learning. Educational strategies should therefore recognize the developmental progression of digital competence, scaffolding younger students' exposure to AI while fostering critical reflection and ethical judgment among older learners. The ultimate goal is technical fluency and informed and responsible use, a key component of future-ready education.

Limitations

This study also has several limitations. First, the rapid pace of technological change in AI means that the tools listed and used by students during data collection may already be outdated or replaced by newer applications. As such, the findings may not fully capture the dynamic and evolving nature of students' AI engagement. Second, while the survey included a large and diverse sample, it relied primarily on self-reported data, which may be subject to recall bias or social desirability effects. Students may have either overestimated or underestimated their AI use or misunderstood the boundaries between AI-based and non-AI tools. This could influence the accuracy of reported usage patterns and attitudes. In addition, because all data were collected from the same source at a single point in time, common method bias cannot be ruled out, and socially desirable responding may have especially influenced sensitive items such as trustworthiness and effort offloading. Third, the set of attitude statements used to explore students' perceptions of AI was intentionally concise and general in scope. While this allowed for broad comparisons across educational levels, it limited the ability to capture more nuanced or domain-specific beliefs about AI, such as concerns related to academic integrity, creativity, or emotional engagement with AI systems. Fourth, the study did not investigate the depth or quality of AI integration into actual learning processes. Although the results show what tools are used and for what purposes, they do not reveal how effectively or meaningfully AI supports learning. For example, using AI to complete homework does not necessarily equate to improved understanding or self-regulation. Fifth, while this study identified important differences between lower and upper secondary students, it did not account for socioeconomic factors, school-level policies, or teacher-level practices, which may significantly shape access to AI tools and their use in learning contexts. Sixth, given the very large sample size, even negligible differences are likely to reach statistical significance. This makes it

essential to emphasize effect sizes and the practical significance of the findings, rather than focusing only on *p*-values. Seventh, the analyses were limited to a two-level split (lower vs. upper secondary). More fine-grained grade-specific patterns may therefore remain hidden, and it is possible that important variations occur at the level of individual grades. Finally, this study is based on cross-sectional survey data and therefore provides only a snapshot in time. While it offers valuable baseline evidence, it does not allow us to examine longitudinal developments or establish causal relationships between AI use and learning outcomes.

Conclusions and future directions

The explosive spread of AI is driving significant transformations in society and education, bringing new opportunities and serious concerns (Farrokhnia et al., 2023; Rospigliosi, 2023; Susnjak, 2022). While public discourse still debates whether and how to integrate AI tools into education, a new generation of learners—Generation AI—has already seamlessly incorporated them into their everyday learning practices. As shown in this and prior studies (Amoozadeh et al., 2024), these tools are no longer seen as innovations but as routine instruments for accessing information and completing academic tasks.

However, these findings also reveal a significant developmental gap. Upper secondary students demonstrated greater usage and more critical and reflective attitudes toward AI. Teachers were likelier to encourage them to use AI and receive guidance about its risks. In contrast, lower secondary students showed less engagement and less exposure to critical discussion, indicating they may require more structured support to develop meaningful digital competence.

This highlights a key challenge: students' use of AI is evolving faster than the education system's capacity to guide and support them. As the DigComp framework stresses, digital competence includes technical skill, critical evaluation, and ethical awareness (Carretero et al., 2017). Without these dimensions, students risk relying on AI in uncritical or counterproductive ways. Moreover, the fact that AI adoption precedes formal instruction exposes a clear implementation gap between student behavior and curricular design. If left unaddressed, this disconnect may widen digital inequalities and hinder the development of higher-order thinking skills. Previous research has warned that excessive or uncritical use of AI can reduce metacognitive engagement and lead to superficial learning (Crawford et al., 2024; Cukurova and Miao, 2024; Grassini, 2023). Therefore, pedagogically sound and age-appropriate strategies must be developed to accompany students on this journey. This may involve basic digital literacy, structured experimentation, and teacher mediation for younger students. For older learners, it should emphasize critical evaluation, self-regulated learning, and ethical judgment. A national study on teachers (Granström and Oppi, 2025) shows that AI's readiness and perceived usefulness are key to successful classroom integration. Strengthening teacher competence, especially in basic education, is thus essential for ensuring that students across all levels are supported in developing informed, responsible, and future-ready AI practices. Extensive training initiatives for teachers and students are essential to strengthen digital literacy, encourage responsible use of AI, and reduce potential biases. In addition, it is vital to revise assessment practices to prioritize authentic learning and emphasize collaboration between humans and AI rather than replacing human input.

While this study provides a valuable baseline of how Estonian students currently use AI tools in learning, future research should move beyond usage patterns and explore how these tools influence actual learning outcomes. For example, longitudinal and experimental designs could help clarify whether AI-supported learning enhances conceptual understanding, self-regulated learning skills, or academic performance across subjects. In addition, more qualitative research is needed to understand students' cognitive and emotional experiences when working with AI, and how it shapes their motivation, critical thinking, and sense of agency. Given the observed age-related differences, it would also be valuable to investigate developmentally appropriate AI literacy interventions, particularly for younger learners who may lack the critical competencies to evaluate or use AI tools effectively. Finally, future studies should explore how teacher practices and school-level strategies mediate the impact of AI in classrooms, building on the growing evidence that educator readiness plays a critical role in shaping meaningful and ethical AI integration in education.

Overall, the results illustrate associations between educational level and student attitudes toward AI tools, rather than causal effects. While the cross-sectional design precludes claims about developmental change, the observed differences highlight an implementation gap between how students are already using AI and the extent to which schools provide structured guidance. Importantly, these patterns resonate with broader research on how digital platforms shape participation and literacies: features such as visibility of peers, threaded communication, and immediate feedback are likely to influence students' engagement and perceptions of AI. Recognizing these affordances underscores the urgency of developing age-appropriate AI literacy and equipping teachers to scaffold meaningful use in diverse classroom contexts.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

MG: Writing – review & editing, Writing – original draft. PO: Writing – review & editing, Writing – original draft.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1688092/full#supplementary-material

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