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School-Level and Demographic Differences in the Use of Artificial Intelligence Among Hungarian Elementary and High School Students

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Abstract

Artificial intelligence (AI), including rapidly expanding generative AI tools, is increasingly shaping how school-age students search for information and complete learning tasks. Yet comparative evidence on AI awareness, use, and attitudes across school levels—especially among under-18 learners—remains limited in Central and Eastern Europe. Guided by the Technology Acceptance Model (TAM), this cross-sectional survey study examined Hungarian elementary and high school students' AI use and school-related applications, focusing on perceived usefulness and willingness to use AI in learning contexts. Data were collected from 183 elementary and 127 high school students using a structured questionnaire. AI use was widespread in both groups, but marked school-level differences emerged. High school students reported more frequent and academically oriented AI use, greater reliance on AI tools when seeking help, and a stronger willingness to use AI during classroom activities. In contrast, elementary students more often relied on familiar platforms such as social media and YouTube and reported comparatively more recreational or conversational uses of AI. Across school levels, students generally viewed AI as useful and potentially engaging for learning, while many also expressed uncertainty about the reliability of AI-generated responses. These findings underscore the need for age-appropriate AI literacy education aligned with students' developmental characteristics and digital habits, and they highlight the importance of teacher support and training to integrate AI meaningfully and responsibly into classroom practice.

Keywords: artificial intelligence; AI in education; generative AI; ChatGPT; Technology Acceptance Model (TAM); elementary school students; high school students; student attitudes

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1. Introduction

Artificial Intelligence (AI) is increasingly recognized as a crucial component in modern education, offering numerous benefits for both elementary and high school students. The roots of AI date back to the 1950s. The 2020 pandemic period marked a significant stage in its continuous development, as education had to adapt to the challenges of distance learning (Musztafa et al., 2024). Since then, there has been an increase not only in developments related to artificial intelligence, but also in research on the subject, as well as systematic

literature reviews on the role of AI in education (e.g., Boulhrir & Hamash, 2025; S. Wang et al., 2024).

AI is a broad term that encompasses interactive and adaptive learning tools that can significantly enhance student engagement and motivation. For example, AI-powered tutoring systems and educational games can make learning more dynamic and enjoyable (Umirova et al., 2024). At present, state school students in Hungary are used to integrating various AI tools into their daily learning, such as language-learning apps like Duolingo and Babbel, and writing assistants like Grammarly and Hemingway Editor (Upadhyay et al., 2025). Moreover, they benefit from AI-powered homework helpers such as Socratic and Quizlet (Upadhyay et al., 2025), adaptive learning platforms such as DreamBox, Knewton, Carnegie Learning, and ALEKS, and interactive tools such as PolluSpot (Giwa, 2025), and ethical-AI education simulations (Rayavaram et al., 2024). Hungary-specific tools like LMEZZ support native-language learning through AI-based sentence analysis (Tóth et al., 2025).

At the same time, studies highlight both the benefits and risks of AI for young learners. AI can support personalized learning and engagement (Jackaria et al., 2024; Kamalov et al., 2023), but overreliance may hinder deeper understanding or critical thinking, and may expose students to unreliable information (Alasgarova & Rzayev, 2024; Zhai et al., 2024). Some research raises concerns about children using AI for social or emotional support (Yang et al., 2025), highlighting the need for informed guidance in school and at home.

Despite the current increasing availability of AI tools, it is important to examine how AI use varies across school levels. However, Hungarian studies still focus mainly on high schools and university students (e.g., Bokor, 2023; Fajt & Kállai, 2024). Empirical evidence on younger age groups, especially elementary students, remains scarce. As AI use and digital behaviors evolve with age, a clearer understanding of how younger students engage with AI is needed. Furthermore, international studies show that AI use among children is influenced by sociodemographic factors such as gender, age, and home environment. However, these patterns have not been systematically examined in the Hungarian context.

Given this gap, there is a need for research that directly compares AI use across different school levels. Such comparative data can help identify school-level differences in familiarity, usage patterns, and attitudes towards AI, and reveal how background factors shape students' engagement with AI tools. Therefore, this study aims to examine school-level and demographic differences in the use of AI among Hungarian elementary and high school students.

2. Literature Review

2.1. Artificial Intelligence (AI)

With the advancement of science and technology, artificial intelligence (AI) has undergone rapid development and has appeared in many sectors, including education (Chen et al., 2020; Huang et al., 2021). It is not easy to define artificial intelligence, as there are many different interpretations in the literature. The aim of our study is not to clarify or precisely define the concept of artificial intelligence, but rather to examine students' AI use at the elementary and high school levels. However, a few AI definitions are provided for a better understanding.

According to Coppin (2004), artificial intelligence is the ability of machines to solve problems, answer questions, and adapt to and handle situations that require a certain level of human intelligence. Chen et al. (2020), building on Whitby's definition, argue that artificial intelligence is the pinnacle of computer and information and communication technology innovation, enabling machines to perform tasks that are most characteristic of humans. Similarly, according to a general definition, AI refers to a computer that performs

cognitive tasks associated with the human mind, such as learning and problem-solving (Loder & Nicholas, 2018). Without claiming to be exhaustive, we can see that the emphasis in these definitions is on the machine's ability to think intelligently and adapt to situations as humans would (Lameras & Arnab, 2022). It is important to emphasize that artificial intelligence is not biological intelligence (Gaonkar & Macyszyn, 2024). However, it cannot be described as a single technology, as it encompasses applications, algorithms, machine learning, etc. Artificial intelligence can therefore be understood as an umbrella term (Baker et al., 2019).

2.2. Importance of AI in Education

Artificial intelligence plays a significant role at all levels of education. It has led to innovations that present opportunities and challenges for those involved in the educational process. The integration of AI into education can influence the way teachers teach and students learn, on the one hand by personalizing learning activities and curriculum, and on the other hand by providing real-time feedback (Kamalov et al., 2023). AI has not only brought about changes in the field of teaching and learning, but also at the administrative level of education. Numerous studies and literature reviews have been published listing the benefits of using AI in education. AI-supported learning can, for example, contribute to students' problem-solving and critical thinking skills (Jackaria et al., 2024), provide an effective learning experience, and support digital literacy (Bello & Aubert, 2025). By personalizing the content of the curriculum and aligning it with abilities, it can shape individual learning paths (Chen et al., 2020). It can increase engagement and motivation to learn, contribute to the acquisition of 21st-century skills (Ma'amor et al., 2024), and improve learning outcomes for both mainstream and special needs students (Chiu, 2024). AI is capable of taking into account students' existing skills and knowledge, learning strategies, needs, and goals (Mohamed et al., 2025; Musztafa et al., 2024). Studies highlight a number of benefits that AI can provide to educators. For example, it can facilitate preparation and differentiation, ensure flexible testing, and automate monitoring and assessment (Ma'amor et al., 2024).

The above summary shows that integrating AI into education has many advantages, but it also urges users to exercise caution. Students may use AI in an unfair way to complete their assignments: on the one hand, they may use it without citing the source (Vieriu & Petrea, 2025), and on the other hand, completing tasks/homework without understanding them, which not only hinders in-depth learning and development, but also simplifies the learning process (Alasgarova & Rzayev, 2024). Sometimes AI does not provide correct, reliable answers to all questions. Accepting this without criticism distorts information and interpretation. The uncritical use of ready-made answers can reduce learning motivation, creativity, and the ability to make informed decisions, as students do not actively participate in the learning process (Zhai et al., 2024). Furthermore, Abbas et al. (2024) investigated the reasons for using ChatGPT *(version not specified)* among university students. Their results show that ChatGPT is used more frequently by students who face greater time pressure and workload, which is associated with procrastination. At the same time, university students who were more reward-oriented were less likely to use ChatGPT. The researchers attributed this to a fear of being caught and getting bad grades. Yang et al. (2025) reported in their control group experiment that the control group learning programming using traditional methods reported higher performance, self-efficacy, and flow experience than the experimental group using ChatGPT.

At the same time, it should be borne in mind that access to technology is not guaranteed for everyone. This means that the use of AI raises the issue of the digital divide, the inequalities caused by digital technologies. Sociodemographic differences are reflected

in access to and use of AI (Hammerschmidt et al., 2025). It can be seen that there are both advantages and disadvantages to the use of artificial intelligence. That is why it is important for students to consider when and to what extent they will use AI in their learning process.

2.3. Previous Research Findings About AI in Education (The International Context)

Research on the use of AI in higher education reveals diverse patterns and benefits across different cultural and geographical contexts. AI applications such as personalized learning experiences, adaptive testing, and predictive analytics are beneficial in enhancing learning efficacy and providing customized educational support (T. Wang et al., 2023). There are different patterns of AI use among students. For example, students use AI frequently for completing assignments and enhancing learning efficacy (Tamimi et al., 2024). Some students use AI for various tasks, including higher-order writing (understanding complex topics, finding evidence) and lower-order writing (revising, editing) (Black & Tomlinson, 2025).

Research focusing on school-age learners suggests that AI use manifests differently at elementary and secondary levels. At the elementary level, AI is often embedded in interactive and guided learning environments, such as educational games, tutoring systems, or subject-specific applications. These interactive and guided learning environments support engagement and foundational skill development (Umirova et al., 2024; Martin et al., 2024; Wong, 2025). Younger students tend to rely on familiar platforms such as YouTube or conversational AI tools, reflecting their developmental stage and digital habits (Arkoumanis et al., 2025).

There are some similarities and differences in students' AI use between elementary and high school levels. Both elementary and high school students similarly benefit from AI's ability to personalize learning experiences. AI tools can provide educational content to meet individual student needs, enhancing engagement and learning outcomes (Song et al., 2025; Umirova et al., 2024). AI applications at both education levels help in providing feedback and adaptive learning paths, which are crucial for personalized education (Umirova et al., 2024). As differences, AI applications at the primary level focus on interactive learning experiences that introduce basic concepts of AI and machine learning. For example, students engage with AI systems that process data and respond to inputs, fostering trust and understanding of technology (Martin et al., 2024). At this primary level, students prefer to use tools, ChatGPT, and YouTube (Arkoumanis et al., 2025). In primary education, AI is integrated into specific subjects like science to enhance understanding and engagement (Wong, 2025). However, high school students use a broader range of AI technologies, including intelligent tutoring systems and adaptive learning platforms (Tariq, 2025). These tools are designed to cater to more specialized educational needs, such as programming and advanced STEM subjects (science, technology, engineering, and mathematics), and they often involve more sophisticated interactions with the technology.

The use of AI in education or learning is reshaping learning experiences for students at both elementary and high school levels. However, the use of AI tools varies significantly based on sociodemographic factors such as gender, age, parental education, and home/settlement type. Research indicates that male students tend to engage more with AI tools, particularly in areas like determination and exploration, compared to female students, who may focus on content comprehension and exam preparation (Samardžija, 2025). This suggests that male students are more likely to use AI for efficiency while female students may use it for foundational learning support (Sultana et al., 2025). Regarding age and cognitive development, younger students (e.g., elementary school students) may not yet possess the cognitive maturity to fully leverage AI tools effectively. In contrast, high school

students are often more adept at using these technologies for complex problem-solving and critical thinking tasks (Yavich, 2025). Based on the parental education level, students from families with higher parental education levels tend to utilize AI tools more frequently and effectively. This correlation suggests that parental support and understanding of technology play a crucial role in shaping students' academic performance and their engagement (Kour et al., 2025). Furthermore, the reliance on AI tools for academic tasks varies significantly based on parental education. The research (Tamimi et al., 2024) shows that students from more educated backgrounds often use these tools to enhance their learning rather than as a crutch.

Regarding the home/settlement type, urban students generally have better access to AI technologies compared to their rural counterparts. This difference can lead to significant differences in educational outcomes, as rural students may face challenges such as unreliable internet access and a lack of personal devices (Ho, 2025). Moreover, other students (Gutiérrez-Santiuste et al., 2025; Hossain et al., 2025) suggest that significant differences in AI perception were found based on geographical origin, with students from different regions showing varied levels of AI literacy and ethical concerns.

Generally, students have positive attitudes towards AI, recognizing its potential to enhance educational quality and personalize learning (Ríos Hernández et al., 2024). In the Philippines, students have a positive attitude towards using AI for academic writing, appreciating its ease of use and perceived usefulness (Bantoto et al., 2024). Elementary students generally exhibit a positive attitude towards AI, viewing it as a helpful tool for learning. In contrast, high school students show a mix of enthusiasm and skepticism towards AI. While many appreciate the utility of AI tools in completing assignments and enhancing learning, they also express concerns about data privacy, over-dependence, and the potential negative impact on critical thinking skills (Phua et al., 2025; Sok et al., 2025).

Regarding influencing factors on students' AI use, a study (Kim & Lee, 2024) shows that gender has influenced students' attitudes towards using AI, with boys generally showing more positive attitudes if they have had AI-related experiences. Moreover, age levels can influence the adoption and use of AI, particularly in how different age groups perceive and interact with technology (Lopez Barrios & Déri, 2025). Sociodemographic factors, including socio-economic status and regional or settlement differences, can impact students' attitudes towards AI. For example, students facing socio-economic challenges showed more positive attitudes towards AI if they had an AI education (Kim & Lee, 2024).

2.4. Previous Research Findings About AI in Education (The Hungarian Context)

As in the case of international research, studies conducted among students in higher education are predominant in Hungary (e.g., Demeter & Mező, 2023; Fajt & Kállai, 2024; Rajki et al., 2024). Empirical data on the under-18 age group are limited. We consider it essential to extend studies to both primary and secondary schools, as the social and cognitive foundations for lifelong learning are laid at the beginning of education (Boulhrir & Hamash, 2025). As new technologies can transform how skills are developed and knowledge is acquired, we need to understand the needs and opportunities of these age groups so that we can intervene more effectively in the planning of education.

In December 2024, a research report commissioned by the National Media and Communications Authority, which involved high school students, was published. A total of 657 students participated in the online survey. The research aimed to examine the respondents' awareness of AI. According to the results, ChatGPT was the most frequently used AI application among students when they were looking for answers to questions or problems. However, there was a divide in the use of AI in learning, which was correlated with attitudes towards AI use (Szűts et al., 2024). Research conducted by the National

Media and Communications Authority examined the knowledge, fears, and perceptions of 13- to 16-year-old students regarding AI. Data collection took place between September and November 2024, with a total of 1197 participants taking part in the study. Ninety-eight percent of respondents were familiar with AI, which most had first heard about on social media. Curiosity typically motivates children to try and use AI. According to the results of the research, the frequency and differentiation of AI use increased with age. In terms of gender, boys had a higher rate of experimentation. Seventy percent of respondents considered AI useful, but nearly 30% expressed fears about its use. More than 70% of students had used AI for school assignments, while others had used it for chatting with friends (NMHH, 2025).

In 2021, Bokor conducted an online survey involving 463 high school students to find out what they think about the potential of AI in education. The surveyed students were able to imagine AI being used more in math classes than in literature classes, but at the same time, the majority of students believed that AI could be used effectively in school administration. Most respondents could imagine AI teaching classes, tutoring, and even grading in the future. Based on the analysis of the data, the author concludes that although students view AI as part of everyday life, they do not yet consider schools to be ready for its use in education (Bokor, 2023).

In Hungary, empirical research on AI in education mirrors international trends in its focus on older learners. Most available studies examine university students or, to a lesser extent, high school students, while evidence on elementary school students is almost entirely absent (Bokor, 2023; Demeter & Mező, 2023; Fajt & Kállai, 2024). As a result, existing Hungarian research provides limited insight into how AI use develops across school levels or how younger students engage with AI-based tools in educational and everyday contexts.

2.5. Theoretical Framework of Technology Acceptance

This study is based on the Technology Acceptance Model (TAM), which is one of the most widely applied frameworks for explaining individuals' adoption of new technologies (Davis, 1989; Tetik et al., 2024; Venkatesh & Davis, 2000). According to TAM, users' acceptance and actual use of a technology are primarily determined by two key beliefs such as perceived usefulness and perceived ease of use (Abuhassna et al., 2023; Rubiyanti et al., 2023). Perceived usefulness is defined as the extent to which a person believes that using a technology enhances performance, while perceived ease of use reflects the degree to which the technology is seen as effortless to use (Davis, 1989; Gil-Fernández & Calderón-Garrido, 2023; Malatji et al., 2020). These beliefs shape users' attitudes toward technology and their behavioral intention to use it, which in turn predicts actual usage.

TAM has been extensively applied in educational contexts to explain students' adoption of digital learning tools, online platforms, and AI-supported applications (Kamalov et al., 2023; Venkatesh et al., 2012). Recent studies on AI in education have similarly shown that students' perceived usefulness of AI tools strongly predicts their willingness to integrate AI into learning activities (Bantoto et al., 2024; Phua et al., 2025). In this aspect, students' evaluations of AI as helpful for homework, information searching, or lesson engagement can be interpreted as indicators of perceived usefulness, while their expressed willingness to use AI in class reflects behavioral intention (Taherdoost et al., 2024).

Guided by this TAM framework, the present study examines students' AI use, perceived usefulness, and willingness to use AI across school levels and demographic groups. Based on the analysis of technology acceptance, the findings can be integrated not only as descriptive differences but also as meaningful variations in students' readiness and motivation to engage with AI-supported learning.

2.6. Rationale of the Study

Although AI use is becoming increasingly common in Hungarian higher education, research focusing on younger learners remains scarce. Studies among university students (e.g., Karahan Adalı & Bilgili, 2025; Maxwell et al., 2025; Rajki et al., 2025) show substantial variation in AI usage across disciplines, demographic groups, and attitudes. They indicate that AI adoption is shaped by complex individual and contextual factors. International findings similarly highlight big demographic differences, including gender, age, parental education, and settlement type, in students' access to and attitudes towards AI (Ho, 2025; Kour et al., 2025; Sultana et al., 2025). However, much less is known about how these factors operate at the primary and secondary school levels, especially in Hungary (Central and Eastern Europe).

While several recent reviews have examined AI use in primary education globally (Arkoumanis et al., 2025; Boulhrir & Hamash, 2025; Song et al., 2025), empirical evidence from Hungary is still missing. To date, no dedicated Hungarian study has systematically explored elementary school students' familiarity with AI, their usage patterns, or their attitudes toward AI-supported learning. However, international research suggests that children in this age group increasingly encounter AI in tutoring systems, educational games, and everyday applications, with potential benefits for engagement, personalization, and early skill improvement (Lubis et al., 2024; Umirova et al., 2024; Wong, 2025). Considering that Hungary has strengthened its national strategies related to digital literacy, algorithmic thinking, and AI awareness (Tolner & Pogátsnik, 2024), the absence of empirical data on younger pupils represents a significant knowledge gap.

At the high school level, the available evidence remains limited and fragmented. Existing Hungarian research (Szűts et al., 2024; Turós et al., 2025) provides insights into AI-based homework use, awareness, and concerns among adolescents, but these studies do not compare high school students with younger cohorts, nor do they investigate how background factors jointly shape AI use and attitudes. International students, for example, from Estonia (Granström & Oppi, 2025), show that secondary students often rely on AI for homework and content understanding, suggesting that similar tendencies may be emerging in Hungary. However, without comparative national data, it is difficult to determine whether Hungarian students follow these regional patterns and how their practices differ across school levels.

Based on the above review, no Hungarian research has yet conducted a direct comparison between elementary and high school students. Consequently, it lacks systematic knowledge about whether AI use develops in predictable ways across age groups, how students at different school levels perceive the usefulness and reliability of AI, and how demographic factors influence AI-related behaviors among younger learners. Therefore, this study aims to fill this gap by examining AI usage patterns, attitudes, and influencing factors among Hungarian elementary and high school students. The research focuses on identifying similarities and differences across school levels and exploring how background variables shape students' engagement with AI.

Accordingly, the following research questions were addressed.

RQ1: What are the demographic differences in AI usage patterns between elementary and high school students in Hungary?
RQ2: How do students at the two educational levels differ in their attitudes toward the use of AI in learning?
RQ3: What background factors (gender, parental education, settlement type) are associated with students' AI use and attitudes at each school level?

3. Materials and Methods

3.1. Sample Presentation

With the help of purposive sampling, a total of 310 students participated in the study by completing the online questionnaire. Participants were recruited through cooperating elementary and secondary schools from multiple regions of Hungary. They were selected on their willingness to participate and their accessibility through existing professional and institutional networks. The sampling frame included public elementary schools, general secondary schools (gymnasium), vocational secondary schools, and vocational training schools, allowing for variation in school type and educational track. No formal stratification was applied; however, efforts were made to include students from different settlement types (capital city, towns, and rural areas) and school levels to ensure diversity in educational contexts.

Of the total sample, 183 participants were elementary school students, and 127 were high school students. In terms of their place of residence, 41% of respondents lived in the capital, followed by 34% in the countryside and 24% in towns. Regarding school type, primary school students constituted the largest share of the sample (58%). Vocational school students represented 31%, with 18% enrolled in technical or vocational high schools and 13% in vocational training schools. Traditional high school (gymnasium) students were the least represented, accounting for 11% of the sample. Boys were overrepresented in both groups, comprising 54% of elementary school students and 75% of high school students. Table 1 provides an overview of participants' educational attainment across the two subsamples.

Table 1. Distribution of parents' educational attainment by sub-sample (%).

School	Parents	Less than 8 Years of Primary School	Elementary School	High School Without a Diploma	High School with a Diploma	College, University
Elementary school	mother	1.6	4.4	7.7	28.4	57.9
	father	0	5.5	15.7	32.3	46.5
High school	mother	1.6	4.9	11.5	35.5	46.4
	father	0	6.3	30.7	31.5	31.5

The comparison of parental educational attainment across the two subsamples revealed different patterns for mothers and fathers. For mothers, no statistically significant difference emerged between elementary and high school students ($\chi^2 = 8.99$, $p > 0.05$). In contrast, fathers' educational levels differed significantly between the two groups ($\chi^2 = 21.19$, $p < 0.01$). Fathers of elementary school students were more likely to hold higher education degrees, whereas fathers of high school students were more often represented in the category of secondary education without a high school diploma. When examining the total sample, mothers demonstrated significantly higher educational attainment than fathers overall ($\chi^2 = 27.7$, $p < 0.01$).

3.2. Design and Instrument

This study employed a cross-sectional survey design. Data were collected through an online questionnaire developed in Microsoft Forms. Participation was voluntary and anonymous, and no identifying information was requested. Schools disseminated the questionnaire to students through internal communication channels (e.g., school mailing lists, digital learning platforms, or teacher mediation). Inclusion criteria were enrollment in an elementary or high school institution in Hungary and parental consent, where required. No exclusion criteria were applied beyond incomplete questionnaire responses. Data

collection occurred in April and May 2025. The questionnaire consisted of closed and open-ended items. First, participants' demographic information was collected on gender, school level, mother's and father's educational attainment, and settlement type (capital city, town, countryside). These variables were used to explore potential subgroup differences.

3.2.1. Assessment of AI Use and Experience

For this study, "AI tools" were defined as digital applications or online services that use AI or machine-learning based functionalities to generate, adapt, or recommend content in response to user input. This included generative AI systems (e.g., ChatGPT), AI-supported search or question answering tools, language and translation applications, AI-assisted writing or editing tools, adaptive learning platforms, and conversational AI systems. Platforms that primarily provide static content without AI-based personalization were not categorized as AI tools unless students explicitly perceived or used them as such.

Students' engagement with AI was assessed through factual, closed-ended items. Students reported whether they had previously used AI (yes/no), how frequently they used it (single-choice scale ranging from "never" to weekly or more often), and which online platforms they typically used when seeking information (multiple-response "select all that apply" format). They also indicated the purpose for which they used AI by selecting from a response checklist (e.g., learning-related searching, homework help, translation, preparing short presentations, personal interests, image editing, chatting with AI). A yes/no item asked whether teachers had assigned tasks requiring AI. Perceived usefulness of AI in education was measured using a five-point Likert scale (1 = not useful at all, 2 = sometimes useful, 3 = indifferent, 4 = useful, 5 = very useful).

3.2.2. Assessment of Attitude Towards AI in Education

Students' attitudes about AI in learning contexts were measured using single-item Likert-type questions. Students rated their willingness to use AI for education employing a graded scale with responses such as "not at all, won't be bad, I would like to, very much, I don't know." Perceived reliability of AI responses was measured through a categorical scale (reliable, not always reliable, unreliable, not sure). Then, students rated whether AI would make lessons more interesting and selected all subjects in which they could imagine using AI (multiple-response format). Because these constructs were measured using single items, internal consistency reliability indices (e.g., Cronbach's alpha) could not be calculated.

Moreover, students were asked short-answer questions about where they first heard about AI, and invited to share additional comments regarding their AI use. Open-ended responses were analyzed inductively using MAXQDA 24.

3.3. Analysis

The data from the closed-ended items were analyzed using IBM SPSS 25 statistical software. Descriptive statistics were first calculated to summarize students' demographic characteristics, AI usage patterns, and attitudinal responses. To examine differences between elementary and high school students, as well as associations with background variables such as gender, parental education, and settlement type, Chi-square (χ^2) tests of independence were conducted. Statistical significance was set at $p < 0.05$. The open-ended questions were analyzed using inductive content analysis in MAXQDA 24.

4. Results

4.1. School-Level and Demographic Differences in AI Use

4.1.1. Online Platforms Used

Most students in the sample had used AI before. In total, 90.30% reported at least one experience with AI. The rates were very similar across school levels: 89.60% of elementary school students and 91.30% of high school students had already used AI. The study then explored how often students used AI. None of the background variables other than school level (e.g., gender, parental education, settlement type) were associated with frequency of use, but school level showed a significant difference ($\chi^2 = 12.35$, $p < 0.05$). High school students were more likely to report using AI on a weekly basis, while elementary school students more often said that they used it only rarely. When searching for information, the two groups differed in the online platforms they used (Figure 1). These differences show that elementary and high school students tend to rely on different digital sources for help.

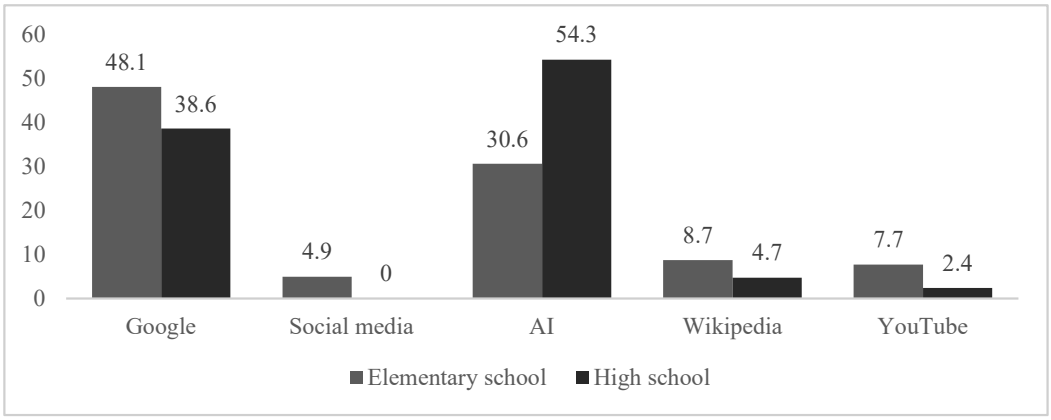


Figure 1. Online help requests by school level (%).

Figure 1 shows clear differences between elementary and high school students in the online platforms they use to search for information and ask for help ($\chi^2 = 23.78$, $p < 0.01$). High school students reported using AI tools more often than elementary school students. In contrast, elementary students relied more on social media and YouTube when looking for answers. These findings suggest that older students are more confident using AI-based platforms, while younger students prefer more familiar and entertainment-oriented sites. This pattern may reflect differences in digital experience and online behavior that develop with age. Then, we examined how students evaluated the accuracy of AI responses. When asked whether AI had ever given an incorrect answer, both groups reported similar experiences (72.7% in elementary school, 68.5% in high school). However, a significant difference appeared in students' judgements of AI reliability ($\chi^2 = 5.74$, $p < 0.05$). High school students were more likely to state that AI is not always reliable, whereas elementary students more often said they were unsure. These findings may be related to students' experience, meaning that older students likely use AI more frequently and for more complex tasks.

4.1.2. Sources of AI Knowledge

Students were asked in an open-ended question where they first heard about AI. Their responses were coded and analyzed using MAXQDA 24.

Figure 2 presents the frequency of each code for both groups (the first number shows occurrences among elementary students, and the second among high school students). The most noticeable difference appears in two areas, such as interpersonal sources (family vs. school) and online platforms (YouTube vs. general Internet sources). For elementary

school students, the family was the most common source of initial AI knowledge. Among high school students, however, the most frequent source shifted to the school environment, especially classmates. This pattern aligns with developmental trends, as peer influence generally increases during adolescence. YouTube was also a common source among elementary students, which corresponds with earlier findings showing that they rely heavily on YouTube and social media when searching for information. High school students, in contrast, mentioned broader internet sources more often.

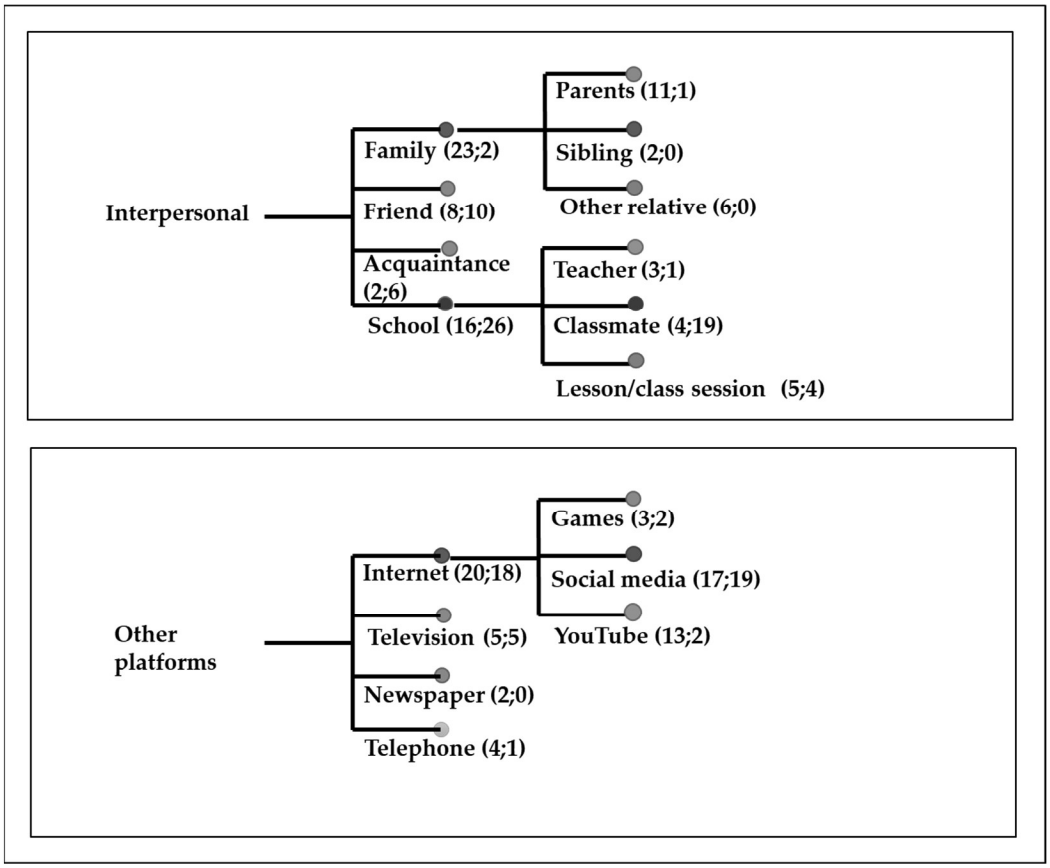


Figure 2. Sources of AI knowledge by school level. Note. Numbers in parentheses indicate the frequency of each code: first = elementary school students; second = high school students.

4.1.3. Purposes of AI Use

Students reported the purposes for which they use artificial intelligence. They could select multiple options from a predefined list. The distribution of responses by school levels is shown in Figure 3.

The findings indicate that high school students use AI more frequently than elementary school students across most categories. Differences greater than 10% appear in activities such as searching for learning-related information, getting help with homework, using AI for translation, exploring personal interests, and preparing short presentations. In contrast, elementary school students reported higher use of AI for image editing and chatting. This suggests that younger students may engage with AI in more social or recreational ways, while older students tend to use it more for academic and informational purposes.

4.1.4. Role of AI in Education

Students reported on the role of AI in their education or learning processes. First, the study examined whether teachers had ever asked the students to use AI to complete a task. A total of 34.50% of high school students and 19.70% of elementary school students reported

such an experience. This difference was statistically significant ($\chi^2 = 8.87$, $p < 0.01$), indicating that AI-based tasks are more commonly assigned in high school than in elementary school. Although this study does not explore the reasons behind this difference, it may be related to differences in curriculum, teacher familiarity with AI tools, or age-appropriate expectations. Then, students were asked how useful they consider AI in education (Figure 4). The overall findings showed that slightly more than half of the students at both school levels viewed the use of AI in education as useful. High school students showed somewhat more positive opinions than elementary school students, although this difference was not statistically significant ($\chi^2 = 4.32$, $p = 0.37$).

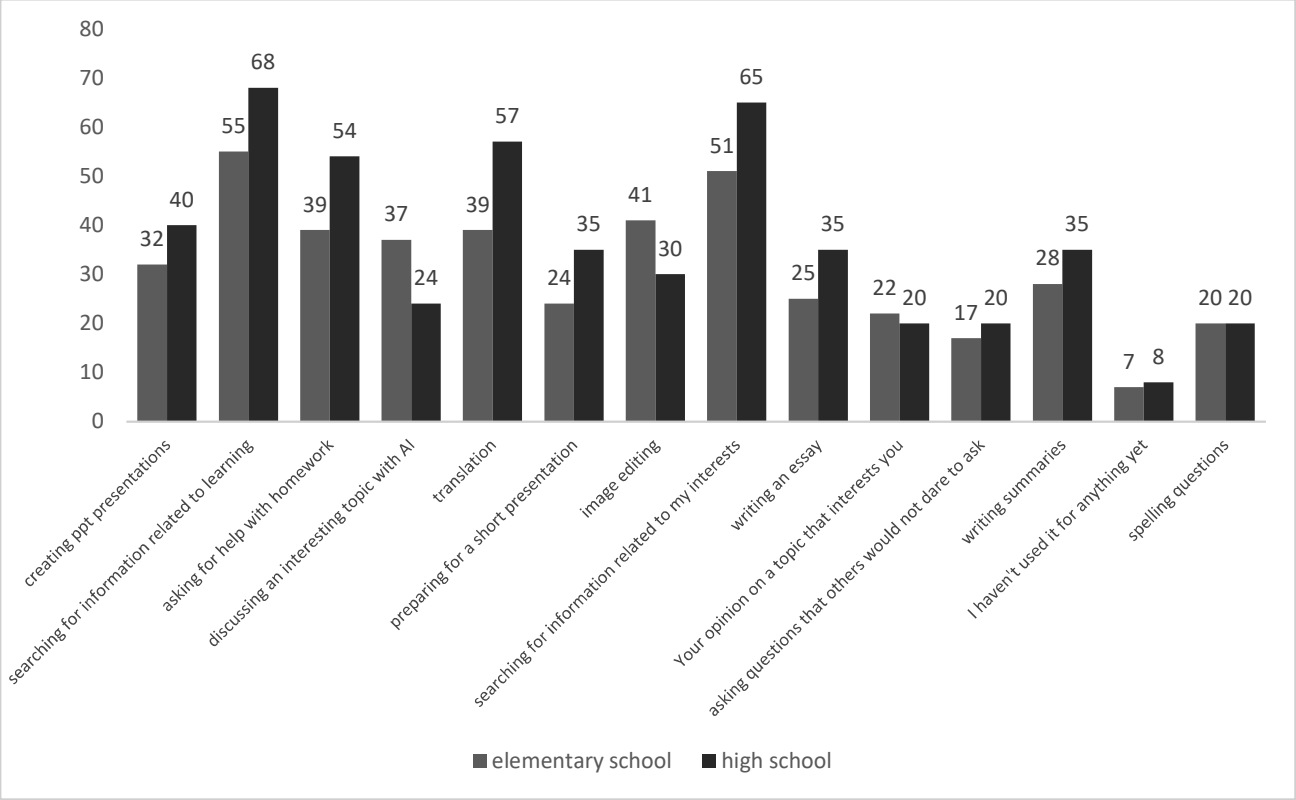


Figure 3. Types of AI use by school level (%).

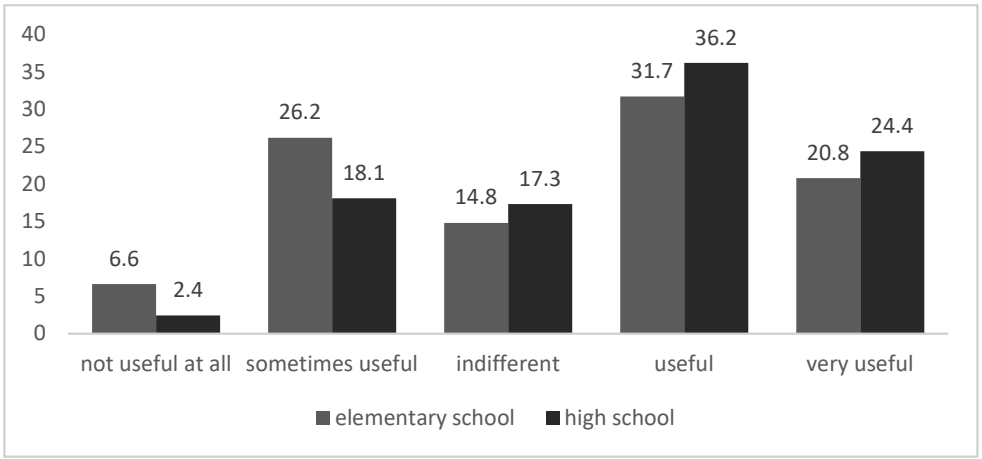


Figure 4. Assessment of the use of AI in education by school level (%).

4.2. Attitudes Towards AI Use

Students were asked whether they would be willing to use AI during class activities. Figure 5 shows the distribution of responses by school level. In the findings, a higher proportion of high school students reported being "*very willing or very much*" to use AI in classes, while elementary students more often selected "*don't know.*" The difference between the two groups was statistically significant ($\chi^2 = 9.22$, $p < 0.05$).

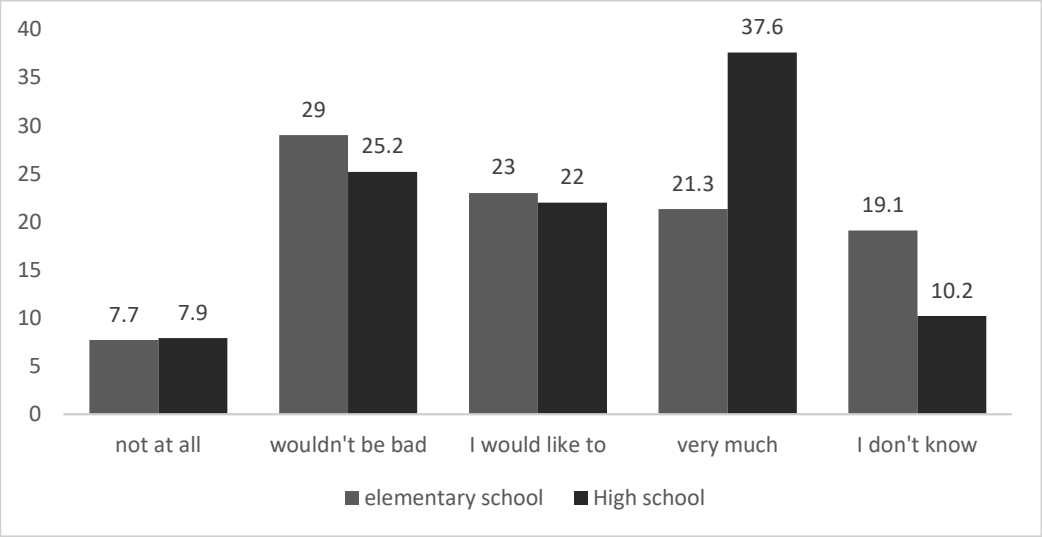


Figure 5. Attitudes toward the use of AI in class by school level (%).

Then, students had to select the subjects in which they could imagine using AI. Two subjects showed differences greater than 10% between the two groups. High school students were more open to using AI in history (48% compared to 33% in elementary school) and in literature (47% compared to 31% in elementary school). This suggests that older students may see broader applications of AI across academic subjects.

4.3. Associating Factors of AI Use and Attitudes

First, the study examined whether students' background characteristics were related to AI use. For both age groups, AI use was not associated with gender ($\chi^2 = 2.54$, $p = 0.11$; $\chi^2 = 2.62$, $p = 0.11$), mother's education ($\chi^2 = 5.75$, $p = 0.22$; $\chi^2 = 3.91$, $p = 0.27$), or father's education ($\chi^2 = 0.79$, $p = 0.94$; $\chi^2 = 2.38$, $p = 0.50$). Settlement type was also unrelated to AI use among elementary school students ($\chi^2 = 5.30$, $p = 0.15$). However, a significant difference appeared among high school students ($\chi^2 = 8.02$, $p < 0.05$), suggesting that those living in the countryside were more likely to use AI than students living in the capital or in smaller towns.

The study then explored whether background variables were related to students' perceptions of usefulness. Gender showed a significant association in the full sample ($\chi^2 = 18.45$, $p < 0.01$) and in the high school subsample ($\chi^2 = 12.82$, $p < 0.05$). In both groups, boys were more likely to rate AI as very useful, while girls tended to give more moderate or less positive ratings. Settlement type was not related to usefulness among elementary school students ($\chi^2 = 17.45$, $p = 0.13$). However, a significant association was found among high school students ($\chi^2 = 22.95$, $p < 0.05$), with students living in the countryside reporting higher levels of AI usefulness compared to those living in the capital or other towns. Regarding the relationship assessment, mothers' and fathers' educational levels were not associated with students' perceptions of AI usefulness in either subsample.

Finally, it investigated whether background variables were related to students' willingness to use AI (attitudes towards using AI). A significant relationship with gender was

found only among high school students ($\chi^2 = 17.43$, $p < 0.01$). In this group, boys were more willing to use AI in class, whereas girls were more likely to report uncertainty. No significant associations were found with settlement type, mothers' education, or fathers' education in either subsample. Then, students were asked whether lessons would be more interesting if AI were used. The findings showed that school level was not related to this perception ($\chi^2 = 7.11$, $p = 0.13$). Additional analyses showed that none of the background variables, such as gender, settlement type, or parental education, were significantly associated with students' views on whether AI would make lessons more interesting.

5. Discussion

This study aimed to compare Hungarian elementary and high school students' AI use, their attitudes towards AI-supported learning, and the background factors that influence these patterns. Three research questions were addressed in the study.

The first research question was to explore demographic differences in students' AI use between the two school levels. Out of several findings of this study, the major finding is that AI use is widespread across both school levels, with around 90% of students reporting prior experience with AI. This aligns with the national data from the National Media and Infocommunications Authority (NMHH, 2025) showing that almost all Hungarian adolescents aged 13–16 are familiar with AI tools. It also corresponds with international studies indicating the rapid expansion of AI-supported applications among young learners (Boulhrir & Hamash, 2025; Umirova et al., 2024).

Despite this overall similarity, clear school-level differences emerged. High school students reported more frequent AI use and relied more often on AI-driven platforms when searching for information. This is consistent with evidence that older adolescents have greater digital autonomy and make broader use of technology for academic purposes (Granström & Oppi, 2025; Tamimi et al., 2024). In contrast, elementary students relied more on familiar and entertainment-oriented platforms such as social media or YouTube. This finding aligns with a pattern reported in studies of younger learners in other countries (Arkoumanis et al., 2025). From the TAM perspective, the more frequent and academically oriented AI use among high school students suggests stronger technology acceptance driven by higher perceived usefulness, whereas elementary students' more limited and informal use reflects an earlier stage of acceptance (Davis, 1989; Tetik et al., 2024; Venkatesh & Davis, 2000).

Differences appeared in the purposes for which students used AI. High school students more frequently used AI for homework assistance, translation, and academic searches, whereas elementary school students reported higher engagement in recreational or conversational uses. A relatively high proportion of elementary students (40%) used AI for chatting. This aligns with NMHH (2025) findings and reflects international concerns about children using AI for social or emotional interaction (Yang et al., 2025). This may reflect children's preferences for immediate, low-effort digital responses or limited access to human support at home. It suggests a need for stronger digital guidance to help younger learners distinguish social communication from academic use.

The second research question concerns students' attitudes towards AI use. Regarding their attitudes, students at both levels saw AI as potentially useful and engaging in educational contexts, confirming earlier findings that young people tend to hold generally positive beliefs about the role of AI in learning (Ríos Hernández et al., 2024; Sok et al., 2025). However, significant differences emerged in students' willingness to use AI in class. High school students showed greater readiness, which may be explained by their higher digital experience, stronger academic demands, and increased confidence in evaluating AI-generated content. Elementary students often selected "*I don't know*," suggesting uncer-

tainty rather than resistance. This uncertainty could be attributed to their limited exposure to formal AI-related tasks. In line with TAM, high school students' greater willingness to use AI in classroom activities can be interpreted as stronger behavioral intention resulting from clearer perceptions of AI's usefulness for learning. However, elementary students' uncertainty indicates less fully formed technology acceptance rather than negative attitudes (Davis, 1989; Gil-Fernández & Calderón-Garrido, 2023; Malatji et al., 2020). Fewer elementary teachers in this study sample assigned AI-based activities, compared with high school teachers. The international literature indicates that teacher familiarity and confidence strongly influence the extent to which AI is integrated into classroom activities (Bello & Aubert, 2025). Thus, the lower rate of AI-supported tasks in elementary school may partially explain younger students' reluctance or uncertainty.

There were differences in students' perceived suitability of AI for certain subjects. High school students were more open to using AI in subjects like literature and history. Bokor (2023) reported some skepticism among high school students towards AI in literature, the broader acceptance observed in this study suggests growing awareness of AI's potential for summarization, text analysis, and research support.

The third research question is about the exploration of students' demographic variables on their AI use. Gender is significantly associated with students' willingness to use AI, but not for basic AI use frequency. In contrast to several international studies showing strong demographic influences on AI use (Kour et al., 2025; Sultana et al., 2025), parental education was not associated with students' AI use and willingness to use AI in this study. This may be due to the relatively high overall availability of digital technologies among Hungarian students in the present study. However, settlement type emerged as a significant factor among high school students, with those living in the countryside reporting higher AI use. This contrasts with findings in countries where urban students typically have greater digital access (Ho, 2025). One possible reason is that rural students of the present sample in Hungary may rely more on online tools due to limited access to tutoring or extracurricular support, making AI an accessible alternative for homework assistance. However, this interpretation remains speculative, as the present study did not directly measure access to tutoring or learning support. Future research should explicitly examine whether differences in educational resources contribute to students' reliance on AI. From the TAM standpoint, these findings suggest that demographic factors such as gender and settlement type influence students' behavioral intention to use AI more strongly than actual access or exposure, reinforcing the model's distinction between technology use and willingness to adopt it (Kamalov et al., 2023; Venkatesh et al., 2012).

Regarding the implications of the study, several implications arise from the findings. First, the school-level differences observed suggest the need for age-appropriate digital education. Elementary students may require a structured, guided introduction to AI tools, with a focus on safe and responsible use, while high school students may benefit from instruction on critical evaluation of AI outputs and academic integrity. As such, teachers' preparedness appears essential. Since AI-based tasks were less common in elementary classrooms, targeted professional development could help teachers integrate AI in pedagogically meaningful ways. This aligns with earlier research showing that teacher confidence directly influences classroom adoption of AI (Bello & Aubert, 2025). Moreover, the finding that many younger students use AI for conversational or emotional purposes highlights the need for digital well-being education. Schools and families should help students distinguish between appropriate and inappropriate uses of AI, ensuring that human relationships remain central in their social relationships. In addition, the study did not directly measure teachers' instructional practices or classroom policies regarding AI use. However, the findings suggest that teacher encouragement or restriction may shape

students' exposure to AI and influence their attitudes, particularly among elementary students whose responses may reflect limited opportunities to use AI in formal learning contexts. Finally, policymakers should consider the uneven patterns of AI use across regions. If rural students rely more heavily on AI, ensuring equitable digital literacy training and safe access becomes especially important.

The study has some limitations that should be acknowledged. First, the sample was obtained through purposive sampling and does not represent the wider population of Hungarian elementary or high school students. Therefore, the findings cannot be generalized. Second, the study relied on self-reported data, which may be influenced by recall bias or students' desire to provide socially acceptable responses. Third, AI use was measured through single-item questions, which limit the depth and reliability of the constructs examined. Fourth, as a cross-sectional study, the results capture students' behaviors and attitudes at one point in time and cannot reflect developmental changes or long-term trends. Fifth, the rapid evolution of AI tools means that students' practices may change quickly, and updated longitudinal research will be needed to obtain a more detailed and accurate picture of AI use in Hungarian schools. The final limitation of the study concerns sample composition. The quantitative representation of elementary and high school students was unequal, with elementary students constituting a larger proportion of the sample. In addition, male students were overrepresented, particularly in the high school subsample. Although the analyses focused on within-group comparisons and associations rather than population estimates, these imbalances may have influenced the observed patterns, especially in relation to attitudes and willingness to use AI. Consequently, the findings should be interpreted with caution, and future research using more balanced and representative samples is needed to examine where the observed school-level and gender-related differences hold in the broader student population.

6. Conclusions

The study compared AI use among Hungarian elementary and high school students, offering one of the first empirical insights into younger learners' engagement with AI. The findings show that AI is already widely used across both groups, although its functions differ. High school students use AI more frequently for academic purposes and show a greater willingness to integrate it into classroom activities. Elementary students rely more on social media or YouTube for help and often use AI for conversational or recreational purposes. Despite these differences, both groups recognize the potential usefulness of AI in learning. These results point to several recommendations. AI education should be age-appropriate; younger students need guidance on safe and responsible use, while older students require support in evaluating AI-generated content. Teacher training remains essential, particularly in elementary schools where AI-based activities are less common. Schools should also promote digital well-being by helping students understand the appropriate role of AI in social and emotional contexts. Ensuring equitable access to digital tools across regions and school types is similarly important.

To conclude, the study highlights both shared patterns and school-level differences in students' AI use. Future research should involve larger, more representative samples and examine how students' practices evolve as AI becomes integrated into Hungarian education.

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References

Abbas, M., Jam, F. A., & Khan, T. I. (2024). Is it harmful or helpful? Examining the causes and consequences of generative AI usage among university students. *International Journal of Educational Technology in Higher Education*, *21*(1), 10. [CrossRef]

Abuhassna, H., Yahaya, N., Zakaria, M. A. Z. M., Zaid, N. M., Samah, N. A., Awae, F., Nee, C. K., & Alsharif, A. H. (2023). Trends on using the technology acceptance model (TAM) for online learning: A bibliometric and content analysis. *International Journal of Information and Education Technology*, *13*(1), 131–142. [CrossRef]

Alasgarova, R., & Rzayev, Z. (2024). The role of artificial intelligence in shaping high school students' motivation. *International Journal of Technology in Education and Science*, *8*(2), 311–324. [CrossRef]

Arkoumanis, G., Sofos, A., Ventista, O. M., Ventistas, G., & Tsani, P. (2025). The impact of artificial intelligence on elementary school students' learning: A meta-analysis. *Computers in the Schools*, 1–22. [CrossRef]

Baker, T., Smith, L., & Anissa, N. (2019). *Educ-AI-tion rebooted? Exploring the future of artificial intelligence in schools and colleges*. Nesta. Available online: https://media.nesta.org.uk/documents/Future_of_AI_and_education_v5_WEB.pdf (accessed on 13 July 2025).

Bantoto, F. M. O., Rillo, R., Abequibel, B., Mangila, B. B., & Alieto, E. O. (2024). Is AI an effective "learning tool" in academic writing? Investigating the perceptions of third-year university students on the use of artificial intelligence in classroom instruction. In *International conference on digital technologies and applications* (Vol. 1098, pp. 72–81). Lecture Notes in Networks and Systems (LNNS). Springer. [CrossRef]

Bello, L., & Aubert, L. (2025). Artificial intelligence in the classroom: Democratizing knowledge and transforming education. *Seminars in Medical Writing and Education*, *4*, 7. [CrossRef]

Black, R. W., & Tomlinson, B. (2025). University students describe how they adopt AI for writing and research in a general education course. *Scientific Reports*, *15*(1), 8799. [CrossRef] [PubMed]

Bokor, T. (2023). A mesterséges intelligencia alkalmazása az oktatásban—Kihívások és következmények technológiainvariáns szempontból [The application of artificial intelligence in education—Challenges and consequences from a technology-invariant perspective]. In Z. Kovács (Ed.), *A mesterséges intelligencia és egyéb felforgató technológiák hatásainak átfogó vizsgálata* [A comprehensive examination of the effects of artificial intelligence and other disruptive technologies] (pp. 114–129). Military National Security Service.

Boulhrir, T., & Hamash, M. (2025). Unpacking artificial intelligence in elementary education: A comprehensive thematic analysis systematic review. *Computers and Education: Artificial Intelligence*, *9*, 100442. [CrossRef]

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, *8*, 75264–75278. [CrossRef]

Chiu, T. K. F. (2024). Future research recommendations for transforming higher education with generative AI. *Computers and Education: Artificial Intelligence*, *6*, 100197. [CrossRef]

Coppin, B. (2004). *Artificial intelligence illuminated*. Jones and Bartlett Publishers.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340. [CrossRef]

Demeter, Z., & Mező, K. (2023). Tanító szakos hallgatók és a mesterséges intelligencia [Teacher training students and artificial intelligence]. *Mesterséges Intelligencia*, *5*(1), 73–87. [CrossRef]

Fajt, B., & Kállai, B. J. (2024). (Nem) gondolkodom, tehát ChatGPT-zek? Egyetemi hallgatók plágiummal és ChatGPT-val kapcsolatos véleményei [I (don't) think, therefore I use ChatGPT? University students' views on plagiarism and the use of ChatGPT]. *Iskolakultúra*, *34*(12), 75–96. [CrossRef]

Gaonkar, B., & Macyszyn, L. (2024). Technological view. In A. E. M. Eltorai, & H. H. Guo (Eds.), *Impact of artificial intelligence in radiology* (pp. 54–61). CRC Press. [CrossRef]

Gil-Fernández, R., & Calderón-Garrido, D. (2023). Teachers' perceptions of the challenges of the digital society: From technology acceptance models to the development of teachers' digital competences. *Bordon. Revista de Pedagogia*, *75*(4), 93–108. [CrossRef]

Giwa, T. A. (2025, March 15). *PolluSpot: A novel tool for teaching model training to middle school students*. 15th IEEE Integrated STEM Education Conference, ISEC 2025, Princeton, NJ, USA. [CrossRef]

Granström, M., & Oppi, P. (2025). Student engagement with AI tools in learning: Evidence from a large-scale Estonian survey. *Frontiers in Education*, *10*, 1688092. [CrossRef]

Gutiérrez-Santiuste, E., López-Pérez, L., Poza-Vilches, F., Molina-Cabrera, D., Montes-Soldado, R., & Alcalá, L. (2025). Pre-university students' perception of algorithmic biases of artificial intelligence. *Educational Technology and Society*, *28*(3), 369–382. [CrossRef]

Hammerschmidt, T., Stolz, K., & Posegga, O. (2025). Bridging the gap: Inequalities that divide those who can and cannot create sustainable outcomes with AI. *Behaviour & Information Technology*. Advance online publication. 1–30. [CrossRef]

Ho, C.-W. (2025). A study on integrating artificial intelligence into teaching activities in rural communities for elementary school students. *International Journal of Information and Education Technology*, *15*(6), 1144–1149. [CrossRef]

Hossain, Z., Biswas, M. S., Khan, N. A., & Khan, G. (2025). Artificial intelligence literacy among South Asian library and information science students: Socio-demographic influences and educational implications. *IFLA Journal*, *51*(3), 629–646. [CrossRef]

Huang, J., Shen, G., & Ren, X. (2021). Connotation analysis and paradigm shift of teaching design under artificial intelligence technology. *International Journal of Emerging Technologies in Learning*, *16*(5), 73–86. [CrossRef]

Jackaria, P. M., Hajan, B. H., Mastul, A.-R. H., & Sali, F. Z. (2024). Generation AI in a reimagined classroom: Challenges, opportunities and implications to education. In Z. Zaremohzzabieh, R. Abdullah, & S. Ahrari (Eds.), *Exploring youth studies in the age of AI* (pp. 174–185). IGI Global Scientific Publishing. [CrossRef]

Kamalov, F., Santandreu Calonge, D., & Gurrib, I. (2023). New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability*, *15*(16), 12451. [CrossRef]

Karahan Adalı, G., & Bilgili, A. (2025). Generative AI in higher education: Students' perspectives on adoption, ethical concerns, and academic impact. *Acta Infologica*, *9*(1), 147–166. [CrossRef]

Kim, S.-W., & Lee, Y. (2024). Investigation into the influence of socio-cultural factors on attitudes toward artificial intelligence. *Education and Information Technologies*, *29*(8), 9907–9935. [CrossRef]

Kour, J., Bhatia, R., & Joshi, R. (2025). Artificial intelligence in education: Insights from gender and locality-based perspectives. In F. Mobo (Ed.), *Impacts of AI on students and teachers in education 5.0* (pp. 193–210). IGI Global Scientific Publishing. [CrossRef]

Lameras, P., & Arnab, S. (2022). Power to the teachers: An exploratory review on artificial intelligence in education. *Information*, *13*(1), 14. [CrossRef]

Loder, J., & Nicholas, L. (2018). *Confronting Dr robot: Creating a people-powered future for AI in health*. Nesta Health Lab. Available online: https://media.nesta.org.uk/documents/confronting_dr_robot.pdf (accessed on 13 May 2025).

Lopez Barrios, M., & Déri, C. E. (2025). The usage of generative artificial intelligence according to sociodemographic characteristics of undergraduate students. *Journal of Scholarly Publishing*, *56*(2), 440–462. [CrossRef]

Lubis, Y., Dalimunte, M., Salmiah, M., Lubis, Z., & Ismahani, S. (2024). Utilizing AI to improve the quality of learning in elementary schools in Indonesia. *BIO Web of Conferences*, *146*, 01089. [CrossRef]

Ma'amor, H., Achim, N., Ahmad, N. L., Roszaman, N. S., Kamarul Anuar, N. N., Khairul Azwa, N. C. A., Abd Rahman, S. N., & Aqilah Hamjah, N. A. (2024). The effect of artificial intelligence (AI) on students' learning. *Information Management and Business Review*, *16*(3S(I)a), 856–867. [CrossRef]

Malatji, W. R., van Eck, R., & Zuva, T. (2020). Understanding the usage, modifications, limitations, and criticisms of the technology acceptance model (TAM). *Advances in Science, Technology and Engineering Systems*, *5*(6), 113–117. [CrossRef]

Martin, F., Vahedian Movahed, S., Dimino, J., Farrell, A., Irankhah, E., Ghosh, S., Jain, G., Mahipal, V., Rayavaram, P., Temitayo Sanusi, I., Salas, E., Wolkowicz, K., & Narain, S. (2024, March 20–23). *Perception, trust, attitudes, and models: Introducing children to AI and machine learning with five software exhibits*. SIGCSE 2024: Proceedings of the 55th ACM Technical Symposium on Computer Science Education v. 2 (pp. 1740–1741), Portland, OR, USA. [CrossRef]

Maxwell, D., Oyarzun, B., Kim, S., & Bong, J. Y. (2025). Generative AI in higher education: Demographic differences in student perceived readiness, benefits, and challenges. *TechTrends*, *69*, 1248–1259. [CrossRef]

Mohamed, A. M., Shaaban, T. S., Bakry, S. H., Guillén-Gámez, F. D., & Strzeleczki, A. (2025). Empowering the faculty of education students: Applying AI's potential for motivating and enhancing learning. *Innovative Higher Education*, *50*, 587–609. [CrossRef]

Musztafa, M. Y., Tlili, A., Lampropoulos, G., Huang, L., Jadrić, P., Zhao, J., Salha, S., Xu, L., Panda, S., López-Pernas, S., & Saqr, M. (2024). A systematic review of literature reviews on artificial intelligence in education (AIED): A roadmap to a future research agenda. *Smart Learning Environments*, *11*(1), 59. [CrossRef]

Nemzeti Média-és Hírközlési Hatóság, NMHH. (2025). *Media awareness is becoming more valuable in the age of artificial intelligence*. Available online: https://english.nmhh.hu/article/255259/In_the_age_of_artificial_intelligence_media_literacy_is_becoming_increasingly_valuable (accessed on 10 November 2025).

Phua, J. T. K., Neo, H.-F., & Teo, C.-C. (2025). Evaluating the impact of artificial intelligence tools on enhancing student academic performance: Efficacy amidst security and privacy concerns. *Big Data and Cognitive Computing*, *9*(5), 131. [CrossRef]

Rajki, Z., Dringó-Horváth, I., & Nagy, J. T. (2025). Artificial intelligence in higher education: Students' artificial intelligence use and its influencing factors. *Journal of University Teaching and Learning Practice*, *22*(2), 1–21. [CrossRef]

Rajki, Z., Nagy, J. T., & Dringó-Horváth, I. (2024). A mesterséges intelligencia a felsőoktatásban: Hallgatói hozzáférés, attitűd és felhasználási gyakorlat [Artificial intelligence in higher education: Student access, attitudes, and usage practices]. *Iskolakultúra*, *34*(7), 3–22. [CrossRef]

Rayavaram, P., Narain, S., & Martin, F. (2024, October 13–16). *Let's go for a drive: Exploring AI's societal impact in K-8 education with an interactive self-driving car tool*. Proceedings—Frontiers in Education Conference, FIE, Washington, DC, USA. [CrossRef]

Ríos Hernández, I. N., Mateus, J.-C., Rivera-Rogel, D., & Ávila Meléndez, L. R. (2024). Perceptions of Latin American students on the use of artificial intelligence in higher education. *Austral Comunicación*, *13*(1), e01302. [CrossRef]

Rubiyanti, N., Abu Sujak, A. F., Madiawati, P. N., Nurutami, F., & Bt Raja Razali, R. R. (2023, August 2–3). *Perceived usefulness: A bibliometric visualization*. 2023 International Conference on Digital Business and Technology Management, ICONDBTM 2023, Lombok, Indonesia. [CrossRef]

Samardžija, J. (2025, June 2–6). *AI-enhanced exam preparation: Addressing economic and sustainability challenges in digital transformation*. 2025 MIPRO 48th ICT and Electronics Convention (pp. 1117–1122), Opatija, Croatia. [CrossRef]

Sok, S., Heng, K., & Pum, M. (2025). Investigating high school students' attitudes toward the use of AI in education: Evidence from Cambodia. *SAGE Open*, *15*(3), 21582440251353575. [CrossRef]

Song, X., Mak, J., & Chen, H. (2025). Teachers and learners' perceptions about the implementation of AI tools in elementary mathematics classes. *SAGE Open*, *15*(2), 21582440251334545. [CrossRef]

Sultana, A., Abdul Latheef, N., Siby, N., & Ahmad, Z. (2025). Exploring students' attitudes toward artificial intelligence (AI): Psychometric validation of AI-attitude scale. *SAGE Open*, *15*(4), 21582440251378375. [CrossRef]

Szűts, Z., Nagy, R., & Turós, M. (2024). *Fiatalok mesterséges intelligenciával kapcsolatos nézetei, különös tekintettel az oktatásra és a digitálismédia-tartalmakra. A Nemzeti Média- és Hírközlési Hatóság megbízásából készített kutatási jelentés [Young people's views on artificial intelligence, with particular regard to education and digital media content. Research report commissioned by the National Media and Communications Authority]*. Available online: https://onlineplatformok.hu/files/967e7de9-2bcb-495c-bce6-b1a2414e06c1.pdf (accessed on 14 May 2025).

Taherdoost, H., Mohamed, N., & Madanchian, M. (2024). Navigating technology adoption/acceptance models. *Procedia Computer Science*, *237*, 833–840. [CrossRef]

Tamimi, J., Addichane, E., & Alaoui, S. M. (2024). Evaluating the effects of artificial intelligence homework assistance tools on high school students' academic performance and personal development [Special issue]. *Arab World English Journal*, *(10)*, 36–42. [CrossRef]

Tariq, M. U. (2025). AI-driven personalized learning: Revolutionizing student engagement and teacher efficiency in education 5.0. In *AI and emerging technologies for emergency response and smart cities* (pp. 75–95). IGI Global Scientific Publishing. [CrossRef]

Tetik, G., Türkeli, S., Pinar, S., & Tarim, M. (2024). Health information systems with technology acceptance model approach: A systematic review. *International Journal of Medical Informatics*, *190*, 105556. [CrossRef]

Tolner, N., & Pogátsnik, M. (2024). The large language models in the service of education [Special issue]. *Magyar Nyelvor*, *148*(5), 629–649. [CrossRef]

Tóth, N. E., Oszkó, B., & Yang, Z. G. (2025). Hungarian sentence analysis learning application with transformer models. *Acta Cybernetica*, *27*, 83–91. [CrossRef]

Turós, M., Nagy, R., & Szűts, Z. (2025). What percentage of secondary school students do their homework with the help of artificial intelligence?—A survey of attitudes towards artificial intelligence. *Computers and Education: Artificial Intelligence*, *8*, 100394. [CrossRef]

Umirova, S., Mahmadiev, S., Zuparov, T., Yuldashev, A., Abdullayev, A., & Sobirova, N. (2024, November 23–24). *AI-assisted tutoring systems: Improving engagement and learning outcomes in elementary education*. International Conference on IoT, Communication and Automation Technology (ICICAT) (pp. 779–784), Gorakhpur, India. [CrossRef]

Upadhyay, P., Bhardwaj, H., & Tomar, P. (2025). Artificial intelligence tools for instructors and learners to optimize the teaching and learning processes. In K. M. Soni, N. Hasteer, A. Bhardwaj, R. Sindhwani, & J. P. Davim (Eds.), *AI-based solutions for inclusive quality education* (pp. 45–56). CRC Press. [CrossRef]

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186–204. [CrossRef]

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, *36*(1), 157–178. [CrossRef]

Vieriu, A. M., & Petrea, G. (2025). The impact of artificial intelligence (AI) on students' academic development. *Education Sciences*, *15*(3), 343. [CrossRef]

Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T., & Du, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems with Applications*, *252*, 124167. [CrossRef]

Wang, T., Lund, B. D., Marengo, A., Pagano, A., Mannuru, N. R., Teel, Z. A., & Pange, J. (2023). Exploring the potential impact of artificial intelligence (AI) on international students in higher education: Generative AI, chatbots, analytics, and international student success. *Applied Sciences*, *13*(11), 6716. [CrossRef]

Wong, W. L. (2025). The feasibility of using artificial intelligence to explore ecological balance in primary education. In S. C. Kong, H. S. Hoppe, T. C. Hsu, & J. Zhao (Eds.), *Proceedings of international conference on computational thinking education* (pp. 175–177). The Education University of Hong Kong.

Yang, T. C., Hsu, Y. C., & Wu, J. Y. (2025). The effectiveness of ChatGPT in assisting high school students in programming learning: Evidence from a quasi-experimental research. *Interactive Learning Environments*, *33*(6), 3726–3743. [CrossRef]

Yavich, R. (2025). Will the use of AI undermine students' independent thinking? *Education Sciences*, *15*(6), 669. [CrossRef]

Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: A systematic review. *Smart Learning Environments*, *11*(1), 28. [CrossRef]

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