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Smart use of artificial intelligence requires human intelligence

Birgy Lorenz and Kaspar Kruup

KEY MESSAGES

- **Artificial intelligence (AI) can help reduce educational inequalities and support inclusive education** by offering new learning opportunities and assisting teachers, who work with limited resources. However, this requires informed and responsible use.
- **When used purposefully, AI can support personalised and effective learning** by helping to tailor content to learners' needs and supporting the development of critical thinking and problem-solving skills.
- **AI may deepen educational inequality** because it primarily benefits those who already possess self-regulated learning and thinking skills, while less independent learners risk becoming passive consumers of technology.
- **Excessive and passive use of AI can hinder the development of learning skills**, since overreliance on technology may reduce learning habits and critical thinking, leaving learners less able to acquire and analyse knowledge actively.
- **AI-generated content is not always distinguishable from human-created work.** This poses new challenges in assessing knowledge and originality in education while calling into question traditional teaching and assessment methods.

INTRODUCTION

In recent years, AI has profoundly influenced education by offering new possibilities for personalised learning and teacher support. At the same time, its misuse can deepen inequality and hinder critical thinking.

Estonia is a leading country in digital education,^{1,2} and since 2025, the integration of AI in schools has become part of a broader educational reform initiative called the AI Leap (TI-Hüpe).³ The main challenge is to ensure that all learners can use



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This article explores the impact of AI on education, focusing on the risks of increasing inequality and ways to prevent it, changes in learning habits and critical thinking, and how teachers are adapting. We analyse both the positive and negative aspects of AI use and offer ways to ensure its balanced and responsible implementation.

AI IN SCHOOLS: SHAPING THE FUTURE OR CHASING THE HYPE?

If Estonia aims to position itself as a leader in AI access and education, it needs initiatives and investment to integrate these technologies into schools and promote personalised learning.

Estonian government agencies have drawn up a White Paper on Artificial Intelligence,⁴ which highlights the key role of education in developing a data-driven society and economy by equipping people with essential data and AI skills and integrating these into curricula at all levels of education. Plans also include using AI to personalise learning and strengthen digital competences, ensuring Estonia has a competitive and technologically literate workforce by 2030.⁵ Similarly, public awareness of the opportunities and risks of AI must be raised to make its use consistent across society, not limited to the public sector.⁶

To support this, the Ministry of Education and Research established an advisory council on AI in 2024 to ensure meaningful goals and continuity in related developments. In addition, guidelines have been prepared for schools.⁷ To provide access to AI and reduce educational inequalities, it is essential to stay informed about both successful and unsuccessful interventions, policies and pilot projects implemented in other countries (such as in the European Union,⁸ the United States,⁹ the United Kingdom,¹⁰ Australia¹¹ and Asia¹²). These examples reveal overenthusiasm, rushed decisions that may stall implementation, and efforts to regulate AI development pre-emptively – and at times unsustainably. The implementation

of AI has prompted the education sector, which usually acts reactively, to become proactive. This means we must be ready for highly flexible decision-making to ensure that the AI Leap does not turn into mere AI hype.

GROWING TECHNOLOGY USE MAY OFFSET EFFICIENCY GAINS

AI is not equally accessible to everyone in the education system. Economic status, place of residence and school resources affect opportunities to use AI – cities have better technological infrastructure and resources, young people encounter AI more often, and schools with STEM (science, technology, engineering and mathematics) programmes lead the way in applying technology.¹³ At the same time, it should not be overlooked that AI applications can enhance the quality of education and bring back to education people with disabilities, who stand to benefit most clearly from technological progress.¹⁴ On the other hand, access to AI is also regulated by the European Union's AI Act,¹⁵ which highlights the need for transparency in developing and using AI solutions in education and restricts high-risk applications such as monitoring learners' emotions. Educational institutions must understand the principles behind AI systems to prevent technology from deepening inequality and to safeguard learners' fundamental right to privacy. Meanwhile, technology companies are considering whether to offer their services in Europe at all, and if so, at what additional cost to consumers.

In the broader context of accessibility and the green transition, it must be remembered that the cost of using AI depends on both economic trends and energy consumption. If large corporations achieve monopoly power, they may raise prices and lower service quality, reducing the accessibility of AI solutions for educational institutions.¹⁶ Furthermore, AI systems increase carbon dioxide emissions, which casts doubt on their environmental sustainability.¹⁷ This creates a situation where greater use of technology cancels out the efficiency gains it initially delivered. As a result, countries and schools that have become heavily reliant on AI may soon find themselves

facing rising energy costs and the environmental consequences of higher emissions, which make previously affordable software prohibitively expensive. The divide between schools and countries that can afford AI in education and those that cannot will thus deepen further – not to mention the broader question of the environmental sustainability of widespread AI use.

HUMAN INTELLIGENCE BEFORE ARTIFICIAL INTELLIGENCE

The use of AI presupposes thinking skills and the ability to reflect on one's own thinking – metacognition.¹⁸ Modern technological interfaces are designed to be so intuitive that ordinary users need no special technical skills. Yet there remains a clear distinction between everyday users and developers, the latter requiring a deep understanding of AI algorithms and how they function.

AI should be used to support, not replace, human intelligence. To ensure that learners and teachers use it in this way, the foundations of thinking skills must be laid before AI is introduced. When we speak about self-regulated learners and learning to learn, we are referring to metacognitive skills – the ability to observe one's own thinking, detect errors, set cognitive goals and direct thought processes purposefully.¹⁹ If schools teach these skills, learners can benefit from AI as a means of developing their intellect.²⁰ However, if the focus remains solely on correct answers and performance monitoring, the introduction of AI may lead to superficial learning and a decline in critical engagement – that is, to the passive use of AI.²¹ Educational institutions must therefore consider whether their teaching methods genuinely promote critical thinking or merely encourage unreflective task completion with technological shortcuts. In the worst case, this hampers the development of learners' thinking because no real thinking takes place at all.

Teachers and schools play a central role in guiding the informed and critical use of AI. They must develop both their own and their pupils' metacognitive abilities so that AI serves as a tool for effective learning rather than an instrument that erodes learning habits and, in the worst case,

exposes learners' data publicly.²² The issue, in this sense, is not necessarily a decline in academic performance but rather that lessons and tasks which never required thinking in the first place could not have raised that level anyway. The real risk lies in the fact that some pupils learn to use technology to enhance their cognitive growth, while others delegate thinking entirely to the machine and lose the ability to reflect on what they may have lost in the process. To prevent this, schools and educators must critically assess whether their teaching truly demands, supports and develops thinking. If the answer is not an evidence-based 'Yes!', then the hasty introduction of AI is likely to be more harmful than beneficial. Schools that fail to harness the potential of human intelligence are unlikely to make effective use of artificial intelligence.

As awareness of metacognitive skills and related learning practices is still evolving, responsibility for ensuring the sensible use of AI rests largely with schools and teachers. Teachers must understand how pupils think, how their thinking develops and how it can be supported. This enables the creation of an environment that encourages thinking – one in which AI has its place within clearly defined boundaries. It should also be remembered that more than five years ago Estonia set a goal for its learners to become not merely consumers but creators of new technologies.²³ To develop AI, many will later need to acquire university-level knowledge and skills in areas such as machine learning, deep learning, natural language processing, computer vision, data science, statistics, algorithm design, big data analysis, cloud computing, cybersecurity and fields yet to be invented.²⁴ This means that pupils should be introduced to these subjects, including AI, already in general or vocational education. Regardless of whether they later choose to study information technology or not, everyone needs to develop crucial 21st-century competencies: problem-solving, critical thinking, communication, the ability to recognise bias and a sense of ethics in using AI – all of which are essential for thriving in the information society.

IF AI EVALUATES YOU, THEN WHO EVALUATES THE AI?



The use of AI in education raises ethical questions related to algorithmic bias, data protection and the misuse of AI tools. Transparency in data collection and processing is essential to safeguard privacy and prevent violations of learners' rights.²⁵ Regulating the use of AI in education requires clear ethical guidelines and stronger data protection measures. Schools and educational institutions must understand how AI makes decisions and what data it uses in order to avoid unfair assessments and unequal opportunities.²⁶ The same applies to Estonian educational technology companies seeking to create new and innovative AI-based applications. However, not every big-data-driven application is suitable for the school environment.

Applications designed for surveillance rather than supporting learning should be treated with caution. When pupils use text-generating tools to complete homework, schools may understandably wish to distinguish AI-assisted work from that produced independently. Yet this desire puts schools in a vulnerable position, making them susceptible to exploitation by companies that sell so-called generative AI detection services. Although such providers often market their software as highly accurate, it is technologically impossible to avoid false positives, which can lead to unjust accusations of AI use directed at pupils who have done nothing wrong. Particular care is needed with AI-based monitoring systems in examinations, where pupils may be wrongly accused of plagiarism or of submitting work generated with AI assistance.²⁷ The authoritative appearance of these technologies and the promises made by their developers can be misleading, and excessive reliance on them undermines the trust that should exist between pupils and teachers, schools and the state. Turning to yet another technology to solve the problems created by the first is not a sustainable path forward.

TEACHING 2.0 AND THE REDISTRIBUTION OF ROLES IN THE

AGE OF AI

AI is transforming the role of teachers: their traditional task of transmitting knowledge is increasingly giving way to guiding and supporting learners. AI tools can enable personalised learning and help manage classrooms, but they also demand new competencies from teachers, including digital literacy, the ability to interpret data and the ethical use of AI.²⁸ While today's technologies do not yet allow for fully automated personalisation, that future is not far off.

Challenges related to AI in the classroom include access to AI resources, evaluating their reliability and integrating them into existing curricula. AI also affects teacher–pupil interaction by enabling personalised learning and adapting instruction and support to individual learners, thereby enhancing the overall learning experience. However, particular attention must be paid to preserving meaningful human relationships in an increasingly digitalised classroom.

Looking to the near future, by 2030 Estonia is likely to implement automated training programmes and tools that enable teachers and pupils to use AI in an informed, critical and effective way. Ongoing discussions will address the challenges of large-scale AI implementation, the changing nature of the learning process and the evolving role of the teacher.²⁹ The intelligent use of AI can help reduce teachers' workloads, support differentiated tasks, enable personalised assessment and provide individual guidance. Teachers will possess strong skills in both digitalisation and AI use, working alongside automated AI teaching assistants. Teacher burnout and turnover are expected to decrease as intelligent AI systems take over routine tasks.

Nevertheless, it is essential to recognise that AI can never fully replace teachers, as meaningful relationships and the development of critical thinking require human guidance. Teachers must understand how to use AI in ways that support learning rather than hindering independent thought.³⁰ For example, teachers might use AI to design and check assignments, while pupils use it as a consultation partner in a Socratic dialogue.

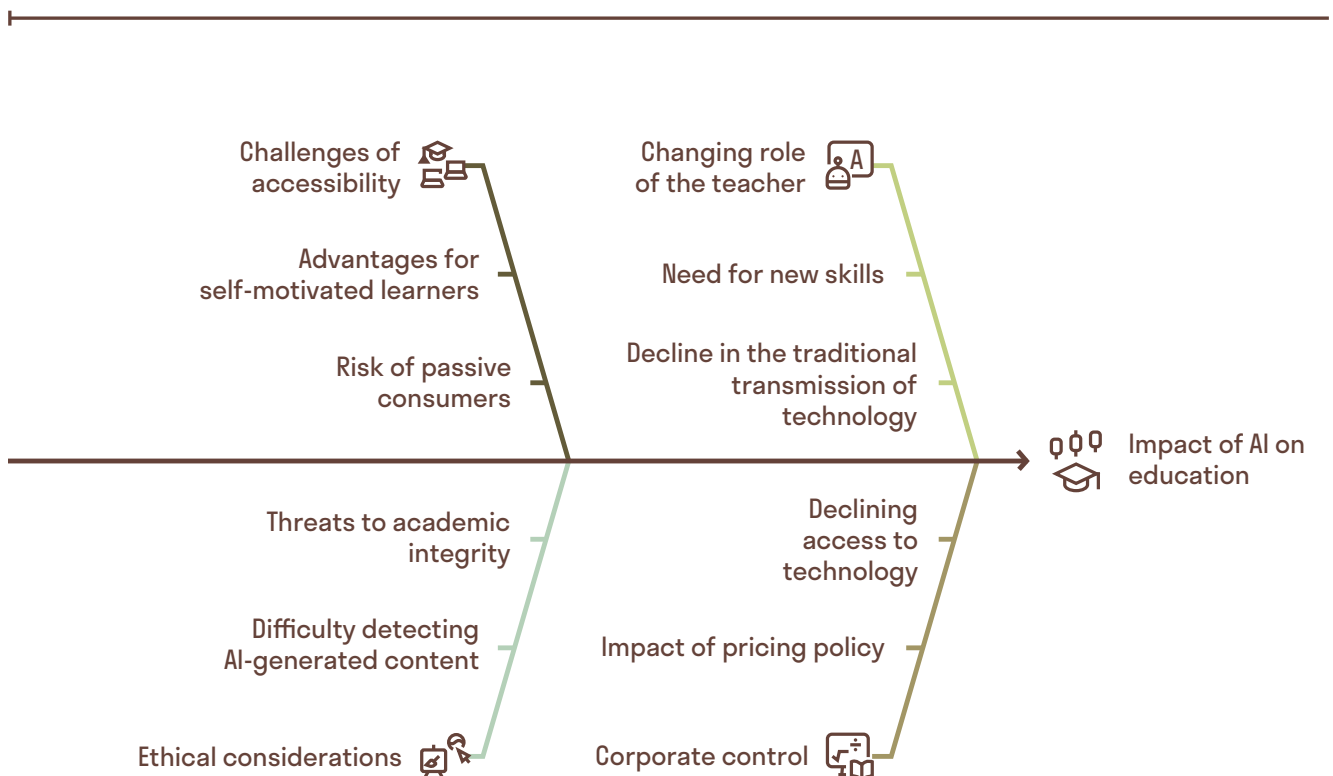
To meet these expectations, Estonia's education policy, supporting frameworks and funding mechanisms must be reviewed to help teachers adapt to AI-enriched learning environments and tools. Ongoing feedback from teachers and opportunities for professional development will ensure that the integration of new technologies into education proceeds responsibly and effectively.

NO KNOWLEDGE WITHOUT LEARNING, NO SKILLS WITHOUT KNOWLEDGE

AI can help personalise learning and reduce teachers' workloads, but its use must be informed and responsible (Figure 5.2.1). The availability of new technologies depends on economic and technological resources, which makes nationally implemented measures necessary to ensure equal opportunities for all learners.

Curricula must promote digital literacy, critical thinking and metacognitive skills so that learners can use technology consciously. The ethical use of AI requires transparency, data protection and, necessarily, teacher training. Overuse of AI must also be avoided, as it can inhibit independent thought. In the future, ensuring the affordability and sustainability of AI services will be vital to avoid dependence on monopolistic providers. Successful use of AI in education depends on cooperation between educational institutions, the state and the technology sector – through training initiatives and by sharing best practices with both learners and society at large. Only through this kind of collaboration can we build the necessary awareness and turn knowledge into practical skills.

Figure 5.2.1 Responsible integration of artificial intelligence in education



SOURCE: figure by the authors

REFLECTION

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The problem of learning in the age of AI is overlooked only by those unconcerned with learners' information processing working only at a superficial level, or not at all. For everyone else, the elephant in the room – a focus on performance rather than mastery – has been stomping about for decades and has now become even more visible with the rise of AI. Yet it bears repeating a fundamental truth: contemporary learning science holds that the most effective learning happens through the learner's own construction and co-construction of knowledge. In other words, genuine learning is still a slow, deep and argumentative or reasoning-based process – one that moves from practice to theory, where individuals, alone or with others, seek to construct explanations, definitions, formulas, conclusions, assumptions, solutions, insights, syntheses and applications through dialogue.³¹ This is precisely the process that AI must never do on our behalf, because thinking skills cannot develop in our minds without direct engagement (and deteriorate if we stop exercising them). Accordingly, in a well-designed educational framework, scientifically grounded AI learning tools – whose genuinely effective forms are still being developed at the time of writing – should mainly be used when no expert teacher or peers are present. In short, AI should serve learning only during a certain portion of the total study time, and time spent together with real people should not be wasted on AI.

The human psyche is an integrated whole – and was so long before AI. To understand what AI can improve in education – or make worse – we must first look squarely at education's own challenges. Perhaps the greatest of these is that many participants in the learning process still do not understand the nature of learning itself, which has wide-ranging consequences. Learners often judge the effectiveness of learning during the process, based on how easy or pleasant it feels, when in fact the opposite tends to be true: effortful learning is more effective.³² Supporting

learning requires an understanding of how mental processes develop: the nature of cognition, the functioning and growth of executive functions, motivation, emotions, how these are interpreted and regulated, and much more. All these factors interact, and when they – or other factors such as social and emotional competence – create barriers to learning, AI-based support tools may help overcome them.

As the article notes, AI can act either as an accelerator of development or as a dangerous substitute for the learner's own thinking – much like a physical education teacher running laps on behalf of their pupils. Ideally, AI should function as a scientifically grounded, step-by-step support system for learners struggling with specific learning difficulties – much like a teacher would, if they could always be there at the right moment. An AI-based solution should be used only up to the ideal point at which it becomes unnecessary – the moment when the learner has internalised the relevant learning skill. This is when learning strategies, attention control, reflection on learning, understanding of learning processes, or metacognition have become part of the learner's own thinking – when the pupil has become an autonomous learner and no longer needs AI as a learning coach.

We do not yet know for how many types of learning difficulties AI could be useful, and optimism may be premature. One key question for the future is whether we can create an AI that acts as an attentive 'learning coach', informed by contemporary research and capable of interpreting a learner's verbal input while considering the many interrelated factors that shape cognition – both universal and individual – and prioritising them appropriately. For example, it may be futile to teach learning strategies to a pupil at times when they are convinced the subject is simply 'not for them', or to offer deep discussion when the learner first needs step-by-

step support in sustaining attention and realising that attention itself can be trained.

Developing research-based educational AI requires rigorous validation, testing and refinement, along with attentiveness to potential unintended or harmful side effects. I share the article's concern that the greatest risk lies in delegating essential cognitive operations and deep information processing to AI due to an insufficient understanding of how learning works. Moreover, there are learners whose difficulties lie elsewhere and who may not even reach the stage of problematic AI use – for them, a specialist AI, which does not yet exist, could possibly become a powerful form of support.

The transformation of the entire learning process.

AI in education resembles both the Covid-19 pandemic and the Trojan horse – it cannot be ignored and makes it impossible to continue as before, yet it also holds the potential to bring long-awaited changes to learning processes that have long been waiting to enter the education system. An education system that uses AI wisely could resemble an enhanced version of the flipped classroom, but one enhanced by all the insights of modern learning science. Everything pupils do at home should aim to deepen their understanding, not to produce something for submission. Home learning should involve preparing for upcoming lessons through reading, exploration and reflection, building prior knowledge that resides in the learner's mind rather than in something tangible to be submitted, possibly for assessment. This does not mean that pupils should not be encouraged to represent their learning to themselves in various ways, such as through visualisations, questions, conclusions, idea summaries, notes identifying points of confusion, syntheses or derivations. In this process, AI could serve as a valuable discussion partner, helping the learner reach insights through experimentation; the goal is not for AI to think but for it to help the learner think more effectively and deeply. In school, learning would then take the form of co-construction with real human minds – applying knowledge collaboratively or individually to solve complex problems in new contexts. The aim would be to recognise that what was learned at home is not yet fully understood and that applying

knowledge in different contexts exposes gaps in understanding – the point at which genuine learning begins. It is also important to remember that if home learning focuses on the individual construction of knowledge, such as through constructive reading, reflection or curiosity, the workload should not be excessive, as deep learning is both time- and energy-intensive.

Assessment's influence on learning. Finally, we must ask: why do pupils so often focus on performance rather than learning? It is encouraging that assessment principles are currently under review. The grading system used in Estonia today originated in the Russian Empire in the first half of the 19th century.³³ Its preservation is at odds with growing evidence that numerical grading does not promote deep learning, motivation, self-assessment skills, relationships, psychological well-being or a commitment to lifelong learning.³⁴ In the current system, grades inevitably become ends in themselves rather than means. This is reflected in how AI is used today: when assessment practices signal that mistakes are punishable and grades matter more than understanding, and when assignments lack meaning from the learner's perspective, it is hardly surprising that pupils turn to AI to produce flawless results rather than to deepen their knowledge. Pupils do what their learning environment directs them to do. Though we created this situation ourselves, AI now compels us to reconsider how pupils perceive what happens in school – the nature and purpose of learning itself.

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