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AI competency framework for teachers

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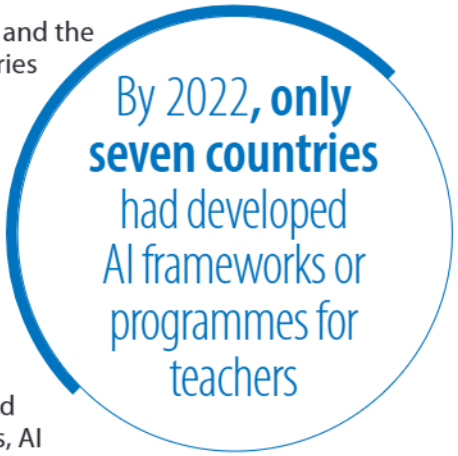
SHORT SUMMARY

Guiding teachers on AI use and misuse in education

AI processes vast information, generates new content, and helps decision-making through predictive analyses. In education, AI has transformed the traditional teacher–student relationship into a teacher–AI–student dynamic.

This shift requires a re-examination of teachers' roles and the competencies they need in the AI era. Yet, few countries have defined these competencies or developed national programmes to train teachers in AI, leaving many educators without proper guidance.



The AI competency framework for teachers addresses this gap by defining the knowledge, skills, and values teachers must master in the age of AI. Developed with principles of protecting teachers' rights, enhancing human agency, and promoting sustainability, the publication outlines 15 competencies across five dimensions: Human-centred mindset, Ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning. These competencies are categorized into three progression levels: Acquire, Deepen, and Create.

As a global reference, this tool guides the development of national AI competency frameworks, informs teacher training programmes, and helps in designing assessment parameters. It also provides strategies for teachers to build AI knowledge, apply ethical principles, and support their professional growth.

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"Since wars begin in the minds of men and women it is in the minds of men and women that the defences of peace must be constructed"

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AI competency framework for teachers

Foreword

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The rapid rise of artificial intelligence (AI) systems is having profound implications for teaching and learning, particularly regarding the role of teachers and the competencies they require to navigate the ever-evolving technological landscape. The use of AI in education is raising fundamental questions about teacher agency and their capacity to determine how and when to make judicious use of this technology.

Teachers urgently need to be empowered to better understand the technical, ethical and pedagogical dimensions of AI. As of 2022, however, only seven countries had developed an AI competency framework or professional development programme for teachers.

This vital new UNESCO AI competency framework for teachers enables countries to fill this gap. The first ever global framework of its kind, it has been designed to inform the development of national AI competency frameworks and professional training programmes for teachers, ensuring that they advance education as a public good.

The framework aligns with UNESCO's mission by advocating for a human-centered approach that integrates AI competencies for teachers with principles of human rights and human accountability. In this way, it responds to the urgent call from the 2021 UNESCO report, *Reimagining our futures together: A new social contract for education*, to help transform humanity's relationship with technology.

The publication builds on UNESCO's previous work in the field, such as the *ICT competency framework for teachers, AI and education: Guidance for policy-makers,* as well as the more recent *Guidance for generative AI in education and research*. It is informed by contributions from a wide range of stakeholders, benefitting from UNESCO Member States' insights on developing and implementing AI school curricula, the expertise of an international working group, four international consultation meetings, and multiple rounds of online consultations.

The AI competency framework for teachers has been developed hand in hand with a competency framework for students. It is my hope that these two frameworks will empower teachers and students to shape the inclusive and sustainable digital futures we want.

In a world characterized by rising complexity and uncertainty, it is our collective responsibility to ensure that education remains the central space for transformation of our shared futures.

Stefania Giannini
UNESCO Assistant Director-General for Education

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List of acronyms and abbreviations

AI	Artificial intelligence
AI4K12	Artificial intelligence for K-12
AI4T	AI for teachers
CFT	Competency framework for teachers
CG	Curricular goal
EI	Education International
EU	European Union
GDPR	General Data Protection Regulation
ICT	Information and communication technology
IT	Information technology
LMS	Learning management system
LO	Learning objective
MOE	Ministry of Education
MOOC	Massive open online course
NETS	National Educational Technology Standard
UNESCO	United Nations Educational, Scientific and Cultural Organization

Chapter 1: Introduction

1.1 Why an AI competency framework?

There are significant implications of artificial intelligence (AI) for education, teaching and learning, and for teachers' roles and competencies. Indeed, AI can process vast amounts of information and text far beyond any human capacity and can produce new content across the range of symbolic representations of human thinking, identify patterns in data presented in various formats, and can facilitate human decision-making by predictive analyses. Emerging practices in the use of AI in education clearly demonstrate the potential of AI to enable new forms of teaching, learning and education management and enhance learning experiences and support teacher tasks.

However, AI can pose significant risks to students, the teaching community, education systems and society at large. AI may threaten human agency, intensify climate change, violate data privacy, deepen long-standing systemic inequalities and exclusion, and lead to new forms of discrimination. In education, AI can reduce teaching and learning processes to calculations and automated tasks in ways that devalue the role and influence of teachers and weaken their relationships with learners. It can narrow education to only that which AI can process, model and deliver. Finally, it can also exacerbate the worldwide shortage of qualified teachers through disproportionate spending on technology at the expense of investment in human capacity development.

The use of AI in education therefore requires careful consideration, including an examination of the evolving roles teachers need to play and the competencies required of teachers to make ethical and effective use of AI. Teachers are the primary users of AI in education, and they are expected to be the designers and facilitators of students' learning with AI, the guardians of safe and ethical practice across AI-rich educational environments, and to act as role models for lifelong learning about AI. To assume these responsibilities, teachers need to be supported to develop their capabilities to leverage the potential benefits of AI while mitigating its risks in education settings and wider society.

National educational authorities need to dynamically review and redefine teachers' roles and required competencies, strengthen teacher-training institutions, and establish appropriate capacity-building programmes to prepare teachers to work with AI in an effective and ethical manner. Yet, according to a recent survey (UNESCO, 2023*a*), only seven countries had developed frameworks or programmes on AI for teachers in 2022. This can be largely explained by the lack of knowledge on how to define teachers' roles and competencies in the context of growing human–AI interactions in educational and pedagogical practices.

This AI competency framework for teachers (AI CFT) is intended to support the development of AI competencies among teachers to empower them to use these technological tools in their teaching practices in a safe, effective and ethical manner. The framework is based on a human-centred approach to the knowledge,

understandings, and skills required to do so. It maintains that while AI offers opportunities to support teachers in both teaching as well as in the management of learning processes, meaningful interactions between teachers and students and human flourishing should remain at the center of the educational experience. Teachers should not and cannot be replaced by technology – it is crucial to safeguard teachers' rights of and ensure adequate working conditions for them in the context of the growing use of AI in the education system, in the workplace and in society at large.

1.2 Purpose and target audience

The AI CFT targets teachers who need to apply AI to facilitate learning in core subject areas. It is not designed for teachers who are specialized and tasked to teach advanced AI knowledge and skills. While the five aspects and three mastery levels of the AI CFT presented below can provide a basis to define AI teachers' competencies, the depth and breadth of these need to be further refined in accordance with the higher-level demands required of teaching AI as a specific subject.

The AI CFT is designed to guide the proactive, continuing professional development and learning of teachers for a human-centred approach to the adoption of AI in education. The specific objectives of the AI CFT are to offer a reference framework that helps shape national, state-level or institutional AI competency frameworks or training programmes for teachers; to provide an operational framework to teacher educators for the design and planning of training courses on AI; and to establish a benchmarking matrix for the assessment of teachers' AI competencies and professional learning regarding the use of AI. As such, the framework is designed for policy-makers, teacher education providers, teachers' unions, school leaders, teachers and educational experts.

1.3 Alignment with the ICT competency framework for teachers

The AI CFT is aligned with, and complements, the 2018 *UNESCO ICT competency Framework for Teachers* (ICT CFT) which remains relevant in supporting teachers to grow their capacities for teaching and professional learning with ICT and digital technologies.

The structure of the AI CFT, as presented in Chapter 3, follows that of the ICT CFT. Both frameworks are underpinned by a vision that aims to empower teachers with the competencies required to appropriately leverage technology in education. The two frameworks share a common architecture with a comprehensive approach to teachers' professional development across the pre-service, in-service and ongoing support stages, thereby ensuring continuous progression and practical integration of ICT and AI tools. By mirroring the holistic approach of the ICT CFT in its organization, the AI CFT also suggests the enabling technology and policy environments needed for effective support of teachers' continuous professional learning. These enabling environments comprise inclusive access to connectivity and content, human-centred policies, conducive curriculum and assessment systems, inter-sectoral support for teachers, and engagement with teaching communities.

1.4 Technological advances in AI and implications for teacher competencies

The AI CFT is aligned with the ICT CFT but goes further by considering the implications for teacher competencies of technological advances that have occurred since previous generations of ICT tools were adopted, manifested by AI technologies.

In its most basic form, what makes AI distinct from other forms of digital technologies is its capacity to mimic human behaviour. This unique feature challenges human agency. Indeed, where previous generations of ICT tools focus more on facilitating routine tasks, AI tools tend to replace human decision-making based on predictions of patterns drawn from the analysis of extensive data of past examples. There is consequently a risk that over-reliance on AI could lead to the atrophy of teachers' essential competencies. This potential of AI to usurp the autonomous decision-making capacity of teachers necessitates a stronger emphasis on teacher agency and on a human-centred mindset that can help ensure that the use of AI serves human capacity development.

The mining of data for training AI systems threatens personal data privacy. The previous generations of ICT tools were designed to transfer or share information and tend to remain responsive to users' manual operation of the tools. In contrast, the data mining behind the design of AI platforms involves actively preying on and exploiting personal data, often without consent. Moreover, the tacit commercial rule behind the providers of AI systems lures users into foregoing a certain degree of their privacy when registering for the 'benefits' of AI services. While the previous generations of ICT tools had raised some ethical concerns around privacy and security, the aggressive approach to the design and provision of AI services has triggered more profound risks and could deepen societal inequalities. This more fundamental and controversial technological advance heightens the urgency of empowering teachers to understand the ethical issues related to interacting with various AI tools in their teaching, in order to ensure safe and responsible use among students.

In its current methods of generating outputs, AI-generated content is more likely to be stochastic. Prior generations of ICT tools tended to be deterministic, with the same inputs always leading to the same outputs. Recent AI tools, on the other hand, are more likely to be stochastic in generating outputs or predictions, as the same inputs may lead to different outputs. The AI-generated content is thus potentially less trustworthy, especially for the teaching of factual and conceptual knowledge. Given the opaqueness of the 'black box' behind the methods used in AI, teachers need both an understanding of how AI is trained and how AI works. They also need the capacity to critically examine the accuracy of AI outputs and to design appropriate pedagogical methodologies to guide the use of AI-synthesized content in teaching and learning.

AI systems are adaptive to diverse problem spaces. As a result, they offer general-purpose foundation models that have the potential to drive transformation across various sectors. Generative AI, in particular, provides foundation models that can support the further training of domain-specific AI models and the customization of personalized tools. As a result of its more dynamic adaptivity, AI technology has the potential to alter business models, as well as social and personal practices. In view of the transformative potentials of AI, it is important to guide teachers to understand its social impact and the responsibilities of citizenship in emerging AI societies, and to motivate and support them through continuous professional learning.

Chapter 2: Key principles

2.1 Ensuring inclusive digital futures

Ensuring equitable and inclusive digital futures in the era of AI must be grounded in a solid human and social foundation. Teachers are the primary users of AI in education and the key mediators in ensuring adequate redefinition and balance in the evolving relationship between humans and technology, in general, and knowledge and learning, in particular. The AI CFT therefore aims to help teachers decipher the multi-layer and multi-perspective foundational values and attitudes towards human–AI interaction, beginning with four main tenets:

- **Debunking AI hype:** The design and use of AI is human led. Those who create AI systems and tools can determine whether, and to what extent, it will be endowed with emancipatory potentials to protect and enhance human capacities or, on the contrary, be embedded with malicious aims and/or unintended biases that violate human rights and undermine human agency and capacity. Teachers need to have the critical capacity to assess the potential positive and negative impacts of AI. They need to be aware that only intentionally ethical design ('ethics by design'), and well-regulated deployment of AI, can genuinely advance human capabilities, inclusivity and sustainability.
- **Understanding threats inherent to the design of AI:** Current algorithmic pathways and models of AI present acute challenges to human rights and privacy. Moreover, AI-generated content has been undermining indigenous knowledge, cultures and languages. Teachers need to understand how AI systems are designed and how AI models work, in order to be able to protect human agency, linguistic and cultural diversity, and indigenous knowledge.
- **Ensuring human and social values prevail:** Profit-driven algorithms also weaken social values and cohesion by promoting isolation of individuals from the real world and from others. Values of empathy, altruism, justice, intercultural compassion and solidarity are essential for social cohesion and to uphold our common humanity. AI and other digital technologies must not discourage people from staying in contact with others and with the real world, as well as from respecting rights to ways of living and knowing beyond digital spaces.
- **Steering AI for human capacity development:** The use of AI in education without appropriate pedagogical guidance may weaken the intellectual development of students. The aim of using AI in education should move beyond merely providing access to information and standardized responses, towards inquiry enrichment, intellectual development and capacity empowerment.

2.2 A human-centred approach to AI

A human-centred approach to AI in education is critical – an approach that promotes key ethical and practical principles to help regulate and guide practices of all stakeholders throughout the entire life cycle of AI systems. These human-centred principles regarding the use of AI in education have been iteratively articulated through UNESCO's *Recommendation on the Ethics of Artificial Intelligence* (2022*a*) as well as various policy guidance tools, including the *Beijing Consensus on Artificial Intelligence and Education* (UNESCO, 2019), *AI and education: Guidance for policy-makers* (UNESCO, 2022*b*), and *Guidance for generative AI in education and research* (UNESCO, 2023*b*). The approach encompasses four core principles: the design and use of AI should be at the service of strengthening human capacities as well as sustainable development; access to, and deployment of AI, should be equitable and inclusive; AI models in use should be explainable, safe and do no harm; and finally, the selection, use and monitoring of the impact of AI should be human controlled and human accountable.

The implementation of a human-centred approach requires regulators, providers of AI and institutions to be co-responsible for governance before requiring teachers to apply principles applicable for their profession. In this context, the AI CFT expands on these principles in the following way, emphasizing teacher mindsets and the ethics of AI:

- **Empowering teachers' human-accountable use of AI:** The ethical and legal responsibilities for designing and using AI should be attributed to individuals. In the specific context of AI competencies for teachers, this human-accountable principle implies that AI tools should not replace the legitimate accountability of teachers in education. Teachers should remain accountable for pedagogical decisions in the use of AI in teaching and in facilitating its uses by students. For teachers to be accountable at the practical level, a pre-condition is that policy-makers, teacher education institutions and schools assume responsibility for preparing and supporting teachers in the proper use of AI.
- **Promoting inclusivity:** Structural exclusion and discrimination are often embedded in the design and use of AI. Teachers should be mindful of potential algorithmic biases. Within the scope of their duties, teachers need to ensure that AI is used in an inclusive manner by and for all students, regardless of their gender, ethnicity, abilities or socio-economic or migration status. Teachers should also be supported to promote social inclusion and cultural pluralism when exploiting AI.
- **Recognizing users' right to question the explainability of AI tools:** AI models used to generate responses that appear reliable or convincing may not be explainable and may be riddled with hidden risks. The AI CFT equips teachers with skills and knowledge, appropriate for the scope of their pedagogical responsibilities, to understand and critically evaluate AI tools, including their explainability and safety. This can enable teachers to understand how AI reaches its conclusions, making it possible to critically assess its use and intervene when necessary.

- **Understanding and monitoring the human-controlled impact of AI:** Teachers need to be aware that AI is human-led and the decisions of designers have impacts on human rights, dignity, and social and environmental well-being. The AI CFT is intended to develop teachers' awareness of the design intent behind AI tools, and their ability to harness the benefits of AI while controlling, within the remit of their role, the possible adverse impacts of AI applications on students' learning and well-being.

2.3 Protecting teachers' rights and iteratively (re)defining teachers' roles

To uphold social values and accountability in the AI era, it is also essential to recognize the indispensability of interaction and collaboration between teachers and learners as being at the core of education. AI tools should never be designed to replace the legitimate accountability of teachers in education. When introducing AI in education, legal protections must be established to protect teachers' rights, and long-term financial commitments need to be made to ensure inclusive access by teachers to technological environments and basic AI tools as vital resources for adapting to the AI era.

Given the potential AI holds to transform teaching and learning, policy-makers should urgently review and iteratively (re)define teachers' roles and required competencies. Appropriate capacity-building programmes are needed to prepare teachers to work in increasingly AI-rich settings. With the emerging capabilities of AI tools in assisting decision loops and generating content, the interaction between teachers and students is arguably becoming triangular, as AI systems are increasingly mediating preparation, teaching, learning and assessment. Teachers therefore need to be empowered to act as collaborative knowledge producers and as guides to citizenship in the era of AI. To help teachers explore and take on these new roles, the AI CFT is designed to nurture their human-centred awareness of the social impacts of AI, as well as their capacity to adapt to and accommodate the evolving nature of AI in education.

2.4 Promoting trustworthy and environmentally sustainable AI for education

It is imperative to validate the safety and trustworthiness of AI systems in education before making teachers responsible for compliance with ethical principles. An 'ethics by design' principle should be mandated through strict validation of AI tools at the national and/or institutional levels before they are adopted in educational settings. This prior validation, and the legal whitelisting of trustable AI tools for education, can relieve teachers from being held accountable for ethical governance beyond their role and/or capacities. Aligned with the aforementioned core values, the validation procedure should attach priorities to the following principles:

- **Mandating the 'do no harm' principle:** Validation should mandate the 'do no harm' principle and the requirement that all AI tools used in education have been designed with a clear understanding of their potential impacts on human rights, dignity, safety, social well-being and environmental sustainability.
- **Prioritizing environmentally-friendly AI tools:** The principle of 'do no harm' should emphasize the environmental costs of AI, particularly the way in which its life

cycle and value chain might harm the environment and exacerbate the climate crisis. This understanding of the carbon emissions of AI is crucial for teachers and is instrumental to their students' awareness of climate change.

- **Validating trustworthy AI for educational purposes:** A strict validation mechanism should also be designed to validate AI systems that are inherently reliable and safe for educational purposes, including for students with special needs. Such AI systems should be free from malicious intent and/or harmful consequences, robust and resilient to manipulation, and able to protect learners' privacy and sensitive personal data. The age-appropriateness and pedagogical utility of AI tools should also be examined and validated before being adopted at scale.
- **Human accountable design and development:** educational institutions and technology providers should be held accountable for the transparency and explainability of the performance, outcomes and impacts of AI.

2.5 Ensuring applicability for all teachers and reflecting digital evolution

AI literacy and access may be considered part of basic rights in the AI era and AI competency is becoming one of the prerequisites for the teaching profession. The AI CFT is therefore designed to be inclusive and universally applicable for all teachers, across diverse educational contexts, acknowledging the varying levels of digital expertise they may possess. The framework specifies a progressive approach to the planning of training programmes that can help all teachers – including those without prior knowledge of AI – to grow gradually from basic to more advanced levels of understanding and skill mastery.

The framework is intended to be a universally applicable reference for the specification of national/local AI competencies, as well as for the planning of curricula, training programmes and for ensuring basic enabling environments. These should ensure that all teachers, regardless of their starting point, are afforded the opportunity to advance their understanding and application of locally accessible and affordable technology, from unplugged and low-tech solutions to AI-rich settings.

The dynamic nature of digital technology and the technological leaps from previous generations of ICT tools to AI technology must be accounted for. The framework consequently offers guidance and resources that enable teachers to transition confidently from the use of previous generations of digital technologies to more recent AI systems and tools.

Given the novel ethical issues triggered by AI and the potentially transformative opportunities AI may provide, it is crucial to equip teachers with the human-centred mindset, ethical behaviours, conceptual knowledge and application skills needed to make use of AI to enhance students' learning and their own professional development. The framework is designed to foster transferable competencies across learning contexts, including the capacity to respond effectively to the rapid upgrading of AI technologies and their evolving implications for education.

2.6 Lifelong professional learning for teachers

Teacher development should be considered as a continuous and lifelong journey of professional growth that spans a teacher's entire career and life experiences. The AI CFT advocates the following holistic approach to support teachers' continuous learning:

- **Navigate personal progression through transferable competencies:** Given the rapid expansion of AI technologies, the complexities of corresponding ethical issues, and the challenges of integrating AI in pedagogy, teachers should be assisted to progressively advance their AI competencies. The AI CFT outlines competencies at multiple levels to guide this progression and suggests training methodologies to help teachers remain conversant with the emerging technologies and their broader implications for pedagogy, ethics as well as their societal impact.
- **Guide continuous reflection and improvement of practical performance:** Lifelong learning entails consistent reflection and enhancement of one's own practice. The AI CFT proposes reviews of exemplar lessons, reflection on teachers' own knowledge and practices, and internalization of values and understanding. It further encourages teachers to iterate cycles of lesson design, implementation, reflection and redesign.
- **Streamline training and support programmes:** Lifelong professional learning needs coherent training and support. The AI CFT advocates the institutional streamlining of programmes for pre-service preparation, in-service training and ongoing coaching to facilitate teachers' learning at different stages of their career. It emphasizes the creation and nurturing of professional development communities and organizational capacity-building, champions peer-coaching and agile learning in response to the evolution of AI technologies, and promotes a human-centred approach in education.
- **Adapt policies to support lifelong professional learning:** Conducive policies and incentive strategies are essential to maintain teachers' motivation to undertake lifelong professional learning. Teacher management policies should allocate sufficient time and resources for teachers to engage in training and professional development activities, as well as recognize or reward their performance in making responsible and innovative use of AI. Furthermore, broad curriculum and assessment systems need to be adapted to allow space for teachers' pilot tests of validated AI tools and new pedagogical methodologies. It is also necessary to review whether current assessment methods excessively circumscribe the leveraging of human-centred potentials of AI for education and, if so, determine how they can be reformed.

Chapter 3: Structure of the AI competency framework for teachers

3.1 Dimensions of the AI CFT

The AI competency framework for teachers is presented in a two-dimensional matrix: five aspects of competency which evolve across three progression levels, forming fifteen blocks as shown in **Table 1**.

The first dimension comprises the five aspects of AI competency, shown in the leftmost column of the table. Competency aspects stand for the interlinked key elements of knowledge, skills, values, and attitudes that teachers need to develop in order to integrate AI effectively and ethically into their teaching practices, in the facilitation of learning, and in professional development. These five aspects, which are detailed further in the next section, are a human-centred mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional development. While each aspect represents a unique constituent element of AI competency, the aspects are related to each other as they are complementary, interdependent and synergistic. Their relatedness contributes to the cohesive growth of AI competence.

- The **Human-centred mindset** aspect defines the values and attitudinal orientation towards human–AI interactions that teachers need to nurture.
- The **Ethics of AI** aspect delineates essential ethical principles, regulations, institutional laws and practical ethical rules that teachers need to understand, apply and help adapt.
- The **AI foundations and applications** aspect specifies conceptual knowledge and transferable skills teachers need to understand and apply in selecting, applying and creatively customizing AI tools to serve student-centred, AI-assisted teaching and learning environments.
- The **AI pedagogy aspect** proposes a set of competencies required for purposeful and effective AI–pedagogy integration. This covers the ability to validate and select proper AI tools and to integrate them into pedagogical strategies to support course preparation, teaching, learning, socialization, social caring and learning assessment.
- The **AI for professional development** aspect outlines competencies teachers need to develop in order to use AI properly in driving their lifelong professional learning, supporting collaborative professional development and exploring professional transformation.

The AI CFT's second dimension, shown along the top of **Table 1**, is the scaffolded progression of competency development. Progression levels represent the levels teachers could possibly develop over time in all five competency aspects as part and parcel of AI competency. The framework recognizes that competence development is

a complex, context-dependent process that is neither hierarchical nor linear. However, the framework serves as a reference pathway for teacher progression, emphasizing and outlining desired outcomes at each level per aspect rather than setting out rigid, prescribed steps that teachers must go through. The three progression levels are: 'Acquire', which defines the essential set of AI competencies all teachers need in order to evaluate, select and use AI tools appropriately in education; 'Deepen', which specifies intermediate competencies that are needed to design meaningful pedagogical strategies that integrate AI; and 'Create', which sets out advanced competencies required for the creative configuration of AI systems and innovative use of AI in education.

By crossing these three levels with the five aspects of competency, the AI CFT defines fifteen competency blocks. These competency blocks are designed to support all teachers – from those with no knowledge at all about AI, to those with a higher degree of competency and experience in AI.

Table 1. The AI competency framework high-level structure: aspects and progression levels

Aspects	Progression		
	Acquire	Deepen	Create
1. Human-centred mindset	Human agency	Human accountability	Social responsibility
2. Ethics of AI	Ethical principles	Safe and responsible use	Co-creating ethical rules
3. AI foundations and applications	Basic AI techniques and applications	Application skills	Creating with AI
4. AI pedagogy	AI-assisted teaching	AI–pedagogy integration	AI-enhanced pedagogical transformation
5. AI for professional development	AI enabling lifelong professional learning	AI to enhance organizational learning	AI to support professional transformation

The AI CFT proposes a set of competencies around which teachers need to be prepared to make proper use of AI in education. However, the effective and ethical use of AI in education depends on various factors including, but not limited to, access to digital infrastructure, and to the internet in particular; availability of AI resources; regulations on data security and privacy; policy guidance and incentives; and professional development opportunities. It is also contingent on the trustworthiness and performance features of the AI tools that are adopted at scale and their implications for teachers' workloads. All of these, and potentially other factors, would likewise affect the extent to which teachers' AI competency can be practised, observed and advanced. The strategies for putting in place relevant enabling conditions are discussed in Chapter 5.

3.2 Aspects of the AI CFT

The five aspects of the AI CFT are intended to cover essential domains of the competencies and reflect their complementary relationships. When training programmes are designed to help teachers progress from 'Acquire' to 'Create', all five aspects should be targeted and integrated as a part of the expected competency development. The main components of the five aspects are summarized below.

3.2.1 Aspect 1: Human-centred mindset

The human-centred mindset defines the values and critical attitudes teachers need to develop towards human–AI interactions based on the aforementioned principles. This aspect encourages teachers to always put human rights and needs for human flourishing as the focus of AI in education. Teachers are encouraged to nurture critical methodologies to evaluate the benefits and risks of AI, while ensuring human agency and human accountability, and understanding AI's societal impact and implications for citizenship in the era of AI.

3.2.2 Aspect 2: Ethics of AI

Ethics of AI delineates the essential ethical values, principles, regulations, institutional laws and practical ethical rules that teachers need to understand and apply, drawn from the rapidly expanding body of knowledge on the ethics of AI and their implications for education. This aspect defines teachers' progressively deeper understanding of fundamental ethics of AI, skills to make safe and responsible use of AI, and comprehensive competencies to participate in the adaptation of ethical rules.

3.2.3 Aspect 3: AI foundations and applications

AI foundations and applications specifies the conceptual knowledge and transferable operational skills that teachers need to understand and apply in order to support their selection, application and creative customization of AI tools to build student-centred AI-assisted teaching and learning environments. Teachers are expected to gain appropriate understanding of the definition of AI, basic knowledge about how AI works, as well as about the main categories of AI technologies; the skills necessary to evaluate appropriateness and limitations of AI tools based on specific needs in specific domains and contexts; and the skills to operate validated tools for real-world tasks; progressively, it involves skills to adapt or customize AI tools to build human-centred and age-appropriate learning environments.

3.2.4 Aspect 4: AI pedagogy

AI pedagogy proposes a set of competencies required for purposeful and effective AI–pedagogy integration, covering comprehensive competencies to validate and select appropriate AI tools and integrate them with pedagogical methods to support course preparation, teaching, learning, socialization, social caring and learning assessment. This aspect implies that teachers need to develop the ability to critically assess when and how to use AI in teaching and learning in an ethical and human-centred manner, as well as to plan and implement inclusive AI-assisted teaching and learning practices. Progressively, teachers need to enhance their capacity to critically adapt and creativity explore innovative practices in the context of advancing capabilities of emerging AI iterations.

3.2.5 Aspect 5: AI for professional development

AI for professional development outlines the emerging competencies teachers need to build in order to use AI to drive their own lifelong professional learning and collaborative professional development in view of transforming their teaching practice. In response to the rapid development of AI, teachers need guidance on how to continue their professional development in educational settings characterized by growing human–AI interaction. This includes the ability to leverage AI to assess professional learning needs and nurture motivation for lifelong learning and professional collaboration. Progressively, teachers are expected to enhance their ability to adapt and create when using AI tools and data analytics to support transformative professional development.

These five aspects are intertwined and complementary, not isolated. In general, effective teaching (with or without AI) requires a holistic approach that integrates various competencies. For example, a teacher's ability to apply AI pedagogy is influenced by their understanding of AI foundations, their awareness of AI policy guidance, and their commitment to continuous professional development. Similarly, their ability to navigate the ethical dilemmas of AI is informed by their understanding of AI foundations and their experiences in applying AI in education. Proficiency in one area can enhance proficiency in another. Indeed, a deeper understanding of the foundations of AI can improve a teacher's ability to apply pedagogical and ethical principles related to AI, and continuous professional development builds a teacher's understanding of all of these aspects.

3.3 Progression levels of the AI CFT

The progression levels of the AI CFT are designed to help assess teachers' existing AI competencies and to define expected professional learning objectives. Theoretically, the training and support at the 'Acquire' level targets teachers with limited or no prior AI knowledge or skills. Indeed, all teachers should have opportunities to access this level of training or guidance in order to acquire the most fundamental set of competencies specified in the framework. In other words, the first level aims to foster basic AI literacy for teachers. The 'Deepen' level targets teachers who already have some knowledge of AI and some experience of using it in education. This level aims to support teachers to engage more deeply with AI tools in order to maximize their capacity to enhance teaching and learning practices. The third level, 'Create', is for teachers who have strong AI knowledge and skills as well as rich experience in using AI in education. This level aims to foster expert teachers who have the competencies to explore the ethically and pedagogically sound, transformative application of AI in teaching and learning.

The three progression levels constitute a 'to-be-scaffolded' roadmap of professional development for teachers. It meticulously benchmarks the starting point of teachers and delineates the next level of learning objectives and thereby maps the difficulty and breadth of the training programmes. When using the AI CFT as a reference framework to evaluate teacher competencies, it is worth keeping in mind that each level is cross-cutting with all five competency aspects (as shown in **Table 1**). Progression in one aspect is expected to influence development in another, reflecting the aforementioned complementary, interdependent and synergistic nature of the five aspects. It is to be noted, however, the

teachers' progression will likely not follow a synchronous sequence across all five aspects. For instance, a teacher might demonstrate competence in AI foundations at the 'Deepen' level, while still working on ethics at the 'Acquire' level. Diagnostic tools to assess individual teachers' AI competencies should consequently be designed to map their strengths and weaknesses in each of the aspects and personalize training priorities and learning pathways.

3.3.1 Progression level 1: Acquire

'Acquire' is a rudimentary level of learning and the initial level of practical AI use, encompassing the essential set of AI competencies required by all teachers to evaluate, select and exploit AI tools effectively and ethically in their practice. At this level, teachers embark on acquiring and utilizing the most fundamental knowledge and skills to use AI. They are expected to learn to recognize both the benefits and risks associated with AI in education, underpinned by an understanding of human rights, social justice, and humanistic values. Teachers should also be expected to gain awareness of the essential ethical principles related to AI, acknowledging its human-led nature and the critical role humans play in its development. Additionally, at this stage, teachers should be equipped to apply basic AI techniques and locally accessible applications. In addition, teachers are expected to foster an appreciation of how AI can potentially bolster or diminish the quality of teaching. This foundational level of AI literacy also sets the stage for educators to integrate AI into their professional development.

In general, this level of AI competencies for teachers can be summarized as a set of 'teachers' AI literacy'. Supported by appropriate training and guidance, all teachers are expected to be able to:

1. **Cultivate** a critical understanding that AI is human-led and that the corporate and individual decisions of AI creators have a profound impact on human autonomy and rights. This critical understanding implies an awareness of the importance of human agency when evaluating and using AI tools.
2. **Develop** a basic understanding of typical ethical issues related to AI and to human–AI interactions as they relate to the protection of human rights, personal data, human agency, and linguistic and cultural diversity, and advocate for inclusion and environmental sustainability.
3. **Acquire** basic knowledge about what AI technology is and how AI models are trained, associated knowledge on data and algorithms, the main categories of AI technologies and examples of each, as well as the basic capacity to assess the appropriateness of specific AI tools for education and to use validated AI tools.
4. **Identify** and leverage the pedagogical benefits of AI tools to facilitate subject-specific lesson planning, teaching and assessment while mitigating the risks.
5. **Explore** the use of AI tools to enhance their professional development and reflective practices, assess their learning needs and personalize their learning pathways in the rapidly evolving educational landscape.

3.3.2 Progression level 2: Deepen

At the 'Deepen' level of AI competency, teachers are expected to demonstrate proficiency in integrating AI into educational practices with a focus on human accountability as well as ensuring safe and responsible use of AI tools. This entails adhering to national and local policies, upholding the safety, privacy and rights of stakeholders, and critically assessing AI tools for ethical implications. Teachers are expected to champion equity, inclusion and diversity, and understand how AI design decisions impact ethical use. Furthermore, at this level, teachers should have the skills to identify, evaluate, select and apply AI tools to enhance teaching and learning practices. They must also be adept at incorporating human-centred pedagogical strategies and use AI to enrich their professional development and peer-learning within their organizations.

Teachers who have reached this mastery level of AI competencies at this level are expected to be able to:

1. **Demonstrate** a deepened understanding of human accountability and human determination in the proper deployment and use of AI. This implies a critical mindset of AI's capacity to facilitate human–AI decision loops, as well as of overhyped claims on the use of AI to substitute humans in making high-stakes decisions in education.
2. **Internalize** essential ethical rules for the safe and responsible use of AI including respecting data privacy, intellectual property rights, as well as other legal provisions, and adopt this ethical perspective when assessing and using AI tools, data and AI-generated content in education.
3. **Proficiently** operate AI tools adopted in educational settings, deepening knowledge and understanding – in an ethical perspective – of various categories of AI technologies as well as of data and algorithms as relevant to teaching responsibilities and background competencies.
4. **Adeptly** integrate AI into the design and facilitation of student-centred teaching practices to foster engagement, support differentiated learning and enhance teacher–student interactions, with aims of promoting students' empathy, critical thinking and problem-solving skills.
5. **Confidently** utilize AI tools for tailored participation in collaborative professional learning communities, leveraging them to share resources, engage in peer-to-peer learning, and contribute to dynamic adaptation.

3.3.3 Progression level 3: Create

At the 'Create' level of AI competency, teachers demonstrate a critical understanding of both the social impact of AI and of their citizen responsibilities. They are expected to contribute to the planning of policies on AI in education and/or the co-creation of ethical standards for the use of AI tools. Teachers at this level should be able to combine or modify open-source or customizable AI toolkits to develop tailored solutions to educational challenges in local contexts. This extends to critically assessing AI's role in teaching and learning processes and exploring AI-enhanced pedagogical activities that can potentially enable open learning options for students. Furthermore, teachers should be able to use AI to support their own continuous and/or transformative professional development and synthesize AI tools to meet the evolving needs of their professional communities.

Teachers who have reached this mastery level are expected to be able to:

1. **Actively** participate in and contribute to the building of inclusive AI societies guided by a critical understanding of the implications of AI for societal norms, and to promoting the design and use of AI for the enhancement of human welfare, inclusion and social justice.
2. **Champion** the ethics of AI through critical advocacy and empathy, leading discussions and actions that address ethical, sociocultural and environmental concerns from design to the use of AI and contribute to the co-creation of ethical standards for AI practices in education.
3. **Proficiently** customize or modify AI tools, applying enhanced conceptual knowledge and skills to create AI-assisted inclusive learning environments and address broader challenges in educational contexts.
4. **Critically** assess AI's impact on teaching, learning and assessment; plan and facilitate AI-immersed learning scenarios to support subject-specific or interdisciplinary learning, critical thinking and problem-solving among students; and leverage data and feedback to continuously explore student-centred pedagogical innovation.
5. **Customize** and modify AI tools to enhance their professional development and continuously test and validate strategies on the effective use of AI to meet their own and their communities' transformative professional development needs.

Chapter 4: The AI CFT specifications

This chapter provides detailed specifications on curricular goals and expected learning objectives that teacher training or support programmes can devise for each of the fifteen competency blocks. These goals and objectives are further illustrated by examples of activities teachers are expected to perform in various contexts, including in subject-specific and/or interdisciplinary teaching practices.

4.1 Progression level 1: Acquire

The overall curricular goal in the 'Acquire' level is to support all teachers to reach a basic level of AI competency or literacy required by the teaching profession across varied contexts. The following goals, learning objectives and examples of activities provide clarity as to what each competency block entails:

Table 2. Competency blocks, objectives and examples for progression level 1: Acquire

Progression level 1: Acquire				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
Human-centred mindset	**1.1 Human agency:** Teachers have a critical understanding that AI is human-led, and that corporate and individual decisions of AI creators have a profound impact on human autonomy and rights, and are aware of the importance of human agency when evaluating and using AI tools.	CG1.1.1 Foster critical thinking on AI by organizing teachers to discuss and take perspectives on the dilemma of benefits offered by AI versus the risks of diminishing human autonomy and human agency; use specific AI tools as examples to support teachers to critically examine the benefits, limitations and risks of AI in local educational settings and with respect to their own responsibilities. CG1.1.2 Illustrate key steps in the life cycle of AI systems and guide teachers to understand how corporate and individual decisions of creators may affect the impact of AI. CG1.1.3 Highlight how overreliance on AI can undermine thinking skills and human agency. CG1.1.4 Offer practices of writing basic tips to help protect human agency when using AI in education, with a specific focus on students with special needs.	LO1.1.1 Critically reflect on the benefits, limitations and risks of specific AI tools in their local educational settings and the subject areas and grade levels they teach. LO1.1.2 Demonstrate an awareness that AI is human-led and the corporate and individual decisions of AI creators affect the impacts on human rights, human agency, individual lives, and societies. LO1.1.3 Outline the role of humans in the basic steps involved in AI development, from the collection and processing of data to the design of algorithms and functionalities of an AI system, to the deployment and use of AI tools. LO1.1.4 Understand the need to use basic measures to protect human agency in key steps regarding the design and use of AI systems by ensuring respect for data ownership, collection of data with consent, anti-bias data labelling and cleaning, discrimination-free AI algorithms, and user-friendly functions and interfaces.	**Unpack hype around AI:** Critically examine hype around concrete AI tools through basic risk-benefit analysis and by highlighting the central role of humans in using AI tools. **Understand why some AI tools should be banned:** Demonstrate a basic understanding of why some AI tools should be banned given their potential to diminish human agency and threaten human rights. **Spotlight risks**: List the potential ways in which teachers' and students' agency may be undermined by certain AI tools, as is the case, for example, with the use of large language models for essay writing. **Know basic dos and don'ts:** Write daily tips to promote human agency when using AI in teaching and to encourage student agency in harnessing and assessing AI.

Acquire				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
Ethics of AI	**2.1 Ethical principles:** Teachers have a basic understanding of ethical issues surrounding AI and of the principles required for ethical human–AI interactions including protection of human rights, human agency, promotion of linguistic and cultural diversity, inclusion and environmental sustainability.	CG2.1.1 Surface ethical controversies through a critical examination of use cases of AI tools in education. CG2.1.2 Facilitate an understanding of essential ethical principles through an examination of use cases related to each of the core ethical principles. Guide teachers to understand why these principles are essential and how neglecting them may cause harm. These principles are encapsulated in the following six subtopics: 'do no harm'; proportionality; non-discrimination; sustainability; human determination in human–AI interaction; and transparency and explainability. CG2.1.3 Build an association between ethical principles and standards through examples of local, national or international regulations regarding the ethics of AI; discuss the implications for individuals and explain how core ethical principles are contextualized in local or national regulatory frameworks. CG2.1.4 Advocate for inclusivity in the use of AI and guide teachers to discuss the risks that specific AI tools can pose to inclusion and equity, including in educational contexts, and with special attention to learners who have disabilities and/or are from marginalized groups; guide teachers to discuss how these risks can be mitigated at the individual level.	LO2.1.1 Exemplify fundamental ethical controversies in the use of concrete AI tools, and do so from the perspectives of human agency, security, privacy, and linguistic and cultural relevance. LO2.1.2 Explain the core ethical principles (as listed in CG2.1.2) and internalize them through their personal selection and use of AI. LO2.1.3 Match key articles of regulations with ethical principles and understand their implications for education. LO2.1.4 Prioritize actions to minimize the negative impact of AI on equity and inclusion when using AI tools in education, with particular attention to students who have disabilities and/or are from marginalized groups.	**'Perspective taking' in ethical dilemmas:** Adopt an ethical perspective on the use of AI in schools based on an understanding of multiple dilemmas they pose around privacy, human agency, equity, inclusion, local cultures and languages, and climate change. **Knowledge-mapping of ethical principles:** Apply basic knowledge-mapping tools (such as paper-based worksheets or digital concept-mapping applications) to visualize the connections among the different core principles, responses to associated controversies, their correspondence with regulations, and examples of AI tools used in schools. **Personal observation of local regulations:** Observe whether local AI regulations keep pace with iterations of AI technologies and evaluate applicable regulations by matching them with ethical principles and local contexts. **Biases of AI tools:** Be mindful of biases of AI tools used in schools and their potential to exclude or marginalize persons with disabilities and students from vulnerable groups; report the risks to the institutional managers or responsible agencies.

Acquire				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI foundations and applications	**3.1 Basic AI techniques and applications:** Teachers are expected to acquire basic conceptual knowledge on AI, including: the definition of AI, basic knowledge of how AI models are trained, and associated knowledge on data and algorithms; main categories of AI technologies and examples of each; and the capacity to examine the appropriateness of specific AI tools for education and operate validated AI tools.	CG3.1.1 Adapt the level of difficulty of basic conceptual knowledge on AI according to teachers' responsibilities and prior experience with AI; illustrate how a specific AI tool is developed based on data and algorithms; and explain the basic methods used by AI tools to process data to generate their outputs. CG3.1.2 Support the hands-on operation of AI tools that are relevant to teachers' responsibilities to give a basic understanding of how these tools work; guide them to experience different types of AI tools and help them understand the technological advances of AI from previous generations of ICT tools, as well as the functional features of different categories of AI tools. CG3.1.3 Support users' testing of AI tools by introducing a rudimentary method for analysing the reliability and appropriateness of specific AI tools for local contexts and engaging teachers in trialing of the method. CG3.1.4 Support teachers to establish their own collection of AI tools, starting from recommending basic exemplar tools and guiding them to curate trustable AI relevant to their needs and local contexts with a particular consideration of open-source tools.	LO3.1.1 Demonstrate conceptual knowledge appropriate to their competencies and responsibilities on how AI systems are developed using data, algorithms and computing architecture; acquire relevant understanding and skills on data, algorithms and programming; and exemplify key steps including problem-scoping, design, training, testing, deployment, feedback and iteration. LO3.1.2 Exemplify what AI is and is not, the main categories of AI techniques and AI technologies, the novel capabilities that AI could actualize compared to previous generations of ICT tools, and the core functions of various categories of AI tools. LO3.1.3 Locate and operate AI tools that are necessary for their daily work in local contexts. LO3.1.4 Explain the importance of evaluating AI tools to ensure their accessibility, inclusivity, and reliability; undertake basic analyses of the appropriateness of specific AI tools for education in local contexts with particular attention to the impact on students with special needs. LO3.1.5 Start consolidating a personal collection of trustable AI tools that are necessary for life and work and relevant to the local language and culture. Investigate the extent to which locally relevant open-source AI tools are available or not.	**Conceptual mapping of how AI works:** Start to draw and iteratively update paper-based or digital concept maps showing how AI systems are developed and the workflow of decision-making regarding specific AI tools used in education. **Extension and enhancement of skills:** Extend knowledge on AI tools that are relevant to the teachers' responsibilities. Help them to enhance the fluency and breadth of their existing operational skills or to develop new skills. **'Navigation compass' for selection of AI tools:** Discern which tools are using AI and which ones are not, and the basic comparative advantages and limitations of ICT tools and AI tools used in local contexts. **Collection of appropriate AI tools:** Cooperate with other teachers and school managers to assess the appropriateness of specific tools being used or recommended by AI providers and discuss whether they should be adopted; collect validated AI tools, share open-source tools and start to curate a collection of trustable AI tools.

Acquire				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI pedagogy	**4.1 AI-assisted teaching:** Teachers are expected to be able to identify and leverage the pedagogical benefits of AI tools to facilitate subject-specific lesson planning, teaching and assessment while mitigating the risks.	CG4.1.1 Organize lesson analyses based on exemplar videos of teachers using AI tools in in the classroom; facilitate teachers' understanding of the appropriateness of these tools, including their efficacy, relationship to pedagogical methods, and effects on inclusion for students with different abilities; additionally, guide teachers' self-reflection on AI-assisted lessons they have designed and implemented. CG4.1.2 Encourage teachers to be mindful of scholarly research on the use of AI to support pedagogical activities by exposing them to selected evidence-based studies and reports on the advantages and disadvantages of AI-assisted teaching activities. CG4.1.3 Facilitate the transferability of foundational knowledge and skills on AI to teaching by presenting locally accessible and validated AI tools that are relevant for teachers' local contexts and responsibilities including institutionally deployed AI systems; use the tools to guide teachers to apply their conceptual knowledge and operational skills to the practical uses of AI tools in teaching; guide teachers to learn how to search for and validate appropriate educational AI tools. CG4.1.4 Facilitate the pedagogical validation of AI and instructional design on AI-assisted teaching; recall and strengthen teachers' understanding of domain-specific pedagogical methodologies and basic instructional design methods (e.g. human-agent interaction proposed by UNESCO's Guidance for generative AI in education and research); guide teachers to conduct hands-on practice of the design-implementation-reflection cycle of lessons, including evaluating the appropriateness of AI to support their subject areas at specific grade levels, making decisions on whether AI should be used and which tools may be appropriate, designing and implementing AI-assisted teaching activities including in preparation of teaching materials, delivery, assessments and support for students with special needs, and conducting reflection on lesson design and implementation in accordance with CG4.1.1.	LO4.1.1 Demonstrate familiarity with a human-centred mindset, ethical principles, domain-appropriate pedagogical methodologies and conceptual knowledge on AI to analyse sample lessons and explain their decisions on whether AI should be used, what tools should be used and why. LO4.1.2 Exemplify the main categories of AI systems and applications designed to assist teaching, learning and assessment demonstrating familiarity with their potential and limitations. LO4.1.3 Demonstrate familiarity with the use of basic instructional design methods to guide decisions on whether and when to use AI, and which tools might be appropriate; confidently prepare and implement AI-assisted teaching and assessment, and support for students with special needs. LO4.1.4 Find and use basic educational AI tools and/or operate institutionally deployed AI systems.	**Starting from basic teaching needs:** Delineate basic needs in the preparation and implementation of teaching and learning assessment. Start from basic needs as the first principle to understand whether a specific AI tool is appropriate – to what extent does it meet these needs, add relevant value, or fit the specific needs in question? **Learning by the iterative cycle of 'design–implementation–reflection':** Learn and gradually improve ability to design and deliver appropriate AI-assisted teaching through an iterative loop of analysing exemplar lessons, designing and implementing their own lesson plans, and assessing/reflecting on implementation. **Evaluating effectiveness against needs:** Gain first-hand experience of the limitations, risks and benefits of AI for teaching and learning, based on the results of actual use of AI to meet teaching needs, and the extent to which AI can achieve the expected outcomes.

Acquire				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI for professional development	**5.1 Enabling lifelong professional learning:** Teachers are expected to be able to explore the use of AI tools to enhance their professional development and reflective practices, assess their learning needs, and personalize their learning pathways in a rapidly evolving educational landscape.	CG5.1.1 Nurture teachers' motivation for lifelong professional learning in the AI era by engaging teachers in discussion on the educational implications of the rapid development of AI, the new roles teachers need to play in AI-rich settings, and the new competencies they need to develop; support teachers to understand the value in becoming a lifelong professional learner in the AI era while being aware that their rights and agency should be protected. CG5.1.2 Guide self-assessment on teachers' AI readiness and identify competency gaps using paper-based or AI-assisted self-assessment instruments. CG5.1.3 Build awareness of teacher-facing AI by introducing teachers to general and specific AI tools that can be used to support their professional development with special attention to teachers who have disabilities and/or work with students who do; help teachers learn how to find and use AI tools to enrich their professional learning. CG5.1.4 Facilitate the leveraging of AI for professional learning, for example by guiding teachers to understand how content-recommendation platforms identify teachers' interests through their inputs and recommend peer mentors and/or training resources; help teachers to comprehend the risks posed to them by data biases and algorithmic discrimination, and how reliance on cocoons of AI-manipulated information could lead to the atrophy of their competencies.	LO5.1.1 Describe the evolution of teachers' rights, working conditions, qualifications and required competencies in the AI era and in local contexts; explain why it is important to be a lifelong learner on AI and its use in education. LO5.1.2 Exemplify the new knowledge, skills and values required by the teaching profession in local contexts in the AI era and assess the gap between their own knowledge and experience on AI and the required AI competencies. LO5.1.3 List various AI tools including locally relevant open-source tools that can be used or repurposed to support self-assessment, reflective practices and professional learning with special attention to enabling accessibility for teachers with disabilities. LO5.1.4 Locate and apply teacher-facing AI tools that are affordable and relevant to respond to the needs of self-assessment and personal professional learning on subject-matter knowledge, pedagogical skills and peer-learning.	**Awareness of teachers' basic rights and obligations in the AI era:** Delineate the rights that should be protected, the basic working conditions and guidance or training opportunities that should be provided for teachers in the AI era, as well as their main professional development responsibilities to ensure the ethical and effective use of AI in education. **Self-assessment of readiness for teaching in the AI era:** Conduct assessments of their own readiness and competency gaps and devise possible roadmaps for professional development to build their capacity for ethical and effective AI-assisted teaching. **Human-directed use of AI to open professional learning horizons:** Gain experience and skills to use AI-assisted social media to prompt new ideas and recommend peers who share similar professional interests and/or can serve as peer coaches or mentors. Learn how to detect and mitigate the negative effects of AI-manipulated information cocoons.

4.2 Progression Level 2: Deepen

The overall curricular goal in the 'Deepen' level is to support teachers to become fully competent teachers or master teachers in using AI. They should demonstrate human-centred perspectives in their analyses and decisions, ethically sound behaviours, deepened conceptual understanding of AI and capacity to apply AI to support pedagogical activities and professional learning. The following goals, learning objectives and examples of activities specify what essential topics can be covered, how training can be organized, and what behaviours teachers might demonstrate after achieving each block of competency.

Table 3. Competency blocks, objectives and examples for progression level 2: Deepen

Deepen				
	TEACHER COMPETENCY	**CURRICULAR GOALS (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
Human-centred mindset	**1.2 Human accountability:** Teachers can demonstrate both a deepened understanding of human accountability and human determination in the proper deployment and use of AI, as well as a critical capacity to assess AI's capabilities in facilitating human–AI decision loops, as well as overhyped claims on the use of AI to substitute humans in making high-stakes decisions in education.	CG1.2.1 Deepen teachers' understanding of the risks related to the absence of human accountability through examination of use cases of AI for decision loops in educational management, assessment, teaching strategies and student interactions with AI, enriching and consolidating their views on the importance of human accountability as a core part of the entire life cycle of AI. CG1.2.2 Develop the understanding that human accountability is a legal obligation by encouraging teachers to debate whether humans or AI should take accountability in AI-assisted decision loops; guide teachers to conduct reviews on how local and international regulatory frameworks define human accountability in the design of AI and the provision of AI services including in education. CG1.2.3 Build associations between human accountability and teachers' rights by highlighting the changing roles and responsibilities of teachers, while emphasizing that the central role of teachers is not replicable and that their accountabilities and autonomy cannot be usurped by AI; support teachers to review whether local policies protect teachers' rights and accountability in the AI era. CG1.2.4 Uncover risks related to the absence of users' accountability by encouraging teachers to examine explainable limitations of specific AI tools (such as that AI cannot understand the real world or make judgements on values), as well as the unexplainable hallucinations, incorrect answers and misrepresentations of facts in the current generation of AI tools; discuss the risks AI poses to student learning, especially for those with special needs (weakening their intellectual development, critical thinking abilities, human interactions, knowledge constructions and ability to formulate and express independent opinions).	LO1.2.1 Understand that human accountability in human–AI decision loops is a legal obligation. LO1.2.2 Apply local and/or international regulatory frameworks to examine whether the design or use of a specific AI tool diminishes human accountability. LO1.2.3 Make reference to international or local policies to defend teachers' accountability in using AI in education and demonstrate resistance to the use of AI outputs and predictions to usurp human teachers' decisions and students' thinking processes, knowledge construction and self-expression. LO1.2.4 Demonstrate teachers' accountability in the decision loops including when determining the appropriateness of AI tools in teaching, designing age-appropriate pedagogical methodologies and providing necessary human interaction to encourage autonomous learning processes with specific support for those with special needs.	**Human accountability in AI-assisted decision loops is a legal obligation:** Draw a concept map of key duty-bearers and their roles in the design, deployment and use of AI in education, and delineate their human accountabilities. **Teachers' accountability and rights cannot be usurped by AI:** Draft a report on the most relevant regulation(s), responsible institution(s) and procedure(s) that can protect teachers' rights and accountability when adopting AI in education. **Teachers' accountability is a human assurance for ethical and effective uses of AI in education:** Draw a concept map on the feasible roles teachers can play in validating and selecting appropriate AI tools, designing pedagogical methodologies, driving human interaction, facilitating students' use of AI and supporting students with diverse abilities.

Deepen				
	TEACHER COMPETENCY	**CURRICULAR GOALS (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
Ethics of AI	2.2 Safe and responsible use: Teachers are expected to be able to internalize essential ethical rules for the safe and responsible use of AI, including respecting data privacy, intellectual property rights and other legal frameworks; and habitually incorporate these ethics into evaluations and utilizations of AI tools, data and AI-generated content in education.	CG2.2.1 Deepen teachers' understanding of main threats to AI safety at the stages of design and use through analysing case scenarios on typical AI safety risks or frequent AI safety incidents from two dimensions: one covering 'safety by design' and 'safety by use', and another covering institutional and personal AI safety. CG2.2.2 Facilitate analyses of typical legal duties when using AI and of the consequences of breaching them – this includes laws that prohibit the use of copyrighted content without consent, violating privacy through the disclosure of personal data, disseminating disinformation or misinformation, promoting hate speech, and engaging in AI-amplified online discrimination or bullying against people with disabilities or vulnerable groups; guide teachers to discuss case studies to deepen their understanding of the social and legal consequences of the irresponsible use of AI. CG2.2.3 Support teachers to build the association between compliance with regulations on the safe and responsible use of AI and their local contexts and work responsibilities; support teachers to search and find examples of international regulations that are relevant to local contexts; and organize teachers to conduct hands-on drafting of their own institutional, classroom, and/or personal rules for the safe and responsible use of AI by adapting international regulations to their particular contexts.	LO2.2.1 Explain typical issues related to AI safety both at institutional and personal levels and demonstrate a deep understanding of the various reasons behind AI safety, including: 'safety by design', 'safety by use', data ownership, data sovereignty, data privacy, rights to decline to forgoing personal privacy to AI service providers, avoiding the disclosure of detailed personal data to prompt AI outputs, and preventing data biases and algorithmic biases. LO2.2.2 Demonstrate familiarity with locally applicable regulations to protect data privacy and ensure AI safety; review the potential ethical risks of specific AI tools in education and suggest mitigation strategies. LO2.2.3 Implement measures for teachers to safeguard their own and their students' data privacy, ensuring their data is collected, used, shared, archived and deleted with their consent; become aware of hidden risks, particularly for students with special needs. LO2.2.4 Apply guidelines to ensure responsible use of AI by teachers and students in compliance with ethical principles such as: respecting others' copyright and protecting their own, mitigating biases, combating deepfakes and AI-amplified hate speech, and protecting themselves and their students, especially those with disabilities, from AI-manipulated bullying and discrimination.	**Personal AI safety tracker:** Draw and update a conceptual map of typical AI safety issues and frequent incidents and their main causes; possible threats to institutions and individuals, especially those with disabilities; and mitigation measures at school and personal levels based on case studies. **Whitelist the personal collections of AI tools for education:** Review the safety of their personal collections of AI tools, looking at the owners, design ethics, data sources, algorithms, inclusive accessibility and functionality choices of each tool to uncover its underlying purposes, potential biases and level of risk. Work with peers and school managers to improve methods for the ethical evaluation of AI tools. **Iteratively update list of dos and don'ts:** Observe and evaluate cases of high-risk and irresponsible AI use in schools, and iteratively update the list of dos and don'ts for teachers and students; explain to students the relevant ethical and legal principles for the responsible use of AI and personal consequences of violating local or international regulations.

Deepen				
	TEACHER COMPETENCY	**CURRICULAR GOALS (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI foundations and applications	3.2 Application skills: Teachers are expected to be able to proficiently operate AI tools adopted in educational settings; to deepen their knowledge of various categories of AI technologies and their practical skills concerning data and algorithms that are appropriate to teaching responsibilities and background competencies while infusing relevant ethical principles in practice.	CG3.2.1 Enrich 'operation and comparison' experiences of typical AI tools, supporting teachers to gain experience of main functions and learn operational skills of these tools; guide them to analyse the similarities and differences of common AI techniques (e.g. symbolic, predictive and generative AI), as well as their implications for education. CG3.2.2 Scaffold deepened construction of conceptual knowledge by facilitating teachers' research-based learning, including on how a selected AI system (such as a large language model) is trained and tested and what typical models, algorithms and datasets are used for the training. CG3.2.3 Support problem-based learning of operational skills in data, algorithms and coding. Based on teachers' prior knowledge and work responsibilities, design typical problem situations to facilitate teachers' acquisition of knowledge and operational skills with regard to data, algorithms and coding, as well as their capacity to use them to design AI applications. CG3.2.4 Offer hands-on practice to assess the 'ethics by design' of AI tools. Organize teachers to review and modify a specific set of criteria or an instrument used to assess key aspects of 'ethics by design'; and facilitate teachers to use the adapted criteria or instruments to assess selected AI tools in relation to data security, data privacy, safety for users, accessibility for people with different abilities, biases (including gender discrimination) in data and algorithms, and potential harms for vulnerable groups, etc.	LO3.2.1 Proficiently operate commonly used AI tools in daily life and in education; exemplify the typical techniques used by these tools and explain their implications for education. LO3.2.2 Visually represent how selected AI systems work, including how they are trained and tested, as well as the typical models, algorithms, and datasets used. LO3.2.3 Demonstrate transferable knowledge on data, algorithms and coding and apply it to solve problems that are appropriate to their abilities and the remit of their role. LO3.2.3 Critically apply knowledge and skills related to data, training, algorithms and models of AI to assess the ethics rooted in the design of AI tools.	**Skillful uses of AI tools in schools:** Based on a deepened understanding of the advantages and limitations of different categories of AI technologies, skillfully operate widely used AI tools. **Visualized 'know-how' on typical categories of AI tools:** Draw a concept map or visualized workflow to explain how selected AI systems are trained and how they work. **Facilitating students to learn about data, algorithms and coding:** Facilitate students or peer teachers who are at beginner level to acquire knowledge of and skills related to data, algorithms and coding. **Informed whistleblowing in ethics by design:** Apply an understanding of how AI is trained and demonstrate capacity to investigate gender biases and discrimination against people with disabilities or vulnerable groups that may be rooted in datasets, data labelling, algorithms and training methods. Reveal and report any evidence-based findings of biases or ethical risks.

Deepen				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI pedagogy	4.2 AI–pedagogy integration: Teachers are able to adeptly integrate AI into the design and facilitation of student-centred learning practices to foster engagement, support differentiated learning and enhance teacher–student interactions, with the aims of promoting empathy, as well critical thinking and problem-solving skills among students.	CG4.2.1 Design and organize learning strategies based on videos of exemplar AI-enhanced learning practice; support teachers to analyse the impact of AI on learning processes, teacher–student interactions, academic learning outcomes, as well as on social and emotional learning; develop teachers' understanding of learning design, the appropriateness of AI tools and their uses, and inclusion for students with variable abilities; facilitate teachers' self-reflection on AI-assisted learning activities they have designed or facilitated. CG4.2.2 Deepen understanding of the impact of AI by encouraging teachers to discuss selected research reports or conduct action studies around impacts of AI on students' agency, thinking and learning processes; interactions with teachers; academic outcomes; and on their social-emotional learning, among other key topics; guide teachers to understand the benefits and risks of AI-assisted learning activities. CG4.2.3 Support the integrated deployment of foundational knowledge and skills on AI to meet the needs of teaching, learning and assessment; where applicable, guide teachers to apply pedagogical principles to review the main functions of integrated AI-assisted learning systems adopted by schools. CG4.2.4 Support the transfer from instructional design to learning design in the context of the validation and pedagogical use of AI; organize hands-on practice for teachers to design and facilitate AI-assisted learning activities based on comprehensive consideration of the uses of AI in the preparation of learning resources, thinking and learning processes, human interactions, performance monitoring and assessment; support teachers' practice-based reflection and redesign in iterative cycles of learning design, learning facilitation, reflection and redesign.	LO4.2.1 Adeptly integrate ethical principles, student-centred pedagogical methodologies and interdisciplinary perspectives on learning objectives into their learning design practices; this can range from their evaluation and blending of AI tools and their design of teaching, learning and assessment, to their planning of teacher–student interactions and facilitation of learning. LO4.2.2 Critically evaluate whether various categories of AI or specific tools present advantages in assisting the co-design of micro-curricula or courses, enhancing student-centric teaching, assisting formative assessment, monitoring learning processes, advising on personalized student engagement and facilitating augmented human interaction; where AI advantages can be validated, blend AI tools and resources into student-centred pedagogical practices to enhance students' higher-order thinking, understanding, application of knowledge and skills, appropriate social interactions and value orientation. LO4.2.3 Critically examine the appropriateness of the use of a specific AI application or an integrated AI-assisted learning system (e.g. LMS) in formative learning assessment and high-stake examinations; when it has clear advantages, adeptly blend appropriate tools in facilitating the design and administration of AI-assisted formative assessments and human-accountable decision loops to bolster students' learning outcomes, intellectual development and psychometric progress.	**Mapping of AI tools and application skills:** Update or scale up the concept map of AI tools to reflect key features of various categories of AI tools, evaluate their pedagogical affordance for student-centric pedagogical activities, and reflect on progression and needs for further upskilling. **Insights into pedagogical assumptions behind AI tools:** Cooperate with peers or experts to examine whether the design of general AI systems considers pedagogical implications, and what those pedagogical implications are for different categories of AI; understand and explain the key pedagogic assumptions that underpin a given educational AI tool or system. **Designing and facilitating students' use of AI for higher-order thinking and social-emotional learning:** Design student-centric teaching and learning activities based on validated educational AI tools and facilitate students' use of AI to support higher-order thinking, collaborations, as well as social and emotional learning. **Human-accountable AI-assisted assessments:** Debunk myths around the use of AI to automate the design, administration and grading of assessments by examining the risks of AI in usurping human accountability when providing feedback and making decisions on students' learning outcomes. Consider the limitations in the local education system regarding assessment structures and analyse possible trade-offs between potential benefits and risks of using AI in summative assessment and examinations. Be persistent in ensuring human accountability in decisions on learning outcomes and prevent the use of AI for making judgements and predictions about learners' social, ethical and psychometric development.

Deepen				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI for professional development	5.2 AI to enhance organizational learning: Teachers are able to confidently utilize AI tools for tailored participation in collaborative professional learning communities, leveraging them to share resources, engage in peer-to-peer learning and contribute to dynamic adaptation.	CG5.2.1 Incite continuous motivation for professional learning and collaboration, supporting teachers to conduct research and discuss case studies on how master teachers adapt their roles and pedagogical practices in AI-rich settings, deepening their understanding of the balance between teachers' fundamentally human role and the obligations to develop AI competencies. CG5.2.2 Facilitate knowledge expansion on AI tools for professional development, introducing locally accessible emerging tools and promoting ones that include provisions for teachers who have disabilities and/or work with students who do. CG5.2.3 Deepen teachers' operational skills in the use of data analytics to support professional learning; guide teachers to transfer and upgrade their knowledge and skills in using data to track and analyse the process of professional development including with respect to subject knowledge, pedagogy and practical performance to facilitate data-informed self-diagnoses and tailoring of learning pathways. CG5.2.4 Offer hands-on practice on assessing deeper ethical issues associated with using AI systems for professional learning; support teachers to apply their knowledge and skills on 'ethics by design' to analyse the risks of AI algorithms in social media platforms, content-recommendation platforms and teacher-facing AI tools in terms of doing harm to teachers' human rights, data privacy, and professional learning and collaborations; recommend guidelines for the effective use of AI platforms to find relevant resources and communities of practice to facilitate peer learning.	LO5.2.1 Critically analyse their roles in designing and facilitating students' use of AI in their own pedagogical practices, deepening their understanding of the balance between their fundamentally human role and the obligations of continuously developing AI competencies. LO5.2.2 Apply foundational knowledge and skills on data using AI tools to track and analyse their own professional development including in terms of subject knowledge, pedagogical knowledge and practical abilities to facilitate data-informed self-diagnoses and autonomous planning of their professional trajectory. LO5.2.3 Expand knowledge and skills on the use of AI, especially emerging tools, for their own professional development; promote the use of AI tools that support teachers who have disabilities or work with students who do, including using locally relevant open-source tools that can be repurposed to support teachers' professional development. LO5.2.4 Evaluate the ethical risks of AI algorithms behind social media platforms and specialized tools as they relate to teachers' human rights, data privacy and professional learning; develop and implement guidelines for the effective use of AI platforms to find relevant resources and communities of practice to facilitate peer learning.	**Autonomous upskilling and peer coaching:** Keep pace with emerging AI technologies and their implications for education in local contexts, autonomously upskilling and reskilling themselves and coaching their peers to do the same. **Using data analytics for self-regulated professional development:** Apply their knowledge and skills on data, algorithms and AI models to draw up analytics of teachers' own professional knowledge and skills; accurately identify gaps, and help them regulate their own professional development activities. **Generative AI simulations for professional development:** Utilize existing generative AI tools or customize new ones to create an AI coach that simulates specific professional development scenarios so teachers can practice and get feedback – examples could include dealing with a difficult class, training on local regulations, or a simulation of students having difficulties. **Human-controlled uses of AI for collaborative professional development:** Uncover ethical risks of AI-manipulated platforms and implement preventive measures to avoid negative impacts. Design human-controlled activities to leverage AI platforms or tools to scope resources or provide online coaching in support of collaborative professional development.

4.3 Progression Level 3: Create

The curricular goal at the 'Create' level is to empower teachers who have sound AI knowledge and competency to become expert teachers and agents of change. They should be able to innovatively use AI for education and engage with communities to explore how it might drive the desired transformation of teaching and learning practices. The following specifications underline the exploratory character of the 'Create' level, defining main competencies, measurable learning objectives and exemplar activities.

Table 4. Competency blocks, objectives and examples for progression level 3: Create

Create				
	TEACHER COMPETENCY	**CURRICULAR GOALS (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
Human-centred mindset	1.3 Social responsibility: Teachers are able to actively participate in, and contribute to, the building of inclusive AI societies guided by a critical understanding of the implications of AI for societal norms, promoting the design and use of AI for the enhancement of human welfare, inclusion and social justice.	CG1.3.1 Foster a critical understanding of the importance of protecting social and emotional well-being from commercially-driven AI manipulation; organize debates or research-based learning for teachers on how AI companies generate profits by reinforcing individual addiction and isolation, promoting individualism and selfishness, and the ranking of social identities; guide teachers to form dynamic and multifaceted understanding that ensuring human rights for all and promoting social justice are the cornerstones of AI ethics, and motivate them to frame and share critiques on the importance of counterbalancing commercial interests with the social-emotional well-being of humans and the health of non-human species across the planet. CG1.3.2 Offer opportunities to reimagine safe, inclusive and just AI societies; organize workshops, group discussions and collaborative activities for teachers to contemplate what an inclusive, just and climate-friendly social order for the AI era may look like, what threats AI may pose to these social norms, and what compacts or regulations are available or should be developed. CG1.3.3 Encourage the internalization of social responsibilities as citizens in an AI society by organizing hands-on workshops to define citizenship in the era of AI, by encouraging teachers to explore how their legal and social responsibilities may evolve, and by discussing ways to uphold and strengthen the core social rights and obligations that citizens in the era of AI need to assume.	LO1.3.1 Critically evaluate and reflect on the implications of AI for society at large, particularly how it might affect education, work, interpersonal interaction and human connections with each other and with the environment. LO1.3.2 Actively contribute to the formation of policies related to AI in education at the institutional, local and/or national level including how to leverage the benefits of AI and mitigate its social and educational risks. LO1.3.3 Personalize and actualize social and civic responsibilities in the era of AI and promote the development of such citizenship qualities through education.	**Teachers' voices on human and planetary well-being in the AI era:** Write thought pieces, essays or online blog posts about how profit-driven AI providers threaten humans' social and emotional well-being and planetary well-being based on real-world case studies or syntheses of research findings, and the implications for education. **Reflection on and promotion of human-centric social relations and social cohesion:** Write blogs or champion dialogues on what desirable social relations and social cohesion can look like in the AI era, the technological and economic barriers to the building of human relations and social order and list the global and local compacts that are being developed to lead to the societies we want. **Rights, obligations, and responsibilities of citizenship in the era of AI:** Engage in discussing, consulting on, or contributing to the drafting of policies that define the rights, obligations and responsibilities of citizens in the AI era.

Create				
	TEACHER COMPETENCY	**CURRICULAR GOALS (CG) (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (LO) (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
Ethics of AI	2.3 Co-creating ethical rules: Teachers are able to champion the ethics of AI through critical advocacy, leading discussions and actions that address ethical, sociocultural and environmental concerns in the design and use of AI, and contributing to the co-creation of ethical rules for AI practices in education.	CG2.3.1 Foster inquiry into the social impact of AI by organizing teachers' research-based reviews of the social impact of selected AI tools; encourage teachers to take part in and evaluate how these tools affect local economies, social justice and climate change, as well as risk exacerbating discrimination against, and exclusion of, certain linguistic and cultural communities or groups with special needs; organize dialogues or debates based on the findings. CG2.3.2 Enhance critical examination of existing users' guidance published by AI providers by inviting teachers to evaluate selected tools on their potential to risk marginalizing people with disabilities, amplify social discrimination, and threaten linguistic and cultural diversity; compare users' guidance against the likelihood of negative impacts; gather feedback and draft notes of feedback on how to revise the users' guidance. CG2.3.3 Upgrade knowledge on AI ethics and skills to guide further iterations of ethical rules and standards; guide teachers to search for and review multistakeholder negotiations behind the adoption of regulations on AI (such as the negotiation behind Europe's AI Act); simulate multi-stakeholder debates on how to revise a selected regulatory framework from the perspectives of policy-makers, regulatory agencies, lawyers, researchers, AI companies, and the adults, children and institutions who use AI tools; draft a memorandum of shared understanding or dispute.	LO2.3.1 Critically analyse the social impact of AI from both the global and local perspectives and gain insights into the potential impact of emerging AI technologies on social equity, inclusion, linguistic and cultural diversity, institutional and individual safety and security, and the intellectual and social development of children as well as on planetary well-being. LO2.3.2 Assess the appropriateness and sufficiency of guidance for users of a specific AI tool against the ethical risks rooted in its design and the potential social controversies caused by its use, and frame recommendations for remedying or improving the guidance accordingly. LO2.3.3 Solidify the view that regulations on AI ethics must be designed by and for human stakeholders; advocate for and participate in the dialogues, development or further iteration of local or institutional regulatory frameworks or guidelines that promote ethics in the design, validation, adoption, deployment and application of AI.	**Localized global view on the social impact of AI:** Holistically review the social impact of AI on individual human rights and development, economic activity, social justice and planetary well-being; translate the global view into local implications to investigate AI's effects on society. **Spotlighting ethical gaps in users' guidance:** Audit the claims made by the providers of selected AI tools and the terms stated in their users' guidance against a full list of risks and social impacts. Monitor potential threats or harms to users, especially children, students with disabilities and vulnerable groups. Assume responsibility for reporting these and filing complaints with providers and regulators (e.g. data protection authorities). **Master teachers as advocates of AI ethics:** Play active roles in launching awareness campaigns on the ethics of AI, interpreting ethical principles, sharing knowledge on relevant regulations, promoting dialogues on AI safety and work with communities to revise existing regulations and/or develop new ethical standards. **Co-designing ethical prototypes of AI tools for education:** Launch a hypothetical AI development project and invite interdisciplinary collaboration on it, bringing together teachers, students and technologists to co-design an ethical AI tool that addresses a specific educational need.

Create				
	TEACHER COMPETENCY	**CURRICULAR GOALS (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI foundations and applications	3.3 Creating with AI: Teachers are able to customize or modify AI tools in a proficient manner, applying enhanced conceptual knowledge and operational skills to create AI-assisted inclusive learning environments, and address broader challenges in educational contexts.	CG3.3.1 Nurture adaptability and creativity in customizing AI tools; support teachers to integrate skills on data, algorithms, programming and AI models to customize or design tools to address challenges in education, focusing on the needs of people with different abilities and protecting linguistic and cultural diversity in local contexts. CG3.3.2 Foster critical views on open-source AI by supporting teachers to deepen critical views on the advantages, limitations and risks of open-source in comparison with commercial AI tools; support teachers to learn how to review, adapt and/or iterate open-source AI tools. CG3.3.3 Simulate and practice adaptability and creativity in co-creating AI tools through project-based learning. Design and facilitate project-based learning practices to simulate teachers to learn how to adapt accessible and affordable 'off-the-shelf' commercial AI models/tools, semi-finished tools and/or open-source toolkits to assemble or create new AI tools to address real-world problems based on human-centred and ethical approaches; enhance teachers' adaptability, resilience and ability to clarify ambiguities, overcome obstacles and take risks when solving complex authentic problems. CG3.3.4 Support teachers to embed values, knowledge and skills into existing repositories of educational AI tools; offer hands-on opportunities for teachers to examine the ethical and pedagogical appropriateness of the tools, and iteratively update the repository of AI tools for schools.	LO3.3.1 Demonstrate knowledge and skills on AI system design at the level of expert teachers as well as comprehensive competencies to analyse the limitations of selected AI systems in solving real-world problems in local educational contexts. LO3.3.2 Apply appropriate knowledge and skills on data, algorithms, programming and AI models to customize and/or assemble existing AI tools or semi-finished AI models to create AI tools or fine-tune open-source AI systems to create solutions that are both relevant and affordable for local settings and specific use cases. LO3.3.3 Revise or define criteria for the comprehensive testing of a self-created AI tool and for the purpose of optimization and further iteration of the tool. LO3.3.4 Contribute to a new or existing repository of user-created or tailored AI tools based on personal and institutional needs and promote a focus on only utilizing the most appropriate tools for education.	**Driving the design of AI tools for inclusion:** Collaborate with a community of co-creators to add functions to existing AI tools or design new ones to facilitate accessibility, targeting AI or digital learning platforms for people with disabilities. Design AI tools to support the detection of inclusive accessibility among widely used AI platforms. **Promoting the co-creation of AI tools to support climate-friendly actions:** Co-create AI tools or organize hackathons to facilitate students to design AI tools that promote climate education or climate-friendly actions (e.g. AI tools to track carbon emissions caused by selected AI platforms or the energy consumption of schools). **Coordinating the building and use of repositories of educational AI tools:** Support the creation of a repository of selected trustable and self-created AI tools for education that can be shared through school web spaces or publicly (e.g. on GitHub). Where appropriate, assume the roles of school-based AI coordinators to provide training for other teachers to support their use of the repository.

Create				
	TEACHER COMPETENCY	**CURRICULAR GOALS (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI pedagogy	4.3 AI-enhanced pedagogical innovation: Teachers are able to: critically assess AI's impact on teaching, learning and assessment; plan and facilitate AI-immersed learning scenarios to support students' subject-specific or interdisciplinary learning, critical thinking and problem-solving; and leverage data and feedback to continuously explore student-centred pedagogical innovation.	CG4.3.1 Inspire ideas on possible scenarios where AI is used for students' development; design and organize scenario analyses based on exemplar videos of AI-enhanced open learning options such as co-creation practices and inquiry- and project-based learning; facilitate teachers' review of their readiness in terms of competencies, AI resources and assessment; empower teachers to frame feasible ideas on innovative open and creative learning practices that can be enabled by the use of AI. CG4.3.2 Scaffold teachers' insights into the interplay between pedagogical principles and pedagogical transformations that AI could trigger; facilitate teachers' deliberation on fundamental questions such as what core values in education should not be undermined by the use of AI (e.g. protecting students' human rights, inclusion and social relationships), what basic pedagogical principles should be upheld to guide the use of AI in education (e.g. promoting students' intellectual development, nurturing creativity, encouraging the construction of plural opinions and innovative ideas, and fostering social and emotional skills), and how AI may disrupt or transform pedagogical methodologies. CG4.3.3 Support the improvisation of skills to create new AI tools or expand existing ones; offer teachers opportunities to improve their understanding of validated tools including institutional AI systems for education, and to assemble or co-create AI tools to support and assess students' inquiry- and project-based learning, creativity, innovation, etc. CG4.3.4 Incubate the transfer from learning design to scenario design. Organize hands-on practice where teachers can co-design curricular practices or human–AI interactive scenarios to explore when and how AI could be used to support the cycle of learning—assessment—feedback—adaption; analyse the pros and cons of novel triangular interactions of students, teachers and AI systems, and design strategies to leverage their advantages and mitigate their risks; offer opportunities for teachers to enrich their practical skills in the design and engineering of AI-assisted open learning options for students and nurture students' higher-order intellectual abilities, creativity and curiosity.	LO4.3.1 Critically examine the dynamic interaction between the advancement of AI and the evolution of pedagogical methodologies; utilize the genuine benefits of AI technologies for the achievement of educational aims and identify possible limitations of existing pedagogies for fully leveraging the potentials of emerging AI for education; design and conduct evidence-based tests of open learning options to harness the potential of AI in supporting age-appropriate inquiry based learning, knowledge creation, collaborative project-based learning and agile creativity. LO4.3.2 Assemble AI tools or co-create new AI applications to address needs for inclusive accessibility, linguistic and cultural relevance, ability-appropriate personalized learning needs, social support, inquiry or project-based learning. LO4.3.3 Adeptly design AI augmented learning scenarios that promote students' higher-order inquiry, open exploration, project-based learning, critical thinking and co-creations while ensuring human interactions; engineer and facilitate students' uses of AI in which students have control over their learning paths, make choices on AI tools, and take accountability in making AI-assisted decisions, ensuring embedded time and space for human interactions and reflections. LO4.3.4 Design and appropriately integrate the use of AI to support the collection and use of data to support learning analytics and adjustment of teaching strategies. LO4.3.5 Adeptly use AI to generate content across text, audio and video to support the co-creation of national or school-based textbooks, curricular resources or digital materials which are to be validated by curriculum developers. LO4.3.6 Streamline the use of AI for teachers' administrative tasks, teaching and learning tasks, engagement with parents and local communities.	**Guiding the pedagogical uses of AI while leveraging AI to open new pedagogical horizons:** Uphold human-centred pedagogical principles to guide the design and uses of AI in pedagogical activities (protecting human rights, human agency, students' autonomy and independent thinking, linguistic and cultural diversity, plural opinions and plural expressions). Continue to challenge the limit of existing pedagogies and explore whether existing teaching and learning methodologies are sufficient to fully leverage the potentials of AI for education. Keep abreast of emerging learning scenarios **bein**g enabled by AI and examine whether they are extensions of existing pedagogical methods or represent pedagogical innovations. **Engineering triangular interactions between teachers, students and AI:** Understand and continuously review how AI, and generative AI in particular, interact with teachers and students throughout the teaching and learning processes and the extent to which generative AI can be embedded in thinking processes and knowledge exploration and construction processes. Navigate the teacher–AI–student triangular relations; design and engineer the desirable scenarios of teacher–student, teacher–AI, student–AI and teacher–AI–student interactions. **AI empowering students with special needs:** Promote assistive AI or co-create assistive AI tools and design activities to provide students with disabilities and special needs opportunities for empowerment while protecting their human rights and privacy. **Human–AI hybrid approach to development of curricular resources:** Continuously engage in the use of AI to facilitate the review of existing literature and the production of inclusive and accessible curricular resources that combine text, audio and video materials; co-create and implement a human-accountable validation mechanism for the AI-assisted production of curricular resources.

Create				
	TEACHER COMPETENCY	**CURRICULAR GOALS (Teacher training or support programmes should …)**	**LEARNING OBJECTIVES (Teachers can …)**	**CONTEXTUAL ACTIVITIES (Teachers can demonstrate the following attitudinal or behavioural changes)**
AI for professional development	5.3 AI to support professional development: Teachers are able to customize and modify AI tools to enhance their professional development and to continuously test and validate strategies on the effective use of AI to meet their own, and their communities', professional development needs.	CG5.3.1 Motivate teachers to be agents of change by organizing case studies and/or discussions on how expert teachers could inform and champion the transformation of education that AI may trigger, nurturing the traits of being agents of change with simulating examples and interesting exercises. CG5.3.2 Enhance skills to use AI to support institutional professional learning; provide opportunities of hands-on workshops where teachers co-create AI tools to track professional development of a certain institution or group, with the aim of facilitating data-informed monitoring, diagnosis and recommendations on organizational learning. CG5.3.3 Support teachers to customize or assemble AI tools to enable access to professional development opportunities for peers with disabilities or special needs. CG5.3.4 Nurture the traits of being creative users of AI to foster self-actualization and transformation; convene practical workshops where teachers can build communities for the co-creation of AI tools; encourage teachers to engage with communities of practice on the question of how AI could be leveraged to inspire professional transformation.	LO5.3.1 Show commitment and persistence in the co-creation and usage of AI tools and methods to fulfil their professional and social responsibilities in AI societies, aiming at new iterations of ethical rules, customized AI solutions and transformative pedagogical approaches. LO5.3.2 Blend AI tools and human coaching to facilitate well-informed self-reflection and assessment, goal setting and the mobilization of knowledge and human mentors to support personal and collaborative transformation. LO5.3.3 Where possible, configure or create AI solutions to monitor and critically assess organization-wide professional learning trajectories, and blend AI and other methods to collect and synthesize constructive feedback and actionable recommendations. LO5.3.4 Understand the roles of AI to support self-actualization and to personalize citizenship in the AI era from the perspective of being a teacher; contribute to educational communities' co-creation of AI tools to support the self-actualization and professional transformation of teachers in the era of AI.	**Human–AI hybrid coach for teachers:** Build or utilize existing generative AI toolkits to customize an AI-assisted agent or coach for teachers' professional development to support activities such as self-assessment and diagnosis, as well as to simulate specific scenarios to practice skills and receive feedback (e.g. meeting the needs of students with learning difficulties or solving ethical dilemmas related to the use of AI). Use the agent or coach to help their peers as well. **AI-enhanced design of training programmes:** Leverage AI tools to expand reviews of existing programmes that are relevant to the needs of a specific group of teachers, extend ideas on training content and training methods, and assist the production of inclusively accessible training courses to be validated by human master-trainers or facilitators. **Communities for the co-creation of AI tools, pedagogical innovations, or ethical rules:** Lead or engage in collaborative research teams working on innovative pedagogical methodologies, and/or communities for the co-creation of trustable, accessible, and inclusive AI tools for education or iteratively updated ethical rules on the use of AI.

Chapter 5: Suggested implementation strategies

The AI CFT is a global reference framework for teachers, policy-makers, providers of teacher education programmes and school leaders across the world. This chapter goes beyond articulating competencies to offer guidance on conducive policy environments and other enabling factors that can support the effective use of AI by teachers. It also explores how the AI CFT can be used to achieve the three main objectives of guiding the design of specific AI competency frameworks across diverse contexts, steering the design and provision of teacher professional development in AI, and supporting the articulation of benchmarking specifications for teachers' self-assessment.

5.1 Regulate AI and ensure trustworthy AI tools for education

The precondition for the responsible use of AI in education is the enforcement of regulations to ensure the trustworthiness of AI tools and to safeguard learners and teachers. Given the multiple risks related to the use of AI, there must be mechanisms in place to ensure that any AI tools introduced into educational environments are reliable and trustworthy. It is therefore critically important to validate AI systems or software before they are introduced into education systems at scale.

The provision of trustworthy AI systems requires an enabling regulatory context. National regulatory frameworks for AI should be developed or reinforced to guarantee the security and ethical compliance of general AI systems that are widely used by students, teachers and educational institutions. This requires the establishment of robust data protection laws akin to the General Data Protection Regulation (GDPR) adopted by the European Union (EU) in 2016, and/or specific regulations for the design and provision of AI services, which should address their appropriateness for users at different ages and with varied abilities.

Such regulations also need to be regularly reviewed and adapted to respond to novel ethical issues presented by emerging technologies such as generative AI. The specific official regulation on generative AI issued in China in July 2023, and the EU's AI Act introduced in March 2024, are examples of recent efforts to address the new risks posed by generative AI. Indeed, the EU AI Act identifies four levels of risk that AI systems may pose for citizens, and stipulates legal regulations for each. The first concerns AI systems that entail unacceptable risk and which must be banned. The second comprises AI applications that are considered to pose high risk and which require strict regulation. Most AI applications for education fall into this category. The third category concerns AI systems that pose limited risk and for which specific transparency obligations are required. Finally, the last category comprises minimal-risk AI and which can be freely used. Enforcing regulations based on the level of risk requires independent institutional mechanisms for the validation of AI systems. This is particularly important for education, where most AI applications are considered to be high-risk, requiring strict regulation.

While regulations on general AI systems provide significant legal protection, ensuring trustworthy AI for education requires further

regulations and institutional validation. This applies both to general AI systems being deployed in schools at scale, as well as for educational tools which incorporate AI technology. To prevent AI from causing irreversible harm to students, it is imperative to ensure mechanisms are in place for the validation of these AI systems for use in education. This is particularly true of AI services targeting younger children. Independent validation of educational software and resources that integrate AI tools needs to be ensured before they are used in schools and other educational institutions.

Regulatory agencies should cooperate with educational institutions, teacher unions, and parent associations to define and apply relevant validation methods for AI tools including through trials, simulations and model-centred approaches.

Box 1: Regulations on AI: key elements of accountabilities for multiple stakeholders

UNESCO's 2023 Guidance for generative AI in education and research recommends that to properly regulate AI to ensure the realization of its benefits in education and other development contexts, regulations need to specify the responsibilities of: (1) governmental regulatory agencies, (2) providers of AI systems and AI services, (3) institutional users, and (4) individual users.

(1) Governmental regulatory agencies

These agencies should be responsible for the following seven key elements and actions: intersectoral coordination through a national body to lead on a whole-of-government approach to AI; alignment of national/local regulations on AI with relevant legislative and regulatory provisions; ensuring balance between the necessary regulation of generative AI and the promotion of AI innovation; identification of levels of potential risk of AI and specifying regulations accordingly (see the EU AI Act for an example of this approach); protection of data privacy; definition and enforcement of age limit for engaging in unsupervised chat with AI platforms or applications; and enhancing national data ownership and containing the risk of data poverty.

(2) Providers of AI systems and AI services

The providers of AI systems and services should be held to account for the following legal and social responsibilities: guaranteeing human accountability for AI incidents and legal issues; ensuring trustworthy data and models; adopting algorithms and methods towards non-discriminatory content generation; promoting the explainability and transparency of AI models; labelling AI-generated content properly; complying with security and safety principles; providing specifications on appropriate access to and use of AI systems; acknowledging limitations and preventing predictable risks; establishment of mechanisms for complaints and remedies; and monitoring and reporting unlawful use.

(3) Institutional users

Educational authorities and institutions with responsibilities for determining whether AI should be adopted and which types of AI tools should be procured should be accountable for: institutional auditing of AI algorithms, data and outputs; validating proportionality and protecting users' well-being; reviewing and responding to long-term impacts; and monitoring age-appropriateness.

(4) Individual users

Individual teachers and students have the following responsibilities: being aware of terms of reference for the use of AI; complying with ethical principles when using AI tools; and taking personal responsibility for monitoring and reporting any unlawful application of AI systems or services.

Source: UNESCO, 2023*b*

At a minimum, validation criteria should cover the following aspects of AI systems and their usage:

- security;
- bias;
- accuracy of outputs;
- human accountability for the protection of data privacy and legal data ownership;
- explainability of AI models;
- linguistic and cultural representativeness of data used to train the AI models for target users;
- appropriateness for users at different ages and with different abilities;
- collection and exploitation of users' data;
- intended business models; and
- impact on teachers' rights and human agency.

The regulations also require the engagement of multiple stakeholders to consider the long-term implications of AI on education, promoting a human-centred approach through inclusive debates, multistakeholder policy dialogues, and participatory drafting.

5.2 Build enabling policies and conditions for the use of AI in education

While a necessary pre-condition, the definition of AI competencies required by teachers, alone, is not sufficient to ensure the adoption of AI-assisted practices in teaching and learning on a large scale. Indeed, various barriers prevent teachers from finding and using AI, becoming familiar with trustable AI tools, understanding how to make responsible use of AI, and incorporating them into teaching and learning based on relevance and applicability for subject areas and grade levels.

While the framework presented here considers some of these issues, it is beyond the scope of the AI CFT to address the subjective barrier of teachers' personal interest and motivation. It is also beyond the scope of this framework to address the economic and structural barriers of AI affordability and access, as it is to help resolve the challenge of balancing AI among other policy priorities. To address the challenges and overcome these barriers, national AI competency frameworks for teachers need to be supported by conducive policy contexts that provide enabling conditions for the use of AI in education.

One of the primary functions of policies on AI in education is to help institutions to weigh the option of AI against other existing options and priorities, before promoting its use to teachers. A common starting point for this is to conduct a cost–benefit analysis to determine the trade-offs between the forward-looking yet unproven value of AI for education, versus the urgent need to ensure/improve other conditions for learners, independent of technology. It is fair to argue that, despite media hype, AI is unlikely to solve any of the major problems confronting education systems around the world, such as inadequate school infrastructure or teacher shortages. As strategic policy choices about AI in education have significant implications for financial and human resource investment, decisions must be informed by rigorous evidence-based research and multistakeholder dialogue. If large-scale adoption of AI technology in education is seen as a means to address key challenges, human agency, creativity and ingenuity of teachers must remain at the core. As part and parcel of their AI competency, teachers should be able to choose to apply affordable

AI tools or co-create relevant solutions only after determining that benefits clearly outweigh the risks.

A second function of policies on AI in education is to support and motivate teachers to use AI in a responsible manner. Strategies to motivate teachers could include such actions as: reaffirming the importance of developing teachers' AI competencies in professional qualification frameworks; introducing measures to mitigate the negative impact of AI use on teachers' workloads and well-being; providing well-funded relevant training on AI and school-based support programmes grounded in needs assessments; recognizing and promoting forerunner teachers for their efforts in making pedagogically-appropriate use of AI in their practice; and recognizing teachers' innovative practice in using AI as part of teaching performance evaluation criteria.

The third function of policy frameworks can be to support teachers to address the barrier of AI access and affordability. To help ensure inclusive access to AI resources, and to enable teachers and students in diverse local contexts to use AI, policy measures include ensuring inclusive access to the internet as well as to validated, trustworthy and affordable AI tools and other resources; upgrading of obsolete or dysfunctional digital infrastructure; and ensuring free

Box 2: The Republic of Korea's National Strategy for Artificial Intelligence

The National Strategy for AI (Ministry of Science and ICT, Republic of Korea, 2019) has three main focus areas: (1) establish reliable AI infrastructure, including to support human talent and improve technology; (2) expand the utilization of AI throughout the industrial and social sectors; and (3) respond proactively to social changes, including labour market needs. To support the achievement of these objectives, the strategy prioritizes two key elements: strengthening teachers' software and AI capabilities and securing school infrastructure.

Under the key task of Strengthening Teachers' Software/AI Capabilities launched in 2020, the Republic of Korea has been supporting teachers to complete courses on AI as part of initial training and recruitment. To this end, institutions with responsibilities for teacher preparation have been supported to enhance their programmes: universities of education have revised the standard for the qualification of teachers to complete AI-related courses; colleges of education have been supported to add and integrate AI-related contents into teaching and related majors; and post-graduate schools of education have established new majors focusing on AI-integrated education and on supporting participating teachers. The parallel Revamping Teacher Training System initiative aims to make rigid qualification requirements for elementary and secondary teachers more flexible. In doing so, the initiative hopes to incentivize teachers to explore future-proofing innovative practices in their schools and beyond.

Since 2020, governmental agencies and partners have, within the Securing School Infrastructures framework, been establishing high-speed wireless networks in at least four classrooms in each elementary and middle school across the country. Additionally, strategies have been implemented to promote the provision of AI-related educational opportunities at various levels and locations beyond schools, and to launch initiatives both to find and nurture AI-gifted students and to ensure educational opportunities for vulnerable groups and rural communities.

Source: Ministry of Science and ICT, Republic of Korea, 2019

or affordable access to applications and hardware, including through engagement with academia and the private sector.

5.3 Formulate and adopt local AI competency frameworks for teachers

The AI CFT is designed to be instrumental in guiding the design of national or institutional AI competency frameworks for teachers. Its structure and specifications are intended to be localized and tailored to the specific degree of digital readiness and existing levels of competency among teachers in a country, locality or organization.

The formulation of these localized frameworks requires a holistic approach involving multiple stages. The starting point is a thorough assessment of AI readiness in terms of both the tools available for students and teachers, as well as current median competency levels in AI among teachers. This would be followed by an assessment of gaps between definition of AI competencies that the government or institutions intend to develop for all teachers and what is proposed in existing teacher training and support programmes. Finally, the key aspects and main mastery levels for localized AI competency frameworks would need to be articulated.

These localized frameworks should be designed in alignment with existing digital competency and/or general professional

Box 3: Examples of non-governmental AI competency frameworks for teachers

AI4T[1] is a European Commission-funded Erasmus+ K3 project, developed in collaboration with France, Ireland, Italy, Luxembourg, and Slovenia. Launched in 2021, it aims to contribute to training on AI in education based on three categories of AI competences: (1) 'Teaching for AI' covers AI competencies relevant to all citizens, mainly drawn from the existing EU digital competence framework, DigComp2.2; (2) 'Teaching with AI' covers AI competencies specifically for teachers, and draws guidance from the European Commission's 2022 Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators; and (3) 'Teaching about AI' covers competencies to guide the training of students on the fundamentals of AI, including basic digital skills, computational thinking, mathematical skills, and AI applications and which are mainly drawn from the framework of AI4K12, 'Five Big Ideas for AIEducation' (European Union, 2023).

In the Republic of Korea, the efforts made by the AI Education Alliance and Policy Lab provides another example of a framework to enhance teachers' AI and digital competencies. This framework covers three domains: AI and digital fundamentals, implementation of AI and digital education, and professional development.[2] These three domains are divided into the following eight competencies: utilization of AI and digital technologies, practice of AI and digital ethics, educational context analysis utilizing AI and digital technologies, instructional design utilizing AI and digital technologies, development of educational resources using AI and digital technologies, implementation of lessons using AI and digital technologies, educational evaluation and reflection using AI and digital technologies, and professional development. Behavioural indicators are defined for each of these competencies, to aid the design of assessment tools that can help to measure levels of AI and digital competency among teachers.

1 See https://www.ai4t.eu/

2 Further information on the AI Education Alliance and Policy Lab (AIEDAP) project is available at https://aiedap.or.kr

qualification frameworks for teachers. Where appropriate, the local AI frameworks should have certain binding effects for national or institutional certifications. To maximize the relevance of the national/local AI competency frameworks for teachers, the design and implementation of the frameworks and associated programmes should build on a coordinated governmental approach. This is seldom the case at present, where the development of AI competency frameworks for teachers is often driven by academic institutes, commercial companies and regional or international organizations. If we are to ensure effective, meaningful and sustainable use of AI in education, teacher competency frameworks need to be developed and endorsed by governmental agencies.

5.4 Design and streamline training and support programmes on AI competencies

The AI CFT provides an operational framework for the design and planning of training courses and support programmes for teachers. More specifically, the detailed specifications of 'curricular goals' presented in Chapter 4 are intended to frame the main elements of knowledge, skills and values that the training programmes of each competency block may cover, to suggest training methods that are relevant to the domains and levels of trainees, and to suggest practical approaches for the organization of the training and coaching programmes.

Box 4: Examples of training and support programmes on AI for teachers

The EU's AI4T programme has a specific massive open online course (MOOC) designed to improve teachers' AI competencies.[3] This MOOC has four modules: (1) 'AI in education' provides a general introduction; (2) 'What is meant by AI' offers content on AI foundations and applications; (3) 'How does AI work' explores the technical aspects of AI and ethics; and (4) 'AI at our service as teachers' presents material on the human-centred mindset and ethics of AI. While the main focus of the MOOC is AI foundations, it also addresses issues of human agency by covering the risks of AI-based decision-making, the importance of keeping teachers in the loop, as well as ethical issues. As a MOOC, it is naturally limited in terms of active learning opportunities for teachers and is not tailored to their specific needs.

Singapore's approach involves offering a dedicated platform for AI competency development. The Government of Singapore launched the initiative 'AI Singapore' in 2017, bringing together Singapore-based research institutions and AI companies to carry out research, generate knowledge, create tools, and develop talent in the field of AI. The platform[4] enables teachers to access AI tools and models, allowing them to develop competencies relevant to their educational contexts. It also provides MOOC-style courses with a strong emphasis on community engagement. The content is centred mainly on AI foundations and applications, and technical issues such as prompts, data science and the usage of specific tools.

3. See https://www.ai4t.eu/teacher-training
4. See https://learn.aisingapore.org/educators

These programmes and associated guidance for teachers need to be planned throughout the key steps of teachers' careers and lifelong professional development journeys. This includes pre-service preparation, in-service training, school-based support, and engagement with peer mentorship and communities of practice. The AI CFT can inform design at of all these stages, ensuring that they are consistent with the required competencies, while also being flexible enough to adapt to the unique needs and contexts of specific educational environments. The AI CFT can, for instance, guide the development, review and updating of pre-service programmes at teacher-training institutions and universities to ensure that newly trained teachers are well-prepared to deploy AI tools and relevant pedagogical methodologies. The planning or adaptation of in-service teacher programmes should naturally build on pre-service training programmes. School-based support programmes can also use the framework to tailor continuous learning and development opportunities that are directly relevant to the specific needs of particular groups of teachers. Furthermore, peer-coaching initiatives, including both offline and online communities of practices, can utilize the AI CFT to plan learning outcomes and monitor progress in a collaborative professional learning environment.

5.5 Develop contextual performance-based assessment tools

The AI CFT can also serve as a guide to craft contextually-relevant criteria to support the institutional assessment of teachers' AI competencies or the design of self-assessment tools. The detailed specification of AI competencies in Chapter 4 serves to inform the construction of assessment tools by providing a structured profiling of teachers' AI skills, attitudinal orientations and behavioural performances in educational settings across various levels – from 'Acquire' to 'Create'. These tables of specifications can be adapted for assessment purposes. More specifically, concrete examples of training methodologies and expected outputs are embedded in the curricular goals and learning objectives within the specifications, and they can be referenced to design assessment methods and assessment items that are relevant to the domain-specific nature and the target cohort of teachers. **Table 5** illustrates how the specification for the competency 'Human-centred mindset' at the first progression level can be referenced to design assessment tools.

Table 5. An example of designing assessment tools based on the AI CFT

Example of the design of an assessment on the 'Human-centred mindset' competency at the 'Acquire' level			
TEACHER COMPETENCY	**Adapt the following learning objectives according to the prior knowledge and work responsibilities of the target group of teachers**	**Design assessment methods and items relevant to the domain of competency and the expected mastery level**	**Grading criteria for performance and latent competencies**
Human agency: Teachers have a critical understanding that AI is human-led and that decisions of AI creators, whether corporate or individual, have a profound impact on human autonomy and rights; teachers are aware of the importance of human agency when evaluating and using AI tools.	LO1.1.1 Critically reflect on the benefits, limitations and risks of specific AI tools in their local educational settings, subject areas and teaching grade levels. LO1.1.2 Demonstrate an awareness that AI is human-led and the corporate or individual decisions of AI creators can impact human rights, human agency, individual lives, and societies. LO1.1.3 Outline the role of humans in the basic steps involved in AI development, from the collection and processing of data to the design of algorithms and functionalities of an AI system, to the deployment and use of AI tools. LO1.1.4 Understand the need to use basic measures to protect human agency in key steps regarding the design and use of AI systems by ensuring respect for data ownership, consent as the basis of data collection, anti-bias data labelling and cleaning, discrimination-free AI algorithms, and user-friendly functions and interfaces.	Write an essay to present your views on the benefits, limitations and risks of using facial recognition (or the auto-correct function of generative AI, or another common AI tool) in education. Design a poster or digital presentation on how the individual and corporate decisions of AI creators may affect teachers' rights, and the agency of both teachers and students. Exemplify an AI tool that should be banned according to the EU AI Act and explain why. Draft a list of daily tips to promote teachers' autonomous use of AI and to encourage student agency.	(To be specified in accordance with the adapted learning objectives and the type of the assessment items)

5.6 Conclusion

The AI CFT is intended to affirm the critical roles of teachers in ensuring the ethical and effective adoption of AI in education. It also aims to inform policy-makers, providers of teacher education programmes, personnel of teacher education institutions, school leaders and teachers themselves of the dynamic evolution of competencies that the transition of education in the AI era may require. Through the launch of the AI CFT, UNESCO calls on its Member States to accelerate the development of national AI competency frameworks and the provision of teacher training programmes in support of lifelong professional learning.

Given the nature of AI as a general-purpose technology with the potential to dramatically transform business models across multiple economic sectors and its rapid advancement at exponential pace, it is likely that the further development of AI and its impact on education will outpace the iterations of the AI CFT. Meanwhile, the surging interest in, and trials of, AI in education will generate a multitude of approaches to the use of AI in education and to the application of the AI CFT in particular. In response to these challenges, UNESCO considers the AI CFT as a 'master framework', rather than a prescriptive blueprint of AI knowledge and skills. It is designed to help frame national, state-level and/or institutional frameworks that can reflect the technological advances over time and changing needs across diverse and varied local contexts. UNESCO therefore recommends that the AI CFT can be used as an overarching framing tool and open-ended roadmap by policy-makers and developers of training programmes to continuously fine-tune the definition of AI competencies and inspire innovative capacity development methodologies.

This is the first edition of the AI competency framework for teachers. It is expected to be updated based on a participatory approach. Stakeholders involved in teacher professional development are encouraged to engage and share their experiences with peer trainers and UNESCO, with a view to co-creating subsequent iterations of this framework.

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AI competency framework for teachers

The *AI competency framework for teachers* presents the first ever global vision of how AI competencies can be defined and developed for the ethical and effective use of artificial intelligence in teaching, learning and assessment.

The framework provides a blueprint on what concrete AI ethical principles, knowledge and skills should be covered and how domain-specific methodologies can be leveraged when developing teacher training programmes.

It emphasizes that preparing teachers' AI competencies is a requirement for the effective use of AI in education and must be based on principles of inclusivity, the centrality of human agency, non-discrimination, and respect for linguistic and cultural diversity.

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4 QUALITY EDUCATION

Sustainable Development Goals

OFFICE OF
Educational Technology

Artificial Intelligence and the Future of Teaching and Learning

Insights and Recommendations

May 2023

Artificial Intelligence and the Future of Teaching and Learning

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Introduction

The U.S. Department of Education (Department) is committed to supporting the use of technology to improve teaching and learning and to support innovation throughout educational systems. This report addresses the clear need for sharing knowledge and developing policies for "Artificial Intelligence," a rapidly advancing class of foundational capabilities which are increasingly embedded in all types of educational technology systems and are also available to the public. We will consider "educational technology" (edtech) to include both (a) technologies specifically designed for educational use, as well as (b) general technologies that are widely used in educational settings. Recommendations in this report seek to engage teachers, educational leaders, policy makers, researchers, and educational technology innovators and providers as they work together on pressing policy issues that arise as Artificial Intelligence (AI) is used in education.

AI can be defined as "automation based on associations." When computers automate reasoning based on associations in data (or associations deduced from expert knowledge), two shifts fundamental to AI occur and shift computing beyond conventional edtech: (1) from capturing data to *detecting patterns* in data and (2) from providing access to instructional resources to *automating decisions* about instruction and other educational processes. Detecting patterns and automating decisions are leaps in the level of responsibilities that can be delegated to a computer system. The process of developing an AI system may lead to bias in how patterns are detected and unfairness in how decisions are automated. Thus, educational systems must govern their use of AI systems. This report describes opportunities for using AI to improve education, recognizes challenges that will arise, and develops recommendations to guide further policy development.

Rising Interest in AI in Education

Today, many priorities for improvements to teaching and learning are unmet. Educators seek technology-enhanced approaches addressing these priorities that would be safe, effective, and scalable. Naturally, educators wonder if the rapid advances in technology in everyday lives could help. Like all of us, educators use AI-powered services in their everyday lives, such as voice assistants in their homes; tools that can correct grammar, complete sentences, and write essays; and automated trip planning on their phones. Many educators are actively exploring AI tools as they are newly released to the public[1]. Educators see opportunities to use AI-powered capabilities like speech recognition to increase the support available to students with disabilities, multilingual learners, and others who could benefit from greater adaptivity and personalization in digital tools for learning. They are exploring how AI can enable writing or improving lessons, as well as their process for finding, choosing, and adapting material for use in their lessons.

Educators are also aware of new risks. Useful, powerful functionality can also be accompanied with new data privacy and security risks. Educators recognize that AI can automatically produce output that is inappropriate or wrong. They are wary that the associations or automations created by AI may amplify unwanted biases. They have noted new ways in which students may

[1] Walton Family Foundation (March 1, 2023). Teachers and students embrace ChatGPT for education. https://www.waltonfamilyfoundation.org/learning/teachers-and-students-embrace-chatgpt-for-education

represent others' work as their own. They are well-aware of "teachable moments" and pedagogical strategies that a human teacher can address but are undetected or misunderstood by AI models. They worry whether recommendations suggested by an algorithm would be fair. Educators' concerns are manifold. Everyone in education has a responsibility to harness the good to serve educational priorities while also protecting against the dangers that may arise as a result of AI being integrated in edtech.

To develop guidance for edtech, the Department works closely with educational constituents. These constituents include educational leaders—teachers, faculty, support staff, and other educators—researchers; policymakers; advocates and funders; technology developers; community members and organizations; and, above all, learners and their families/caregivers. Recently, through its activities with constituents, the Department noticed a sharp rise in interest and concern about AI. For example, a 2021 field scan found that developers of all kinds of technology systems—for student information, classroom instruction, school logistics, parent-teacher communication, and more—expect to add AI capabilities to their systems. Through a series of four listening sessions conducted in June and August 2022 and attended by more than 700 attendees, it became clear that constituents believe that action is required now in order to get ahead of the expected increase of AI in education technology—and they want to roll up their sleeves and start working together. In late 2022 and early 2023, the public became aware of new generative AI chatbots and began to explore how AI could be used to write essays, create lesson plans, produce images, create personalized assignments for students, and more. From public expression in social media, at conferences, and in news media, the Department learned more about risks and benefits of AI-enabled chatbots. And yet this report will not focus on a specific AI tool, service, or announcement, because AI-enabled systems evolve rapidly. Finally, the Department engaged the educational policy expertise available internally and in its relationships with AI policy experts to shape the findings and recommendations in this report.

Three Reasons to Address AI in Education Now

> *"I strongly believe in the need for stakeholders to understand the cyclical effects of AI and education. By understanding how different activities accrue, we have the ability to support virtuous cycles. Otherwise, we will likely allow vicious cycles to perpetuate."*
> *—Lydia Liu*

During the listening sessions, constituents articulated three reasons to address AI now:

First, AI may enable achieving educational priorities in better ways, at scale, and with lower costs. Addressing varied unfinished learning of students due to the pandemic is a policy priority, and AI may improve the adaptivity of learning resources to students' strengths and needs. Improving teaching jobs is a priority, and via automated assistants or other tools, AI may provide teachers greater support. AI may also enable teachers to extend the support they offer to individual students when they run out of time. Developing resources that are responsive to the knowledge and experiences students bring to their learning—their community and cultural assets—is a priority, and AI may enable greater customizability of curricular resources to meet local needs.

As seen in voice assistants, mapping tools, shopping recommendations, essay-writing capabilities, and other familiar applications, AI may enhance educational services.

Second, urgency and importance arise through awareness of system-level risks and anxiety about potential future risks. For example, students may become subject to greater surveillance. Some teachers worry that they may be replaced—to the contrary, the Department firmly rejects the idea that AI could replace teachers. Examples of discrimination from algorithmic bias are on the public's mind, such as a voice recognition system that doesn't work as well with regional dialects, or an exam monitoring system that may unfairly identify some groups of students for disciplinary action. Some uses of AI may be infrastructural and invisible, which creates concerns about transparency and trust. AI often arrives in new applications with the aura of magic, but educators and procurement policies require that edtech show efficacy. AI may provide information that appears authentic, but actually is inaccurate or lacking a basis in reality. Of the highest importance, AI brings new risks in addition to the well-known data privacy and data security risks, such as the risk of scaling pattern detectors and automations that result in "algorithmic discrimination" (e.g., systematic unfairness in the learning opportunities or resources recommended to some populations of students).

Third, urgency arises because of the scale of possible unintended or unexpected consequences. When AI enables instructional decisions to be automated at scale, educators may discover unwanted consequences. In a simple example, if AI adapts by speeding curricular pace for some students and by slowing the pace for other students (based on incomplete data, poor theories, or biased assumptions about learning), achievement gaps could widen. In some cases, the quality of available data may produce unexpected results. For example, an AI-enabled teacher hiring system might be assumed to be more objective than human-based résumé scoring. Yet, if the AI system relies on poor quality historical data, it might de-prioritize candidates who could bring both diversity and talent to a school's teaching workforce.

In summary, it is imperative to address AI in education *now* to realize key opportunities, prevent and mitigate emergent risks, and tackle unintended consequences.

Toward Policies for AI in Education

The 2023 AI Index Report from the Stanford Institute for Human-Centered AI has documented notable acceleration of investment in AI as well as an increase of research on ethics, including issues of fairness and transparency.[2] Of course, research on topics like ethics is increasing because problems are observed. Ethical problems will occur in education, too.[3] The report found a striking interest in 25 countries in the number of legislative proposals that specifically include AI. In the United States, multiple executive orders are focused on ensuring AI is trustworthy and equitable, and the White House Office of Science and Technology Policy has introduced a

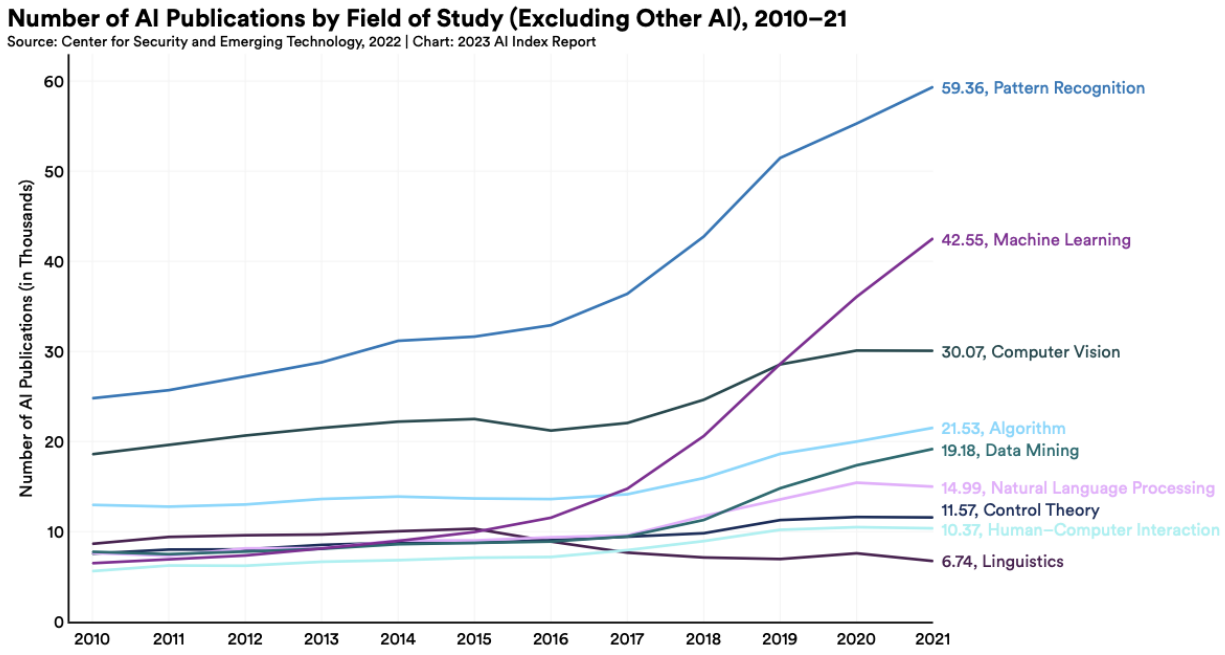
[2] Maslej, N., Fattorini, L., Brynjolfsson E., Etchemendy, J., Ligett, K., Lyons, T., Manyika, J., Ngo, H., Niebles, J.C., Parli, V., Shoham, Y., Wald, R., Clark, J. and Perrault, R., (2023). *The AI index 2023 annual report.* Stanford University: AI Index Steering Committee, Institute for Human-Centered AI.

[3] Holmes, W. & Porayska-Pomsta, K. (Eds.) (2022). *The ethics of artificial intelligence in education.* Routledge. ISBN 978-0367349721

Blueprint for an AI Bill of Rights (Blueprint)[4] that provides principles and practices that help achieve this goal. These initiatives, along with other AI-related policy activities occurring in both the executive and legislative branches, will guide the use of AI throughout all sectors of society. In Europe, the European Commission recently released *Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators*.[5]

AI is moving fast and heralding societal changes that require a national policy response. In addition to broad policies for all sectors of society, education-specific policies are needed to address new opportunities and challenges within existing frameworks that take into consideration federal student privacy laws (such as the Family Educational Rights and Privacy Act, or FERPA), as well as similar state related laws. AI also makes recommendations and takes actions automatically in support of student learning, and thus educators will need to consider how such recommendations and actions can comply with laws such as the Individuals with Disabilities Education Act (IDEA). We discuss specific policies in the concluding section.

Figure 1: Research about AI is growing rapidly. Other indicators, such as dollars invested and number of people employed, show similar trends.



AI is advancing exponentially (see Figure 1), with powerful new AI features for generating images and text becoming available to the public, and leading to changes in how people create text and

[4] White House Office of Science and Technology Policy (October 2022), *Blueprint for an AI bill of rights: Making automated systems work for the American people.* The White House Office of Science and Technology Policy. https://www.whitehouse.gov/ostp/ai-bill-of-rights/

[5] European Commission, Directorate-General for Education, Youth, Sport and Culture. (2022). *Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators*, Publications Office of the European Union. **https://data.europa.eu/doi/10.2766/153756**

images[6]. The advances in AI are not only happening in research labs but also are making news in mainstream media and in educational-specific publications.

Researchers have articulated a range of concepts and frameworks for ethical AI[7], as well as for related concepts such as equitable, responsible, and human-centered AI. Listening session participants called for building on these concepts and frameworks but also recognized the need to do more; participants noted a pressing need for guardrails and guidelines that make educational use of AI advances safe, especially given this accelerating pace of incorporation of AI into mainstream technologies. As policy development takes time, policy makers and educational constituents together need to start now to specify the requirements, disclosures, regulations, and other structures that can shape a positive and safe future for all constituents—especially students and teachers.

Policies are urgently needed to implement the following:

1. leverage automation to advance learning outcomes while protecting human decision making and judgment;

2. interrogate the underlying data quality in AI models to ensure fair and unbiased pattern recognition and decision making in educational applications, based on accurate information appropriate to the pedagogical situation;

3. enable examination of how particular AI technologies, as part of larger edtech or educational systems, may increase or undermine equity for students; and

4. take steps to safeguard and advance equity, including providing for human checks and balances and limiting any AI systems and tools that undermine equity.

[6] Sharples, M. & Pérez y Pérez, R. (2022). *Story machines: How computers have become creative writers*. Routledge. ISBN 9780367751951

[7] Akgun, S., Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI Ethics,* 2, 431–440. https://doi.org/10.1007/s43681-021-00096-7

Building Ethical, Equitable Policies Together

In this report, we aim to build on the listening sessions the Department hosted to engage and inform all constituents involved in making educational decisions so they can prepare for and make better decisions about the role of AI in teaching and learning. AI is a complex and broad topic, and we are not able to cover everything nor resolve issues that still require more constituent engagement. This report is intended to be a starting point.

The opportunities and issues of AI in education are equally important in K-12, higher education, and workforce learning. Due to scope limitations, the examples in this report will focus on K-12 education. The implications are similar at all levels of education, and the Department intends further activities in 2023 to engage constituents beyond K-12 schools.

Guiding Questions

Understanding that AI increases automation and allows machines to do some tasks that only people did in the past leads us to a pair of bold, overarching questions:

1. What is our collective vision of a desirable and achievable educational system that leverages automation to advance learning while protecting and centering human agency?
2. How and on what timeline will we be ready with necessary guidelines and guardrails, as well as convincing evidence of positive impacts, so that constituents can ethically and equitably implement this vision widely?

In the Learning, Teaching, and Assessment sections of this report, we elaborate on elements of an educational vision grounded in what today's learners, teachers, and educational systems need, and we describe key insights and next steps required. Below, we articulate four key foundations for framing these themes. These foundations arise from what we know about the effective use of educational technology to improve opportunity, equity, and outcomes for students and also relate to the new Blueprint.

Foundation 1: Center People (Parents, Educators, and Students)

Education-focused AI policies at the federal, state, and district levels will be needed to guide and empower local and individual decisions about which technologies to adopt and use in schools and classrooms. Consider what is happening in everyday lives. Many of us use AI-enabled products because they are often better and more convenient. For example, few people want to use paper maps anymore; people find that technology helps us plan the best route to a destination more efficiently and conveniently. And yet, people often do not realize how much privacy they are giving up when they accept AI-enabled systems into their lives. AI will bring privacy and other risks that are hard to address only via individual decision making; additional protections will be needed.

There should be clear limits on the ability to collect, use, transfer, and maintain our personal data, including limits on targeted advertising. These limits should put the burden on platforms to minimize how much information they collect, rather than burdening Americans with reading fine print.[8]

As protections are developed, we recommend that policies center people, not machines. To this end, a first recommendation in this document (in the next section) is an emphasis on **AI with humans in the loop**. Teachers, learners, and others need to retain their agency to decide what patterns mean and to choose courses of action. The idea of humans in the loop builds on the concept of "Human Alternatives, Consideration, and Fallback" in the Blueprint and ethical concepts used more broadly in evaluating AI, such as preserving human dignity. A top policy priority must be establishing human in the loop as a requirement in educational applications, despite contrary pressures to use AI as an alternative to human decision making. Policies should not hinder innovation and improvement, nor should they be burdensome to implement. Society needs an education-focused AI policy that protects civil rights and promotes democratic values in the building, deployment, and governance of automated systems to be used across the many decentralized levels of the American educational system.

Foundation 2: Advance Equity

"AI brings educational technology to an inflection point. We can either increase disparities or shrink them, depending on what we do now."
—Dr. Russell Shilling

A recent Executive Order[9] issued by President Biden sought to strengthen the connection among racial equity, education and AI, stating that "members of underserved communities—many of whom have endured generations of discrimination and disinvestment—still confront significant barriers to realizing the full promise of our great Nation, and the Federal Government has a responsibility to remove these barriers" and that the Federal Government shall both "pursue educational equity so that our Nation's schools put every student on a path to success" and also "root out bias in the design and use of new technologies, such as artificial intelligence." A specific vision of equity, such as described in the Department's recent report, *Advancing Digital Equity for All*[10] is essential to policy discussion about AI in education. This report defines digital equity as

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[8] The White House (September 8, 2022). Readout of White House listening session on tech platform accountability. https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/08/readout-of-white-house-listening-session-on-tech-platform-accountability/

[9] The White House (February 17, 2023). Executive order on further advancing racial equity and support for underserved communities through the federal government. https://www.whitehouse.gov/briefing-room/presidential-actions/2023/02/16/executive-order-on-further-advancing-racial-equity

[10] U.S. Department of Education, Office of Educational Technology (2022). Advancing digital equity for all: Community-based recommendations for developing effective digital equity plans to close the digital divide and enable technology-empowered learning. US Department of Education.

"the condition in which individuals and communities have the information technology capacity that is needed for full participation in the society and economy of the United States."

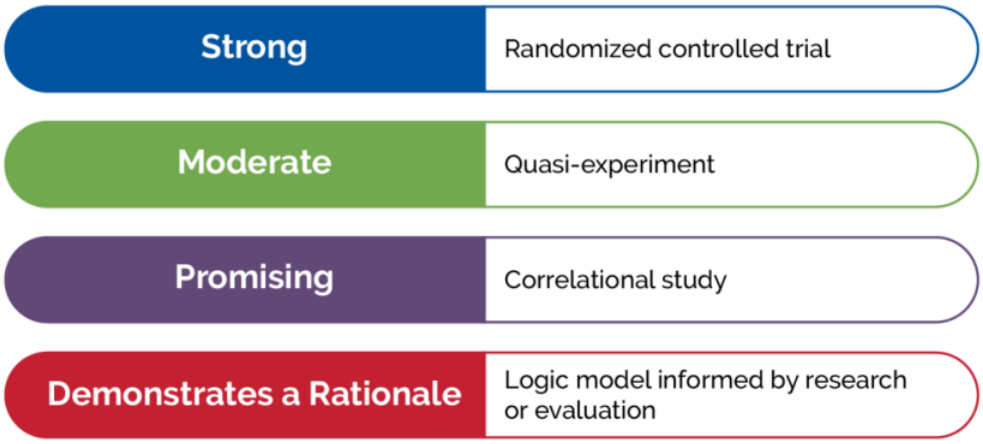
Issues related to racial equity and unfair bias were at the heart of every listening session we held. In particular, we heard a conversation that was increasingly attuned to issues of data quality and the consequences of using poor or inappropriate data in AI systems for education. Datasets are used to develop AI, and when they are non-representative or contain undesired associations or patterns, resulting AI models may act unfairly in how they detect patterns or automate decisions. Systematic, unwanted unfairness in how a computer detects patterns or automates decisions is called "algorithmic bias." Algorithmic bias could diminish equity at scale with unintended discrimination. As this document discussed in the *Formative Assessment* section, this is not a new conversation. For decades, constituents have rightly probed whether assessments are unbiased and fair. Just as with assessments, whether an AI model exhibits algorithmic bias or is judged to be fair and trustworthy is critical as local school leaders make adoption decisions about using AI to achieve their equity goals.

We highlight the concept of "algorithmic discrimination" in the Blueprint. Bias is intrinsic to how AI algorithms are developed using historical data, and it can be difficult to anticipate all impacts of biased data and algorithms during system design. The Department holds that biases in AI algorithms must be addressed when they introduce or sustain unjust discriminatory practices in education. For example, in postsecondary education, algorithms that make enrollment decisions, identify students for early intervention, or flag possible student cheating on exams must be interrogated for evidence of unfair discriminatory bias—and not only when systems are designed, but also later, as systems become widely used.

Foundation 3: Ensure Safety, Ethics, and Effectiveness

A central safety argument in the Department's policies is the need for data privacy and security in the systems used by teachers, students, and others in educational institutions. The development and deployment of AI requires access to detailed data. This data goes beyond conventional student records (roster and gradebook information) to detailed information about what students do as they learn with technology and what teachers do as they use technology to teach. AI's dependence on data requires renewed and strengthened attention to data privacy, security, and governance (as also indicated in the Blueprint). As AI models are not generally developed in consideration of educational usage or student privacy, the educational application of these models may not be aligned with the educational institution's efforts to comply with federal student privacy laws, such as FERPA, or state privacy laws.

Figure 2: The Elementary and Secondary Education Act defines four levels of evidence.



Further, educational leaders are committed to basing their decisions about the adoption of educational technology on evidence of effectiveness—a central foundation of the Department's policy. For example, the requirement to base decisions on evidence also arises in the Elementary and Secondary Education Act (ESEA), as amended, which introduced four tiers of evidence (see Figure 2). Our nation's research agencies, including the Institute of Education Sciences, are essential to producing the needed evidence. The Blueprint calls for evidence of effectiveness, but the education sector is ahead of that game: we need to insist that AI-enhanced edtech rises to meet ESEA standards as well.

Foundation 4: Promote Transparency

The central role of complex AI models in a technology's detection of patterns and implementation of automation is an important way in which AI-enabled applications, products, and services will be different from conventional edtech. The Blueprint introduces the need for transparency about AI models in terms of disclosure ("notice") and explanation. In education, decision makers will need more than notice—they will need to understand how AI models work in a range of general educational use cases, so they can better anticipate limitations, problems, and risks.

AI models in edtech will be approximations of reality and, thus, constituents can always ask these questions: **How precise are the AI models? Do they accurately capture what is most important? How well do the recommendations made by an AI model fit educational goals? What are the broader implications of using AI models at scale in educational processes?**

Building on what was heard from constituents, the sections of this report develop the theme of evaluating the quality of AI systems and tools using multiple dimensions as follows:

- **About AI**: AI systems and tools must respect data privacy and security. Humans must be in the loop.
- **Learning**: AI systems and tools must align to our collective vision for high-quality learning, including equity.
- **Teaching**: AI systems and tools must be inspectable, explainable, and provide human alternatives to AI-based suggestions; educators will need support to exercise professional judgment and override AI models, when necessary.

- **Formative Assessment**: AI systems and tools must minimize bias, promote fairness, and avoid additional testing time and burden for students and teachers.
- **Research and Development**: AI systems and tools must account for the context of teaching and learning and must work well in educational practice, given variability in students, teachers, and settings.
- **Recommendations**: Use of AI systems and tools must be safe and effective for students. They must include algorithmic discrimination protections, protect data privacy, provide notice and explanation, and provide a recourse to humans when problems arise. The people most affected by the use of AI in education must be part of the development of the AI model, system, or tool, even if this slows the pace of adoption.

We return to the idea that these considerations fit together in a comprehensive perspective on the quality of AI models in the *Recommendations* section.

Overview of Document

We begin in the next section by elaborating a definition of AI, followed by addressing learning, teaching, assessment, and research and development. Organizing key insights by these topics keeps us focused on exploring implications for improving educational opportunity and outcomes for students throughout the report.

Within these topics, three important themes are explored:

1. **Opportunities and Risks.** Policies should focus on the most valuable educational advances while mitigating risks.

2. **Trust and Trustworthiness.** Trust and safeguarding are particularly important in education because we have an obligation to keep students out of harm's way and safeguard their learning experiences.

3. **Quality of AI Models.** The process of developing and then applying a model is at the heart of any AI system. Policies need to support evaluation of the qualities of AI models and their alignment to goals for teaching and learning during the processes of educational adoption and use.

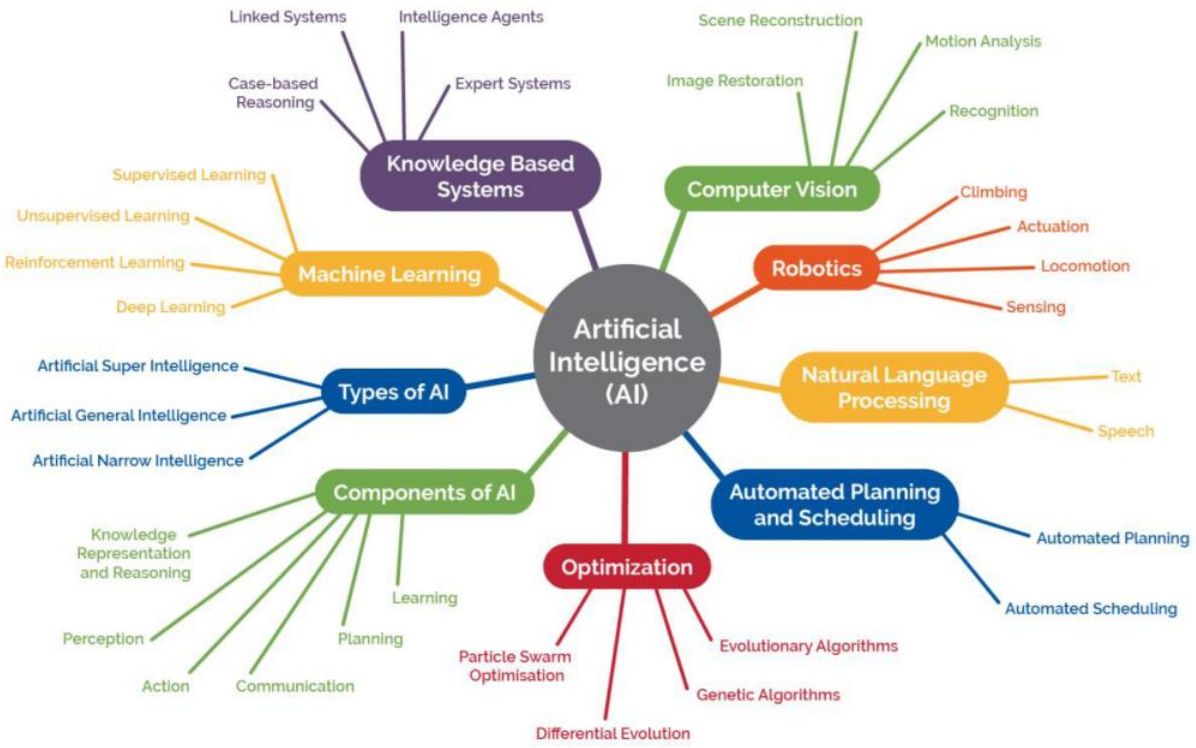
"AI in education can only grow at the speed of trust."
—Dr. Dale Allen

What is AI?

Our preliminary definition of AI as automation based on associations requires elaboration. Below we address three additional perspectives on what constitutes AI. Educators will find these different perspectives arise in the marketing of AI functionality and are important to understand when evaluating edtech systems that incorporate AI. One useful glossary of AI for Education terms is the CIRCLS Glossary of Artificial Intelligence Terms for Educators.[11]

AI is not one thing but an umbrella term for a growing set of modeling capabilities, as visualized in Figure 3.

Figure 3: Components, types, and subfields of AI based on Regona et al (2022).[12]



[11] Search for "AI Glossary Educators" to find other useful definitions.

[12] Regona, Massimo & Yigitcanlar, Tan & Xia, Bo & Li, R.Y.M. (2022). Opportunities and adoption challenges of AI in the construction industry: A PRISMA review. *Journal of Open Innovation Technology Market and Complexity, 8(45).* https://doi.org/10.3390/joitmc8010045

Perspective: Human-Like Reasoning

> *"The theory and development of computer systems able to perform tasks normally requiring human intelligence such as, visual perception, speech recognition, learning, decision-making, and natural language processing."* [13]

Broad cultural awareness of AI may be traced to the landmark 1968 film "2001: A Space Odyssey"—in which the "*H*euristically-programmed *AL*gorithmic" computer, or "HAL," converses with astronaut Frank. HAL helps Frank pilot the journey through space, a job that Frank could not do on his own. However, Frank eventually goes outside the spacecraft, HAL takes over control, and this does not end well for Frank. HAL exhibits human-like behaviors, such as reasoning, talking, and acting. Like all applications of AI, HAL can help humans but also introduces unanticipated risks—especially since AI reasons in different ways and with different limitations than people do.

The idea of "human-like" is helpful because it can be a shorthand for the idea that computers now have capabilities that are very different from the capabilities of early edtech applications. Educational applications will be able to converse with students and teachers, co-pilot how activities unfold in classrooms, and take actions that impact students and teachers more broadly. There will be both opportunities to do things much better than we do today and risks that must be anticipated and addressed.

The "human-like" shorthand is not always useful, however, because AI processes information differently from how people process information. When we gloss over the differences between people and computers, we may frame policies for AI in education that miss the mark.

Perspective: An Algorithm that Pursues a Goal

> *"Any computational method that is made to act independently towards a goal based on inferences from theory or patterns in data."* [14]

This second definition emphasizes that AI systems and tools identify patterns and choose actions to achieve a given goal. These pattern recognition capabilities and automated recommendations will be used in ways that impact the educational process, including student learning and teacher instructional decision making. For example, today's personalized learning systems may recognize signs that a student is struggling and may recommend an alternative instructional sequence. The scope of pattern recognition and automated recommendations will expand.

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[13] IEEE-USA Board of Directors. (February 10, 2017). *Artificial intelligence research, development and regulation.* IEEE http://globalpolicy.ieee.org/wp-content/uploads/2017/10/IEEE17003.pdf

[14] Friedman, L., Blair Black, N., Walker, E., & Roschelle, J. (November 8, 2021) *Safe AI in education needs you*. Association of Computing Machinery blog, https://cacm.acm.org/blogs/blog-cacm/256657-safe-ai-in-education-needs-you/fulltext

Correspondingly, humans must determine the types and degree of responsibility we will grant to technology within educational processes, which is not a new dilemma.

For decades, the lines between the role of teachers and computers have been discussed in education, for example, in debates using terms such as "'computer-aided instruction," "blended instruction," and "personalized learning." Yet, how are instructional choices made in systems that include both humans and algorithms? Today, AI systems and tools are already enabling the adaptation of instructional sequences to student needs to give students feedback and hints, for example, during mathematics problem solving or foreign language learning. This discussion about the use of AI in classroom pedagogy and student learning will be renewed and intensify as AI-enabled systems and tools advance in capability and become more ubiquitous.

Let's start with another simple example. When a teacher says, "Display a map of ancient Greece on the classroom screen," an AI system may choose among hundreds of maps by noting the lesson objectives, what has worked well in similar classrooms, or which maps have desirable features for student learning. In this case, when an AI system suggests an instructional resource or provides a choice among a few options, the instructor may save time and may focus on more important goals. However, there are also forms of AI-enabled automation that the classroom instructor may reject, for example, enabling an AI system or tool to select the most appropriate and relevant readings for students associated with a historical event. In this case, an educator may choose not to utilize AI-enabled systems or tools given the risk of AI creating false facts ("hallucinating") or steering students toward inaccurate depictions of historical events found on the internet. Educators will be weighing benefits and risks like these daily.

Computers process theory and data differently than humans. AI's success depends on associations or relationships found in the data provided to an algorithm during the AI model development process. Although some associations may be useful, others may be biased or inappropriate. Finding bad associations in data is a major risk, possibly leading to algorithmic discrimination. Every guardian is familiar with the problem: A person or computer may say, "Our data suggests your student should be placed in this class," and the guardian may well argue, "No, you are using the wrong data. I know my child better, and they should instead be placed in another class." This problem is not limited exclusively to AI systems and tools, but the use of AI models can amplify the problem when a computer uses data to make a recommendation because it may appear to be more objective and authoritative, even if it is not.

Although this perspective can be useful, it can be misleading. A human view of agency, pursuing goals, and reasoning includes our human abilities to make sense of multiple contexts. For example, a teacher may see three students each make the same mathematical error but recognize that one student has an Individualized Education Program to address vision issues, another misunderstands a mathematical concept, and a third just experienced a frustrating interaction on the playground; the same instructional decision is therefore not appropriate. However, AI systems often lack data and judgement to appropriately include context as they detect patterns and automate decisions. Further, case studies show that technology has the potential to quickly derail from safe to unsafe or from effective to ineffective when the context shifts even slightly. For this and other reasons, people must be involved in goal setting, pattern analysis, and decision-making.[15]

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[15] Russell, S. (2019). Human compatible: Artificial intelligence and the problem of control. Viking. ISBN 978-0-525-55861-3.

Perspective: Intelligence Augmentation

> *"Augmented intelligence is a design pattern for a human-centered partnership model of people and artificial intelligence (AI) working together to enhance cognitive performance, including learning, decision making, and new experiences."* [16]

Foundation #1 (above) keeps humans in the loop and positions AI systems and tools to support human reasoning. "Intelligence Augmentation" (IA)[17] centers "intelligence" and "decision making" in humans but recognizes that people sometimes are overburdened and benefit from assistive tools. AI may help teachers make better decisions because computers notice patterns that teachers can miss. For example, when a teacher and student agree that the student needs reminders, an AI system may provide reminders in whatever form a student likes without adding to the teacher's workload. Intelligence Automation (IA) uses the same basic capabilities of AI, employing associations in data to notice patterns, and, through automation, takes actions based on those patterns. However, IA squarely focuses on helping people in human activities of teaching and learning, whereas AI tends to focus attention on what computers can do.

Definition of "Model"

The above perspectives open a door to making sense of AI. Yet, to assess AI meaningfully, constituents must consider specific models and how they are developed. In everyday usage, the term "model" has multiple definitions. We clarify our intended meaning, which is a meaning similar to "mathematical model," below. (Conversely, note that "model" as used in "AI model" is unlike the usage in "model school" or "instructional model" as AI model is not a singular case created by experts to serve as an exemplar.)

AI models are like financial models: an approximation of reality that is useful for identifying patterns, making predictions, or analyzing alternative decisions. In a typical middle school math curriculum, students use a mathematical model to analyze which of two cell phone plans is better. Financial planners use this type of model to provide guidance on a retirement portfolio. At its heart, AI is a highly advanced mathematical toolkit for building and using models. Indeed, in well-known chatbots, complex essays are written one word at a time. The underlying AI model predicts which next words would likely follow the text written so far; AI chatbots use a very large statistical model to add one likely word at a time, thereby writing surprisingly coherent essays.

When we ask about the model at the heart of AI, we begin to get answers about "what aspects of reality does the model approximate well?" and "how appropriate is it to the decision to be made?" One could similarly ask about algorithms—the specific decision-making processes that an AI model uses to go from inputs to outputs. One could also ask about the quality of the data used to build the model—for example, how representative is that data? Switching among three terms—

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[16] Gartner (n.d.) *Gartner glossary: Augmented intelligence*. Gartner. https://www.gartner.com/en/information-technology/glossary/augmented-intelligence

[17] Englebart, D.C. (October 1962). Augmenting human intellect: A conceptual framework. SRI Summary Report AFOSR-3223. https://www.dougengelbart.org/pubs/augment-3906.html

models, algorithms, and data—will become confusing. Because the terms are closely related, we've chosen to focus on the concept of AI models. We want to bring to the fore the idea that every AI model is incomplete, and it's important to know how well the AI model fits the reality we care about, where the model will break down, and how.

Sometimes people avoid talking about the specifics of models to create a mystique. Talking as though AI is unbounded in its potential capabilities and a nearly perfect approximation to reality can convey an excitement about the possibilities of the future. The future, however, can be oversold. Similarly, sometimes people stop calling a model AI when its use becomes commonplace, yet such systems are still AI models with all of the risks discussed here. We need to know exactly when and where AI models fail to align to visions for teaching and learning.

Insight: AI Systems Enable New Forms of Interaction

AI models allow computational processes to make recommendations or plans and also enable them to support forms of interaction that are more natural, such as speaking to an assistant. AI-enabled educational systems will be desirable in part due to their ability to support more natural interactions during teaching and learning. In classic edtech platforms, the ways in which teachers and students interact with edtech are limited. Teachers and students may choose items from a menu or in a multiple-choice question. They may type short answers. They may drag objects on the screen or use touch gestures. The computer provides outputs to students and teachers through text, graphics, and multimedia. Although these forms of inputs and outputs are versatile, no one would mistake this style of interaction with the way two people interact with one another; it is specific to human-computer interaction. With AI, interactions with computers are likely to become more like human-to-human interactions (see Figure 4). A teacher may speak to an AI assistant, and it may speak back. A student may make a drawing, and the computer may highlight a portion of the drawing. A teacher or student may start to write something, and the computer may finish their sentence—as when today's email programs can complete thoughts faster than we can type them.

Additionally, the possibilities for automated actions that can be executed by AI tools are expanding. Current personalization tools may automatically adjust the sequence, pace, hints, or trajectory through learning experiences.[18] Actions in the future might look like an AI system or tool that helps a student with homework[19] or a teaching assistant that reduces a teacher's workload by recommending lesson plans that fit a teacher's needs and are similar to lesson plans a teacher previously liked.[20] Further, an AI-enabled assistant may appear as an additional "partner" in a small group of students who are working together on a collaborative assignment.[21] An AI-enabled tool may also help teachers with complex classroom routines.[22] For example, a

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[18] Shemshack, A., Spector, J.M. (2020) A systematic literature review of personalized learning terms. *Smart Learning Environments, 7(33).* https://doi.org/10.1186/s40561-020-00140-9

[19] Roschelle, J., Feng, M., Murphy, R. & Mason, C.A. (2016). Online mathematics homework increases student achievement. *AERA Open, 2(4),* 1-12. DOI: 10.1177/2332858416673968

[20] Celik, I., Dindar, M., Muukkonen, H. & Järvelä, S. (2022). The promises and challenges of artificial intelligence for teachers: A systematic review of research. *TechTrends, 66,* 616–630. https://doi.org/10.1007/s11528-022-00715-y

[21] Chen, C., Park, H.W. & Breazeal, C. (2020). Teaching and learning with children: Impact of reciprocal peer learning with a social robot on children's learning and emotive engagement. *Computers & Education, 150,* https://doi.org/10.1016/j.compedu.2020.103836

[22] Holstein, K., McLaren, B.M., & Aleven, V. (2019). Co-designing a real-time classroom orchestration tool to support teacher–AI complementarity. *Journal of Learning Analytics, 6(2).* https://doi.org/10.18608/jla.2019.62.3

tool may help teachers with orchestrating[23] the movement of students from a full class discussion into small groups and making sure each group has the materials needed to start their work.

Figure 4. Differences that teachers and students may experience in future technologies.

	Familiar Technology Capabilities	Future Technology Capabilities
Input	• Typing	• Speaking
	• Clicking and dragging	• Drawing
	• Touching and gesturing	• Analyzing images and video
Processing	• Displaying information and tasks	• Assisting students and teachers
	• Sequencing learning activities	• Planning and adapting activities
	• Checking student work	• Revealing patterns in student work
Output	• Text	• Conversations
	• Graphics	• Annotating and highlighting
	• Multimedia	• Suggesting and recommending
	• Dashboards	• Organizing and guiding

Key Recommendation: Human in the Loop AI

Many have experienced a moment where technology surprised them with an uncanny ability to recommend what feels like a precisely personalized product, song, or even phrase to complete a sentence in a word processor such as the one being used to draft this document. Throughout this supplement, we talk about specific, focused applications where AI systems may bring value (or risks) into education. At no point do we intend to imply that AI can replace a teacher, a guardian, or an educational leader as the custodian of their students' learning. We talk about the limitations of models in AI and the conversations that educational constituents need to have about what qualities they want AI models to have and how they should be used.

> *"We can use AI to study the diversity, the multiplicity of effective learning approaches and think about the various models to help us get a broader understanding of what effective, meaningful engagement might look like across a variety of different contexts."*
> *—Dr. Marcelo Aaron Bonilla Worsley*

[23] Roschelle, J., Dimitriadis, Y. & Hoppe, U. (2013). Classroom orchestration: Synthesis. *Computers & Education, 69,* 512-526. https://doi.org/10.1016/j.compedu.2013.04.010

These limitations lead to our first recommendation: that we pursue a vision of AI where humans are in the loop. That means that people are part of the process of noticing patterns in an educational system and assigning meaning to those patterns. It also means that teachers remain at the helm of major instructional decisions. It means that formative assessments involve teacher input and decision making, too. One loop is the cycle of recognizing patterns in what students do and selecting next steps or resources that could support their learning. Other loops involve teachers planning and reflecting on lessons. Response to Intervention is another well-known type of loop.

The idea of humans in the loop is part of our broader discussions happening about AI and society, not just AI in education. Interested readers could look for more on human-centered AI, responsible AI, value-sensitive AI, AI for social good, and other similar terms that ally with humans in the loop, such as "human-centered AI."

Exercising judgement and control in the use of AI systems and tools is an essential part of providing the best opportunity to learn for all students—especially when educational decisions carry consequence. AI does not have the broad qualities of contextual judgment that people do. Therefore, people must remain responsible for the health and safety of our children, for all students' educational success and preparation for their futures, and for creating a more equitable and just society.

Learning

The Department's long-standing edtech vision sees students as active learners; students participate in discussions that advance their understanding, use visualizations and simulations to explain concepts as they relate to the real world, and leverage helpful scaffolding and timely feedback as they learn. Constituents want technology to align to and build on these and other research-based understandings of how people learn. Educators can draw upon two books titled *How People Learn* and *How People Learn II* by the National Academies of Sciences, Engineering, and Medicine for a broad synthesis of what we know about learning.[24] As we shape AI-enhanced edtech around research-based principles, a key goal must be to strengthen and support learning for those who have experienced unfavorable circumstances for learning, such as caused by the COVID-19 pandemic or by broader inequities. And we must keep a firm eye toward the forms of learning that will most benefit learners in their future lives in communities and workplaces.

Examples of AI supporting learning principles in this section include the following: AI-based tutoring for students as they solve math problems (based on cognitive learning theories), adapting to learners with special needs (based on the Universal Design for Learning framework and related theories), and AI support for effective student teamwork (based on theories in the field called "Computer Supported Collaborative Learning").

Insight: AI Enables Adaptivity in Learning

Adaptivity has been recognized as a key way in which technology can improve learning.[25] AI can be a toolset for improving the adaptivity of edtech. AI may improve a technology's ability to meet students where they are, build on their strengths, and grow their knowledge and skills. Because of AI's powers of work with natural forms of input and the foundational strengths of AI models (as discussed in the *What is AI?* section), AI can be an especially strong toolkit for expanding the adaptivity provided to students.

And yet, especially with AI, adaptivity is always more specific and limited than what a broad phrase like "meet students where they are" might suggest. Core limits arise from the nature of the model at the heart of any specific AI-enabled system. Models are approximations of reality. When important parts of human learning are left out of the model or less fully developed, the resulting adaptivity will also be limited, and the resulting supports for learning may be brittle or narrow. Consequently, this section on *Learning* focuses on one key concept: Work toward AI models that fit the fullness of visions for learning—and avoid limiting learning to what AI can currently model well.

AI models are demonstrating greater skills because of advances in what are called "large language models" or sometimes "foundational models." These very general models still have limits. For example, generative AI models discussed in the mainstream news can quickly generate convincing essays about a wide variety of topics while other models can draw credible images based on just a few prompts. Despite the excitement about foundational models, experts in our

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[24] National Research Council. 2000. *How people learn: Brain, mind, experience, and school.* The National Academies Press. https://doi.org/10.17226/9853; National Academies of Sciences, Engineering, and Medicine. 2018. *How people learn II: Learners, contexts, and cultures*. The National Academies Press. https://doi.org/10.17226/24783

[25] Aleven, V., McLaughlin, E. A., Glenn, R. A., & Koedinger, K. R. (2016). Instruction based on adaptive learning technologies. In Mayer, R.E. & Alexander, P.A., *Handbook of research on learning and instruction*, 522-560. ISBN: 113883176X

listening sessions warned that AI models are narrower than visions for human learning and that designing learning environments with these limits in mind remains very important. The models are also brittle and can't perform well when contexts change. In addition, they don't have the same "common sense" judgment that people have, often responding in ways that are unnatural or incorrect.[26] Given the unexpected ways in which foundational models miss the mark, keeping humans in the loop remains highly important.

Intelligent Tutoring Systems: An Example of AI Models

One long-standing type of AI-enabled technology is an Intelligent Tutoring System (ITS).[27] In an early success, scientists were able to build accurate models of how human experts solve mathematical problems. The resulting model was incorporated into a system that would observe student problem solving as they worked on mathematical problems on a computer. Researchers who studied human tutors found that feedback on specific steps (and not just right or wrong solutions) is a likely key to why tutoring is so effective.[28] For example, when a student diverged from the expert model, the system gave feedback to help the student get back on track.[29] Importantly, this feedback went beyond right or wrong, and instead, the model was able to provide feedback on specific steps of a solution process. A significant advancement of AI, therefore, can be its ability to provide adaptivity at the step-by-step level and its ability to do so at scale with modest cost.

As a research and development (R&D) field emerged to advance ITS, the work has gone beyond mathematics problems to additional important issues beyond step-by-step problem solving. In the early work, some limitations can be observed. The kinds of problems that an ITS could support were logical or mathematical, and they were closed tasks, with clear expectations for what a solution and solution process should look like. Also, the "approximation of reality" in early AI models related to cognition and not to other elements of human learning, for example, social or motivational aspects. Over time, these early limitations have been addressed in two ways: by expanding the AI models and by involving humans in the loop, a perspective that is also important now. Today, for example, if an ITS specializes in feedback as a student practices, a human teacher could still be responsible for motivating student engagement and self-regulation along with other aspects of instruction. In other contemporary examples, the computer ITS might focus on problem solving practice, while teachers work with students in small groups. Further, students can be in the loop with AI, as is the case with "open learner models"—a type of AI-enabled system that provides information to support student self-monitoring and reflection.[30]

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[26] Dieterle, E., Dede, C. & Walker, M. (2022). The cyclical ethical effects of using artificial intelligence in education. *AI & Society*. https://link.springer.com/article/10.1007/s00146-022-01497-w

[27] Mousavinasab, E., Zarifsanaiey, N., R. Niakan Kalhori, S., Rakhshan, M., Keikha, L., & Ghazi Saeedi, M. (2021). Intelligent tutoring systems: A systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments, 29(1),* 142–163. https://psycnet.apa.org/doi/10.1080/10494820.2018.1558257

[28] Van Lehn, K. (2011) The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, *46(4)*, 197-221. https://doi.org/10.1080/00461520.2011.611369

[29] Ritter, S., Anderson, J.R., Koedinger, K.R. & Corbett, A. (2007). Cognitive Tutor: Applied research in mathematics education. *Psychonomic Bulletin & Review, 14,* 249–255/ https://doi.org/10.3758/BF03194060

[30] Winne, P.H. (2021). Open learner models working in symbiosis with self-regulating learners: A research agenda. *International Journal of Artificial Intelligence in Education, 31(3),* 446-459. https://doi.org/10.1007/s40593-020-00212-4

Although R&D along the lines of an ITS should not limit the view of what's possible, such an example is useful because so much research and evaluation has been done on the ITS approach. Researchers have looked across all the available high-quality studies in a meta-analysis and concluded that ITS approaches are effective.[31] Right now, many school systems are looking at high-intensity human tutoring to help students with unfinished learning. Human tutoring is very expensive, and it is hard to find enough high-quality human tutors. With regard to large-scale needs, if it is possible for an ITS to supplement what human tutors do, it might be possible to extend beyond the amount of tutoring that people can provide to students.

Important Directions for Expanding AI-Based Adaptivity

Adaptivity is sometimes referred to as "personalization." Although this is a convenient term, many observers have noted how imprecise it is.[32] For some educators, personalization means giving learners "voice and choice," and for others it means that a learning management system recommends an individual "playlist" of activities to each student. Hidden in that imprecision is the reality that many edtech products that personalize do so in limited ways. Adjusting the difficulty and the order of lesson materials are among the two most common ways that edtech products adapt. And yet, any teacher knows there is more to supporting learning than adjusting the difficulty and sequence of materials. For example, a good teacher can find ways to engage a student by connecting to their own past experiences and can shape explanations until they really connect in an "aha!" moment for that student. When we say, "meet the learner where they are," human teachers bring a much more complete picture of each learner than most available edtech. The teacher is also not likely to "over personalize" (by performing like an algorithm that only presents material for which the learner has expressed interest), thereby limiting the student's exposure to new topics. The nature of "teachable moments" that a human teacher can grasp is broader than the teachable moments today's AI models grasp.

In our listening sessions, we heard many ways in which the core models in an AI system must be expanded. We discuss these below.

1. **From deficit-based to asset-oriented.** Listening session attendees noted that the rhetoric around adaptivity has often been deficit-based; technology tries to pinpoint what a student is lacking and then provides instruction to fill that specific gap. Teachers also orient to students' strengths; they find competencies or "assets" a student has and use those to build up the students' knowledge. AI models cannot be fully equitable while failing to recognize or build upon each student's sources of competency. AI models that are more asset-oriented would be an advance.
2. **From individual cognition to including social and other aspects of learning.** The existing adaptivity rhetoric has also tended to focus on individualized learning and mostly on cognitive elements of learning, with motivational and other elements only brought in to support the cognitive learning goals. Attendees observe that their vision for learning is broader than cognition. Social learning is important, for example, especially

[31] Kulik, J.A., & Fletcher, J.D. (2016). Effectiveness of intelligent tutoring systems: A meta-analytic review. *Review of Educational Research, 86(1),* 42–78; Ma, W., Adescope, O.O, Nesbit, J.C. & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. *Journal of Educational Psychology, 106(4),* 901–918. http://dx.doi.org/10.1037/a0037123

[32] Plass, J.L., & Pawar, S. (2020). Toward a taxonomy of adaptivity for learning. *Journal of Research on Technology in Education, 52(3),* 275–300. https://doi.org/10.1080/15391523.2020.1719943;

for students to learn to reason, explain, and justify. For students who are learning English, customized and adaptive support for improving language skills while learning curricular content is clearly important. Developing self-regulation skills is also important. A modern vision of learning is not individualistic; it recognizes that students learn in groups and communities too.

3. **From neurotypical to neurodiverse learners.** AI models could help in including neurodiverse learners (students who access, process, and interact with the world in less common ways than "neurotypical" students) who could benefit from different learning paths and from forms of display and input that fit their strengths. Constituents want AI models that can support learning for neurodiverse learners and learners with disabilities. Thus, they want AI models that can work with multiple paths to learning and multiple modalities of interaction. Such models should be tested for efficacy, to guard against the possibility that some students could be assigned a "personalized" but inadequate learning resource. In addition, some systems for neurodiverse students are presently underutilized, so designs that support intended use will also be important.

4. **From fixed tasks to active, open, and creative tasks.** As mentioned above, AI models are historically better at closed tasks like solving a math problem or logical tasks like playing a game. In terms of life-wide and lifelong opportunities, we value learning how to succeed at open-ended and creative tasks that require extended engagement from the learner, and these are often not purely mathematical or logical. We want students to learn to invent and create innovative approaches. We want AI models that enable progress on open, creative tasks.

5. **From correct answers to additional goals.** At the heart of many adaptivity approaches now on the market, the model inside the technology counts students' wrong answers and decides whether to speed up, slow down, or offer a different type of learning support. Yet, right and wrong answers are not the only learning goals. We want students to learn how to self-regulate when they experience difficulties in learning, for example, such as being able to persist in working on a difficult problem or knowing how and when to ask for help. We want learners to become skilled in teamwork and in leading teams. As students grow, we want them to develop more agency and to be able to act on their own to advance toward their own learning goals.

Listing every dimension of expansion that we heard in our listening sessions is beyond the scope of this report. Some additional dimensions are presented in the following sections on *Teaching, Assessment,* and *Research*. For example, in *Research*, we discuss all the ways in which AI systems have trouble with context—context that humans readily grasp and consider.

Overall, constituents in the listening sessions realized we need an ambitious outlook on learning to respond to the future today's learners face. Constituents were concerned about ways in which AI might narrow learning. For example, if the incorporation of AI into education slowed attention to students' skills on creative, open-ended tasks and their ability to lead and collaborate in teams, then school districts may be less able to realize their students' progress in relation to a Portrait of a Graduate who excels in communication and other skills valued in communities and careers.

Constituents reminded us that as we conceptualize what we want AI in edtech to accomplish, we must start and constantly revisit a human-centered vision of learning.

A Duality: Learning With and About AI

As AI is brought into schools, two broad perspectives about AI in education arise: (1) AI in support of student learning; and (2) support for learning about AI and related technologies. So far, we've discussed AI systems and tools to support student learning and mastery of subjects like mathematics and writing. Yet, it is also important that students learn about AI, critically examine its presence in education and society, and determine its role and value in their own lives and careers. We discuss risks across each section in this report. Here, it is important for students to become more aware of and savvy to the risks of AI—including risks of bias and surveillance—as they appear in all elements of their lives. In the recent past, schools have supported students' understanding of cybersecurity, for example. AI will bring new risks, and students need to learn about them.

We are encouraged by efforts we've seen underway that would give students opportunities to learn about how AI works while also giving them opportunities to discuss relevant topics like privacy and security.[33] Other learning goals are noted in the K-12 Computer Science Framework. We've seen that students can begin learning about AI in elementary, middle, and high school. They can use AI to design simulations and products that they find exciting. And we've seen that students want to talk about the ethics of products they experience in their everyday lives and have much to say about the kinds of products they'd like to see or not see in school. (And later, in the *Research* section, we note the desire for co-design processes that involve students in creating the next generation of AI-enabled edtech). Overall, it's important to balance attention to using AI to support learning and giving students opportunities to learn about AI.

A Challenge: Systems Thinking About AI in Education

As AI expands into the educational system, our listening session attendees reminded us that it will be entering parts or locations of the system that are presently dysfunctional. AI is certainly not a fix for broken systems, and instead, must be used with even more care when the systems' context is unstable or uncertain.

[33] Forsyth, S., Dalton, B., Foster, E.H., Walsh, B., Smilack, J., & Yeh, T. (2021, May). Imagine a more ethical AI: Using stories to develop teens' awareness and understanding of artificial intelligence and its societal impacts. In 2021 Conference on Research in Equitable and Sustained Participation in Engineering, Computing, and Technology (RESPECT). IEEE. https://doi.org/10.1109/RESPECT51740.2021.9620549; Zhang, H., Lee, I., Ali, S., DiPaola, D., Cheng, Y., & Breazeal, C. (2022). Integrating ethics and career futures with technical learning to promote AI literacy for middle school students: An exploratory study. *International Journal of Artificial Intelligence in Education, 1–35.* https://doi.org/10.1007/s40593-022-00293-3

"First and foremost, they are getting deployed in educational contexts that are already fragmented and broken and unequal. Technology doesn't discriminate—we do. So, as we think about the application of these new systems, we have to really think about the contextual application of AI."
—Dr. Nicole Turner

As discussed previously, because AI systems and tools do not fully align with goals for learning, we have to design educational settings to situate AI in the right place, where educators and other adults can make effective use of these tools for teaching and learning. Within the ITS example, we saw that AI could make learning by practicing math problems more effective, and a whole curricular approach might include roles for teachers that emphasize mathematical practices like argumentation and modeling. Further, small-group work is likely to remain important: Students might work in small groups to use mathematics to predict or justify as they work on responding to a realistic challenge. At the present, one "right place" for people, and not AI, is understanding how learning can be culturally responsive and culturally sustaining, as AI is not even close to being ready to connect learning to the unique strengths in a student's community and family.

Open Questions About AI for Learning

With advances occurring in the foundations for AI, opportunities to use AI in support of learning are rapidly expanding. As we explore these opportunities, the open questions below deserve ongoing attention:

- To what extent is AI enabling adaptation to students' strengths and not just deficits? Is AI enabling improved support for learners with disabilities and English language learners?
- How are youth voices involved in choosing and using AI for learning?
- Is AI leading to narrower student activities (e.g., procedural math problems), or the fuller range of activities highlighted in the National Educational Technology Plan (NETP), which emphasizes features such as personalized learning, project-based learning, learning from visualizations, simulations, and virtual reality, as well as learning across school, community, and familial settings?
- Is AI supporting the whole learner, including social dimensions of learning such as enabling students to be active participants in small group and collaborative learning? For example, does AI contribute to aspects of student collaboration we value like shared attention, mutual engagement, peer help, self-regulation, and building on each other's contributions?
- When AI is used, are students' privacy and data protected? Are students and their guardians informed about what happens with their data?
- How strong are the processes or systems for monitoring student use of AI for barriers, bias, or other undesirable consequences of AI use by learners? How are emergent issues addressed?
- Is high-quality research or evaluations about the impacts of using the AI system for student learning available? Do we know not only whether the system works but for whom and under what conditions?

Key Recommendation: Seek AI Models Aligned to a Vision for Learning

We've called attention to how advances in AI are important to adaptivity but also to ways in which adaptivity is limited by the model's inherent quality. We noted that a prior wave of edtech used the term "personalized" in differing ways, and it was often important to clarify what personalization meant for a particular product or service. Thus, our key recommendation is to tease out the strengths and limitations of AI models inside forthcoming edtech products and to focus on AI models that align closely to desired visions of learning. AI is now advancing rapidly, and we should differentiate between products that have simple AI-like features inside and products that have more sophisticated AI models.

Looking at what's happening in research and development, we can see significant effort and push toward overcoming these limitations. We noted that decision makers need to be careful about selecting AI models that might narrow their vision for learning, as general artificial intelligence does not exist. And because AI models will always be narrower than real world experience, we need to proceed with systems thinking in which humans are in the loop, with the strengths and weaknesses of the specific educational system considered. We hold that the full system for learning is broader than its AI component.

Teaching

Teachers have long envisioned many things that technology could make possible for teachers, their classrooms, and their students but not the changes wrought by the recent pandemic. Today, nearly all teachers have experienced uses of technologies for instruction that no one anticipated. Some of those experiences were positive, and others were not. All of the experiences provide an important context as we think further about teaching and technology.

There is a critical need to focus on addressing the challenges teachers experience. It must become easier for teachers to do the amazing work they always do. We must also remember why people choose the teaching profession and ensure they can do the work that matters. This section discusses examples of AI supporting teachers and teaching including these concepts: AI assistants to reduce routine teaching burdens; AI that provides teachers with recommendations for their students' needs and extends their work with students; and AI that helps teachers to reflect, plan, and improve their practice.

> *"One opportunity I see with AI is being able to reduce the amount of attention I have to give to administrative things and increase the amount of attention I can give to my students with their learning needs in the classroom. So that's the first one that I'd say that I'm super excited about the possibility of AI to support me as a teacher."*
> *—Vidula Plante*

Always Center Educators in Instructional Loops

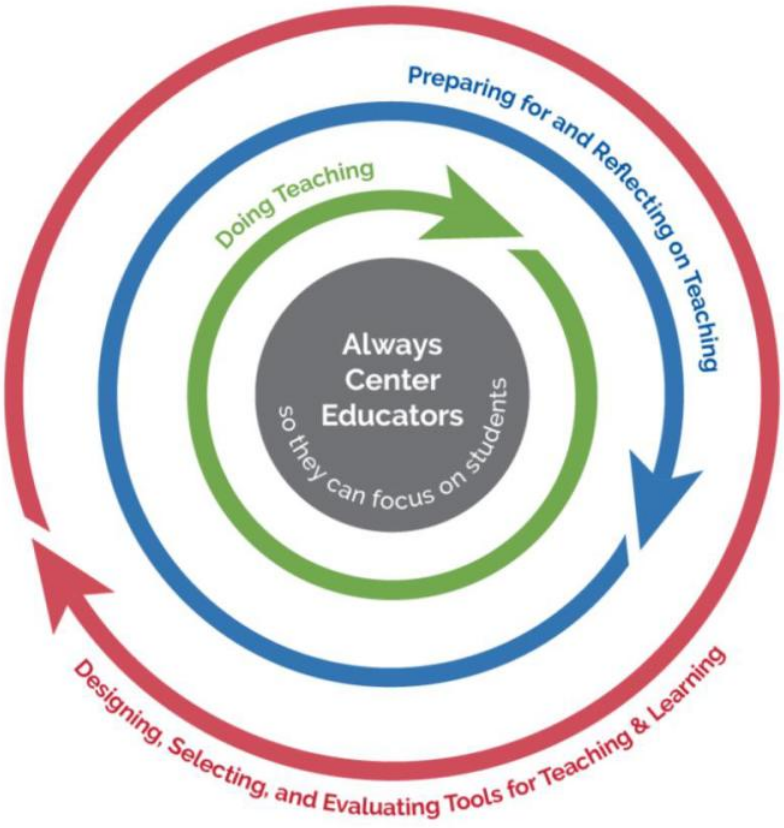
To succeed with AI as an enhancement to learning and teaching, we need to always center educators (ACE). Practically speaking, practicing "ACE in AI" means keeping a humanistic view of teaching front and center. ACE leads the Department to confidently respond "no" when asked "will AI replace teachers?" ACE is not just about making teachers' jobs easier but also making it possible to do what most teachers want to do. That includes, for example, understanding their students more deeply and having more time to respond in creative ways to teachable moments.

To bring more precision to how and where we should center educators, we return to our advocacy for human in the loop AI and ask, what are the loops in which teachers should be centered? Figure 5 suggests three key loops (inspired by research on adaptivity loops[34]):

[34] Aleven, V., McLaughlin, E.A., Glenn, R.A., & Koedinger, K.R. (2016). Instruction based on adaptive learning technologies. In Mayer, R.E. & Alexander, P.A., *Handbook of research on learning and instruction*, 522-560. ISBN: 113883176X

1. The loop in which teachers make moment-to-moment decisions as they do the immediate work of teaching.
2. The loop in which teachers prepare for, plan, and reflect on teaching, which includes professional development.
3. The loop in which teachers participate in decisions about the design of AI-enabled technologies, participate in selecting the technologies, and shape the evaluation of technologies—thus setting a context for not only their own classroom but those of fellow teachers as well.

Figure 5: Three ways to center educators as we conceptualize human in the loop AI



Please note that in the next section, on *Formative Assessment*, we also discuss teachers' important role in feedback loops that support students and enable school improvement. That section also includes a discussion of the concepts of "bias" and "fairness," which are important to teachers.

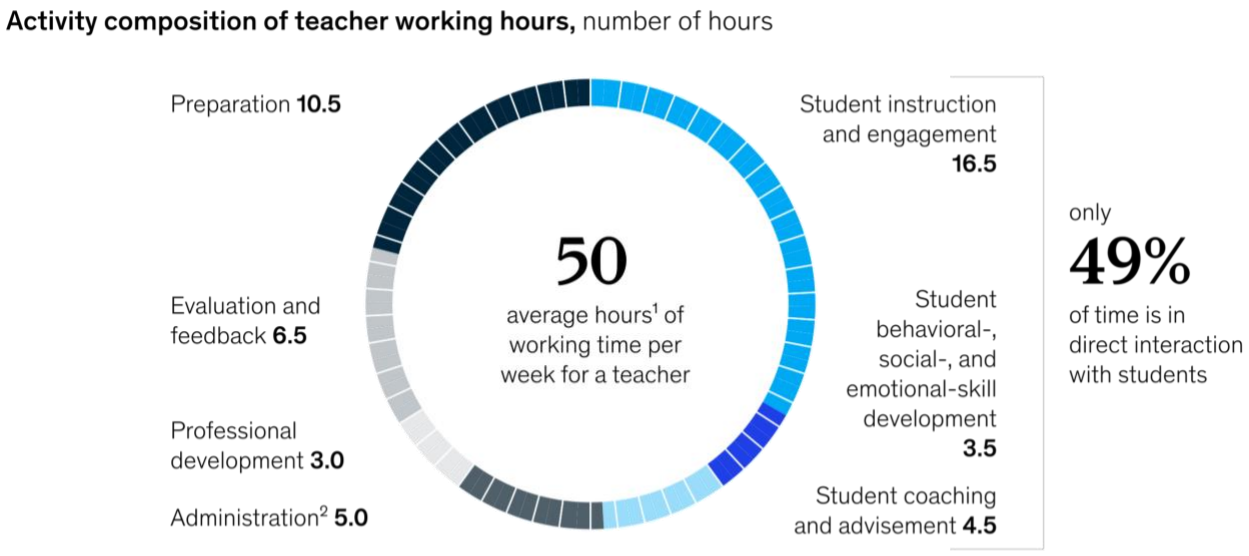
Insight: Using AI to Improve Teaching Jobs

The job of teaching is notoriously complex, with teachers making thousands of decisions each day. Teachers participate in classroom processes, in interactions with students beyond classrooms, in work with fellow teachers, and in administrative functions. They also are part of their communities and thus are expected to interact with families and caregivers.

If the teacher is able to efficiently predict and understand the range of other answers given by students in the class, it becomes possible to think creatively about the novel answer and figure how and why the student might have generated it.[35]

We think about how much easier some everyday tasks have become. We can request and receive alerts and notifications about events. Selecting music that we want to hear used to be a multistep process (even with digital music), and now we can speak the name of a song we want to hear, and it plays. Likewise, mapping a journey used to require a cumbersome study of maps, but now cell phones let us choose among several transportation options to reach a destination. Why can't teachers be supported to notice changing student needs and provided with supports to enact a technology-rich lesson plan? Why can't they more easily plan their students' learning journeys? When things change in a classroom, as they always do, why don't the tools of the classroom make it easier for teachers to adapt to student strengths and needs on the fly?

Figure 6: Teachers work about 50 hours a week, spending less than half the time in direct interaction with students.



A report by McKinsey[36] first suggested that AI's initial benefit could be to improve teaching jobs by reducing low-level burdens in administrative or clerical work (Figure 6). The report also suggests that recovered time from AI-enabled technology should be rededicated toward more

[35] Hammerness, K., Darling-Hammond, L., & Bransford, J. (2005). *Preparing teachers for a changing world: What teachers should learn and be able to do*. Jossey-Bass. ISBN: 0787996343

[36] Bryant, J., Heitz,C., Sanghvi, S., & Wagle, D. (2020, January 14). *How artificial intelligence will impact K-12 teachers.* McKinsey. https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers

effective instruction—particularly, outcomes such as reducing the average 11 hours of weekly preparation down to only six. We highlight these opportunities and two others below.

1. **Handling low-level details to ease teaching burdens and increase focus on students.** A good teacher must master all levels of details, big and small. When working with a particular student, the teacher may wish to later send that student a helpful learning resource. How will they remember to send it? A voice assistant or other forms of an AI assistant could make it easier to stay organized by categorizing simple voice notes for teachers to follow up on after a classroom session ends. We are beginning to see AI-enabled voice assistants in the market, and they could do many simple tasks so that the teachers can stay focused on students. These tasks can include record-keeping, starting and stopping activities, controlling displays, speakers, and other technologies in the classroom, and providing reminders. Many workers may eventually use assistants to make their jobs easier, and teachers are the most deserving of efforts to ease their jobs now.

2. **Extending beyond the teacher's availability with their students but continuing to deliver on the teacher's intent.** Teachers almost always want to do more with each student than they can, given the limited number of hours before the next school day. A teacher may wish to sit with the student as they practice 10 more math problems, giving them ongoing support and feedback. If the teacher can sit with the student for only three problems, perhaps they could delegate to an AI-enabled learning system to help with the rest. Teachers cannot be at their best if on call at all hours to help with homework, but perhaps they can indicate what types of supports, hints, and feedback they want students to receive while studying after school hours. An AI assistant can ensure that students have that support wherever and whenever they do homework or practice skills on their own. Teachers may wish to provide more extensive personal notes to families/caregivers, and perhaps an AI assistant could help with drafts based on students' recent classroom work. Then, the teacher could review the AI-generated comments and quickly edit where needed before returning it to the student for another draft. AI tools might also help teachers with language translation so they can work with all parents and caregivers of their students. AI tools might also help teachers with awareness. For example, in the next section, *Formative Assessment*, we note that teachers can't always know what's going on for each student and in each small group of students; emerging products might signal to the teacher when a student or teacher may need some more personal attention.

3. **Making teacher professional development more productive and fruitful.** Emerging products already enable a teacher to record her classroom and allow an AI algorithm to suggest highlights of the classroom discussion worth reviewing with a professional development coach.[37] AI can compute metrics, such as whether students have been talking more or less, which are difficult for a teacher to calculate during a lesson.[38] For

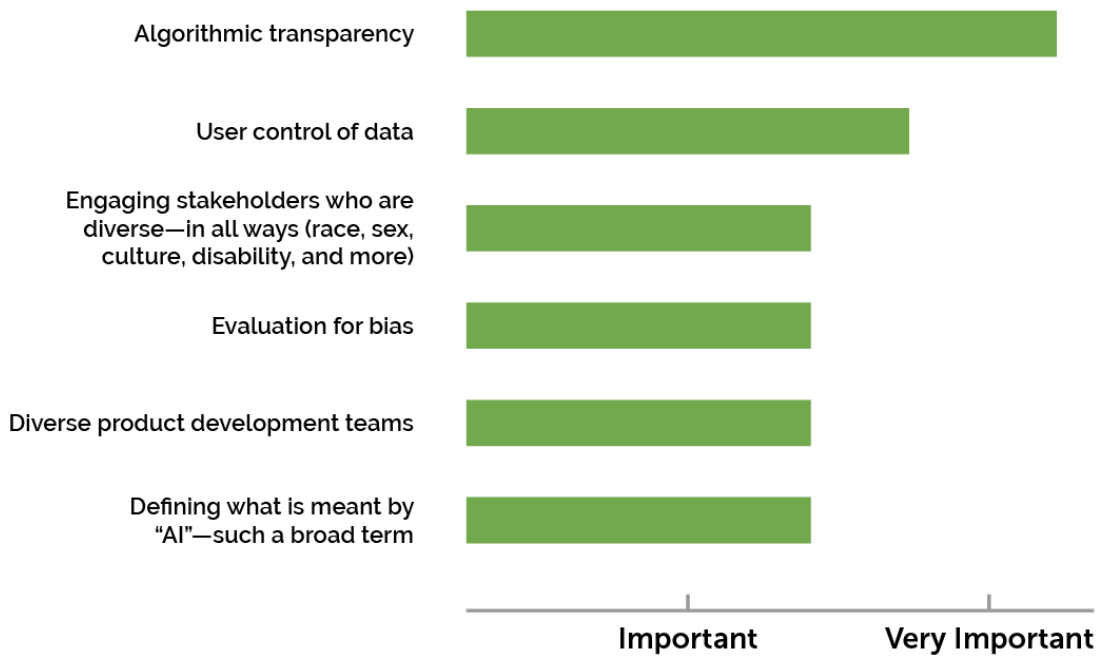
[37] Chen, G., Clarke, S., & Resnick, L.B. (2015). Classroom Discourse Analyzer (CDA): A discourse analytic tool for teachers. *Technology, Instruction, Cognition and Learning, 10(2),* 85-105

[38] Jensen, E., Dale, M., Donnelly, P.J., Stone, C., Kelly, S., Godley, A. & D'Mello, S.K. (2020). Toward automated feedback on teacher discourse to enhance teacher learning. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20). https://doi.org/10.1145/3313831.3376418

teachers who want to increase student engagement, these metrics can be a valuable tool. Classroom simulation tools are also emerging and can enable teachers to practice their skills in realistic situations.[39] Simulators can include examples of teaching from a real classroom while changing the faces and voices of the participants so that teaching situations can be shared and discussed among teachers without revealing identities.

Note the emphasis above on what listening-session panelist Sarah Hampton said about the human touch. Teachers will feel that AI is helping them teach with a focus on their human connection to their students when the necessary (but less meaningful) burdens of teaching are lessened. In Figure 7, below, see concerns that teachers raised about AI during listening sessions.

Figure 7: Concerns raised during the listening session about teaching with AI



Preparing and Supporting Teachers in Planning and Reflecting

ACE also means preparing teachers to take advantage of possibilities like those listed above and more. In the *Research* section, we highlight how pre-service education still tends to compartmentalize and inadequately address the topic of technology. That section suggests a need to invest in research about how to deeply integrate technology in pre-service teacher training programs. In-service teachers, too, will need professional development to take advantage of opportunities that AI can provide, like those presented in the *Teaching* section. Professional development will need to be balanced not only to discuss opportunities but also to inform teachers of new risks, while providing them with tools to avoid the pitfalls of AI.

[39] Ersozlu, Z., Ledger, S., Ersozlu, A., Mayne, F., & Wildy, H. (2021). Mixed-reality learning environments in teacher education: An analysis of TeachLivETM Research. *SAGE Open, 11(3).* https://doi.org/10.1177/21582440211032155.

"Humans are well suited to discern the outcomes…because we are the ones that have the capacity for moral reflection and empathy. So, in other words, I want the AI to help me really quickly and easily see what my student needs in their learning journey."
—Sarah Hampton

By nature, teaching requires significant time in planning as well to account for the breadth of needs across their rosters—especially for inclusive learning environments and students with IEPs and 504 plans. AI could help teachers with recommendations that are tuned to their situation and their ways of practicing teaching and support with adapting found materials to fit their exact classroom needs. For students with an IEP, AI could help with finding components to add to lesson plans to fully address standards and expectations and to meet each student's unique requirements. Even beyond finding components, AI might help adapt standardized resources to better fit specific needs—for example, providing a voice assistant that allows a student with a visual difficulty to hear material and respond to it or permitting a group of students to present their project using American Sign Language (ASL) which could be audibly voiced for other students using an AI ASL-to-Spoken-English translation capability. Indeed, coordinating IEPs is time-consuming work that might benefit from supportive automation and customized interactivity that can be provided by AI.

Reflection is important too. In the bustle of a classroom, it is sometimes difficult to fully understand what a student is expressing or what situations lead to certain positive or negative behaviors. Again, context is paramount. In the moment, teachers may not be aware of external events that could shape their understanding of how students are showing up in their classrooms. Tools that notice patterns and suggest ways to share information might help students and teachers communicate more fully about strengths and needs.

Designing, Selecting, and Evaluating AI Tools

The broadest loop teachers should be part of is the loop that determines what classroom tools do and which tools are available. Today, teachers already play a role in designing and selecting technologies. Teachers can weigh in on usability and feasibility. Teachers examine evidence of efficacy and share their findings with other school leaders. Teachers already share insights on what is needed to implement technology well.

While these concerns will continue, AI will raise new concerns too. For example, the following *Formative Assessment* section raises concerns about bias and fairness that can lead to algorithmic discrimination. Those concerns go beyond data privacy and security; they raise attention to how technologies may unfairly direct or limit some students' opportunities to learn. A key takeaway here is that teachers will need time and support so they can stay abreast of both the well-known and the newer issues that are arising and so they can fully participate in design, selection, and evaluation processes that mitigate risks.

Challenge: Balancing Human and Computer Decision-Making

One major new challenge with AI-enabled tools for teachers is that AI can enable autonomous activity by a computer, and thus when a teacher delegates work to an AI-enabled tool, it may

carry on with that work somewhat independently. Professor Inge Molenaar[40] has wondered about the challenges of control in a hybrid teaching scenario: When should a teacher be in control? What can be delegated to a computational system? How can a teacher monitor the AI system and override its decisions or take back control as necessary?

Figure 8: The tension between human and AI decision making: Who is in control?

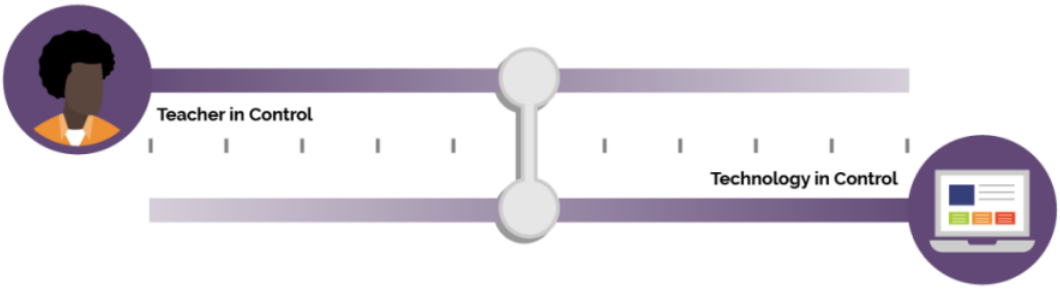


Figure 8 expresses the tension around control. To the left, the teacher is fully in control, and there is no use of AI in the classroom. To the right, the technology is fully in control with no teacher involved—a scenario which is rarely desirable. The middle ground is not one dimensional and involves many choices. Molenaar analyzed products and suggests some possibilities:

- The technology only offers information and recommendations to the teacher.
- The teacher delegates specific types of tasks to the technology, for example, giving feedback on a particular math assignment or sending out reminders to students before an assignment is due.
- The teacher delegates more broadly to the technology, with clear protocols for alerts, for monitoring, and for when the teacher takes back control.

These and other choices need to be debated openly. For example, we may want to define instructional decisions that have different kinds of consequences for a student and be very careful about delegating control over highly consequential decisions (for example, placement in a next course of study or disciplinary referrals). For human in the loop to become more fully realized, AI technologies must allow teacher monitoring, have protocols to signal a teacher when their judgment is needed, and allow for classroom, school, or district overrides when they disagree with an instructional choice for their students. We cannot forget that if a technology allows a teacher choice—which it should—it will take significant time for a teacher to think through and set up all the options, requiring greater time initially.

Challenge: Making Teaching Jobs Easier While Avoiding Surveillance

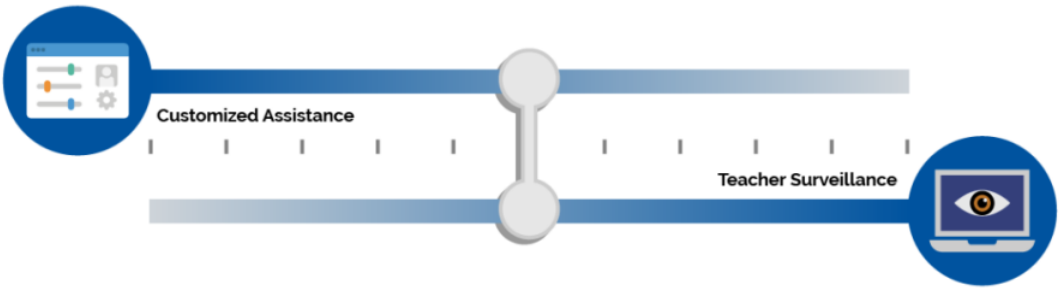
We also recognize that the very technologies that make jobs easier might also introduce new possibilities for surveillance (Figure 9). In a familiar example, when we enable a voice assistant in the kitchen, it might help us with simple household tasks like setting a cooking timer. And yet the same voice assistant might hear things that we intended to be private. This kind of dilemma will

[40] Molenaar, I. (2022). Towards hybrid human-AI learning technologies. European Journal of Education, 00, 1–14. https://doi.org/10.1111/ejed.12527

occur in classrooms and for teachers. When they enable an AI-assistant to capture data about what they say, what teaching resources they search for, or other behaviors, the data could be used to personalize resources and recommendations for the teacher. Yet the same data might also be used to monitor the teacher, and that monitoring might have consequences for the teacher. Achieving trustworthy AI that makes teachers' jobs better will be nearly impossible if teachers experience increased surveillance.

A related tension is that asking teachers to be "in the loop" could create more work for teachers if not done well, and thus, being in the loop might be in tension with making teaching jobs easier. Also related is the tension between not trusting AI enough (to obtain assistance) or trusting it too much (and incurring surveillance or loss of privacy). For example, researchers have documented that people will follow instructions from a robot during a simulated fire emergency even when (a) they are told the robot is broken and (b) the advice is obviously wrong.[41] We anticipate teachers will need training and support to understand how and when they will need to exercise human judgement.

Figure 9: Highly customized assistance vs. increased teacher surveillance



Challenge: Responding to Students' Strengths While Protecting Their Privacy

Educators seek to tackle inequities in learning, no matter how they manifest locally (e.g. in access to educational opportunities, resources, or supports). In culturally responsive[42] and culturally sustaining[43] approaches, educators design materials to build on the "assets"—individual, community, and cultural strengths that students bring to learning. Along with considering assets, of course, educators must meet students where they are, including both strengths and needs. AI could assist in this process by helping teachers with customizing curricular resources, for example. But to do so, the data inputted in an AI-enabled system would have to provide more information about the students. This information could be, but need not be, demographic details. It could also be information about students' preferences, outside interests, relationships,

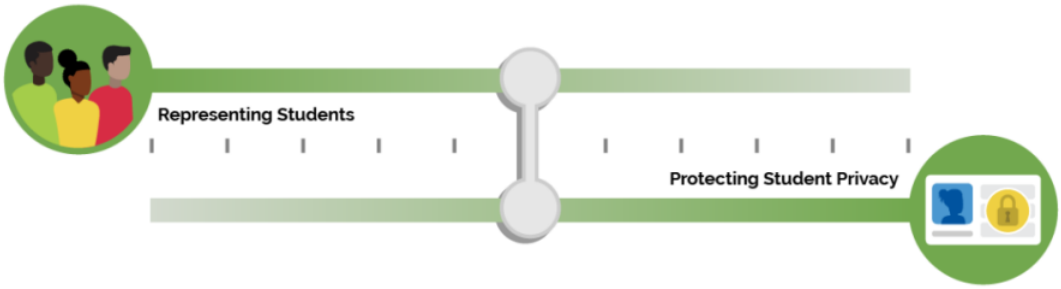
[41] Wagner, A.R., Borenstein, J. & Howard, A. (September 2018). Overtrust in the robotics age. *Communications of the ACM, 61(9),*22-24. https://doi.org/10.1145/3241365

[42] Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice.* Teachers College Press. ISBN: 978-0807758762

[43] Paris, D., & Alim, H.S. (Eds.). (2017). Culturally sustaining pedagogies: Teaching and learning for justice in a changing world. Teachers College Press. ISBN: 978-0807758342

or experiences.[44] What happens to this data, how it is deleted, and who sees it is of huge concern to educators. As educators contemplate using AI-enabled technologies to assist in tackling educational inequities, they must consider whether the information about students shared with or stored in an AI-enabled system is subject to federal or state privacy laws, such as FERPA. Further, educators must consider whether interactions between students and AI systems create records that must be protected by law, such as when a chatbot or automated tutor generates conversational or written guidance to a student. Decisions made by AI technologies, along with explanations of those decisions that are generated by algorithms may also be records that must be protected by law. Therein, a third tension emerges, between more fully representing students and protecting their privacy (Figure 10).

Figure 10: Responding to students' strengths while fully protecting student privacy



Further, representation would be just a start toward a solution. As discussed earlier in this report, AI can introduce algorithmic discrimination through bias in the data, code, or models within AI-enhanced edtech. Engineers develop the pattern detection in AI models using existing data, and the data they use may not be representative or may contain associations that run counter to policy goals. Further, engineers shape the automations that AI implements when it recognizes patterns, and the automations may not meet the needs of each student group with a diverse population. The developers of AI are typically less diverse than the populations they serve, and as a consequence, they may not anticipate the ways in which pattern detection and automation may harm a community, group, or individual.

AI could help teachers to customize and personalize materials for their students, leveraging the teacher's understanding of student needs and strengths. It is time consuming to customize curricular resources, and teachers are already exploring how AI chatbots can help them design additional resources for their students. An elementary school teacher could gain powerful supports for changing the visuals in a storybook to engage their students or for adapting language that poorly fits local manners of speaking or even for modifying plots to incorporate other dimensions of a teacher's lesson. In the *Learning* section, we noted that AI could help identify learner strengths. For example, a mathematics teacher may not be aware of ways in which a student is making great sense of graphs and tables about motions when they are in another teacher's physics classroom and might not realize that using similar graphs about

[44] Zacamy, J. & Roschelle, J. (2022). Navigating the tensions: How could equity-relevant research also be agile, open, and scalable? Digital Promise. http://hdl.handle.net/20.500.12265/159; Baker, R.S., Esbenshade, L., Vitale, J., & Karumbaiah, S. (2022). Using demographic data as predictor variables: A questionable choice. https://doi.org/10.35542/osf.io/y4wvj

motion could help with their linear function lesson. AI might help teachers when they seek to reflect student strengths by creating or adapting instructional resources.

Yet, the broad equity challenges of avoiding algorithmic discrimination while increasing community and cultural responsiveness must be approached within the four foundations we earlier outlined: human in the loop, equity, safety and effectiveness, and evaluation of AI models. We cannot expect AI models to respect cultural responsiveness. The Department is particularly concerned that equity is something that engaged educators and other responsive adults are in the best position to address and something that is never solely addressable as a computational problem.

Questions Worth Asking About AI for Teaching

As leaders in both pre-service and post-service teacher education contemplate how AI can improve teaching (along with policymakers, developers, and researchers), we urge all in the ecosystem to spend more time asking these questions:

- Is AI improving the quality of an educator's day-to-day work? Are teachers experiencing less burden and more ability to focus and effectively teach their students?
- As AI reduces one type of teaching burden, are we preventing new responsibilities or additional workloads being shifted and assigned to teachers in a manner that negates the potential benefits of AI?
- Is classroom AI use providing teachers with more detailed insights into their students and their strengths while protecting their privacy?
- Do teachers have oversight of AI systems used with their learners? Are they exercising control in the use of AI-enabled tools and systems appropriately or inappropriately yielding decision-making to these systems and tools?
- When AI systems are being used to support teachers or to enhance instruction, are the protections against surveillance adequate?
- To what extent are teachers able to exercise voice and decision-making to improve equity, reduce bias, and increase cultural responsiveness in the use of AI-enabled tools and systems?

Key Recommendation: Inspectable, Explainable, Overridable AI

In the Introduction, we discuss the notion that when AI is incorporated into a system, the core of the AI is a model. In the *Learning* section, we discuss that we need to be careful that models align to the learning we envision (e.g., that they aren't too narrow). Now, based on the needs of teachers (as well as students and their families/caregivers), we add another layer to our criteria for good AI models: the need for explainability.[45] Some AI models can recognize patterns in the world and do the right action, but they cannot explain why (e.g., how they arrived at the

[45] Khosravi, H., Shum, S.B., Chen, G, Conati, C., Tsai,Y-S., Kay, J., Knight, S., Martinez-Maldonado, R., Sadiq, S., Gašević, D. (2022). Explainable artificial intelligence in education. *Computers and Education: Artificial Intelligence, 3.* https://doi.org/10.1016/j.caeai.2022.100074

connection between the pattern and the action). This lack of explainability will not suffice for teaching; teachers will need to know how an AI model analyzed the work of one of their students and why the AI model recommended a particular tutorial, resource, or next step to the student.

Thus, explainability of an AI system's decision is key to a teacher's ability to judge that automated decision. Such explainability helps teachers to develop appropriate levels of trust and distrust in AI, particularly to know where the AI model tends to make poor decisions. Explainability is also key to a teacher's ability to monitor when an AI system may be unfairly acting on the wrong information (and thus may be biased. We discuss bias and fairness more in the *Assessment* section next).

Surrounding the idea of explainability is the need for teachers to be able to inspect what an AI model is doing. For example, what kinds of instructional recommendations are being made and to which students? Which students are being assigned remedial work in a never ended loop? Which are making progress? Dashboards in current products present some of this information, but with AI, teachers may want to further explore which decisions are being made and for whom and know of the student-specific factors that an AI model had available (and possibly which factors were influential) when reaching a particular decision. For example, some of today's adaptive classroom products use limited recommendation models that only consider student success on the last three mathematics problems and do not consider other variables that a teacher would know to consider, such as whether a student has an IEP Plan or other needs.

Our call for attending to equity considerations as we evaluate AI models requires information about how discriminatory bias may arise in particular AI systems and what developers have done to address it. This can only be achieved with transparency for how the tools use datasets to achieve outcomes and what data they have available or that a teacher could include in her judgement but are not available to the system (IEP status is offered as an example above).

Teachers will also need the ability to view and make their own judgement about automated decisions, such as decisions about which set of mathematics problems a student should work on next. They need to be able to intervene and override decisions when they disagree with the logic behind an instructional recommendation.[46] Teachers need protection against adverse ramifications when they assert human judgement over an AI system's decision.

[46] Ruiz, P. & Fusco, J. (2022). *Teachers partnering with artificial intelligence: Augmentation and automation.* Digital Promise. https://digitalpromise.org/2022/07/06/teachers-partnering-with-artificial-intelligence-augmentation-and-automation/

"These systems sometimes are seen as a black box kind of a situation where predictions are made based on lots of data. But what we need is to have a clear view—to clearly show how those recommendations or those interactions are made and what evidence is used or what data is used to be able to make those recommendations so teachers and everyone involved know about why that kind of system is providing that type of information. So, having open learning environments or inspectable learner models or applications where the stakeholders can understand how these systems make decisions or recommendations is going to be an important aspect in the future of teaching and learning."
—Diego Zapata-Rivera

Formative Assessment

Formative assessment is traditionally a key use of edtech because feedback loops are vital to improving teaching and learning.[47] As we have emphasized throughout this report, a top priority with AI is to keep humans in the loop and in control, which includes focusing on the people engaged with formative assessments: students, teachers, school leaders, families/caregivers, and others who support learners. In the definition below, please note the overlap between definitions of AI and formative assessment; both have to do with detecting patterns and choosing a future course of action (that adapts to learner strengths and needs).

> *Assessment refers to all those activities undertaken by teachers, and by the students in assessing themselves, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged. Such assessment becomes "formative assessment" when the evidence is actually used to adapt the teaching to meet the needs.*[48]

Building on Best Practices

A number of dimensions hold potential for shaping the future of formative assessments, and many have ready extensions to the field of AI-enabled systems and tools. For example, the 2017 NETP discussed how technology can lead to improved formative assessments along seven dimensions, listed below:

1. **Enabling Enhanced Question Types:**
   to give students more ways to show what they know and can do.
2. **Measurement of Complex Competencies:**
   to better elicit growth in important skills that go beyond typical subject matter standards, for example, in measuring practices, social skills like teamwork, self-regulation, and work-relevant skills (e.g., making presentations or leading teams).
3. **Providing Real-Time Feedback:**
   to maintain and increase student engagement and to support effective learning, providing timely and helpful responses and suggestions to each learner.
4. **Increasing Accessibility:**
   to include neurodiverse learners and to engage learners' best communication capabilities as they share what they know and can do.

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[47] Shute, V.J. (2008). Focus on formative feedback. *Review of Educational Research, 78(1),* 153–189. https://doi.org/10.3102/0034654307313795

[48] Black, P. & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. Phi Delta Kappan, 92(1), 81-90. https://kappanonline.org/inside-the-black-box-raising-standards-through-classroom-assessment/

5. **Adapting to Learner Ability and Knowledge:**
   to make assessments more precise and efficient.
6. **Embedded Assessment in the Learning Process:**
   to emphasize an assessment's role in improving teaching and learning (this report does not focus on assessment for accountability purposes).
7. **Assess for Ongoing Learning:**
   to reveal progress over time and not just predetermined milestones.

AI models and AI-enabled systems may have potential to strengthen formative assessments. In one example, a question type that invites students to draw a graph or create a model can be analyzed with AI algorithms,[49] and similar student models might be grouped for the teacher to interpret. Enhanced formative assessment may enable teachers to better respond to students' understanding of a concept like "rate of change" in a complex, real-world situation. AI can also give learners feedback on complex skills, such as learning American Sign Language[50] or speaking a foreign language[51] and in other practice situations where no person is available to provide immediate feedback.

Generally, an AI assistant may be able to reduce the load for teachers related to grading simpler aspects of student responses, allowing the teacher to focus their specialized judgment on important qualities of a whole essay or a complex project. We also may be able to better provide feedback with accessibility. For example, an AI-enabled learning technology may be able to interact verbally with a student about their response to an essay prompt, asking questions that guide the student to clarify their argument without requiring the student to read a screen or type at a keyboard. In the examples shared earlier in the *Learning* section, we also see that AI can be embedded in the learning process, providing feedback to students as they work to solve a problem, rather than only later after the student has reached a wrong answer. When formative assessment is more embedded, it can better support learning, and timely feedback is critical.[52]

Although there are many points of connection like these between AI and formative assessments, our listening sessions also revealed attendees' desire to tackle some existing shortcomings in the field of formative assessment; namely, the time-consuming and sometime onerous nature of taking tests, quizzes, or other assessments and the lack of perceived value in the feedback loop by teachers and students.

Implications for Teaching and Learning

Real-time instructional feedback can be beneficial when it helps learners and teachers to improve. But common experience too often leaves students and teachers with unpleasant feelings toward assessment and thus poses a provocative conflict between the potential benefits

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[49] Zhai, X., He, P., Krajcik, J. (2022). Applying machine learning to automatically assess scientific models. *Journal of Research in Science Teaching*. https://doi.org/10.1002/tea.21773

[50] Shao, Q., Sniffen, A., Blanchet, J., Hillis, M.E., Shi, X., Haris, T.K., & Balkcom, D. (2020). Teaching american sign language in mixed reality. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 4(4),* 1-27. https://doi.org/10.1145/3432211

[51] Godwin-Jones, R. (2021). Big data and language learning: Opportunities and challenges. *Language Learning & Technology, 25(1),* 4–19. http://hdl.handle.net/10125/44747

[52] Wiggins, G. (2015). *Seven keys to effective feedback*. ACSD. https://www.ascd.org/el/articles/seven-keys-to-effective-feedback

of data collected through formative assessments and the practical implications of administering additional assessments in classrooms and schools.

Some AI-enabled systems and tools seek to address this potential conflict. For example, one AI-enabled reading tutor listens to students as they read aloud and provides on-the-spot feedback to improve their reading.[53] Students reportedly enjoyed reading aloud, and the approach was effective. Researchers have also embedded formative assessments in games so that students can show how well they understand Newtonian physics as they play increasingly difficult levels of a game.[54] If a student can more easily ask for and receive help when they feel frustrated or confused, reducing those feelings can feel encouraging. Student feelings of safety, confidence, and trust in the feedback generated by these AI-enabled systems and tools are essential to showcase their learning. That focus on learning growth and gains is optimal (absent negative consequences or a high-stakes environment).[55]

AI-enhanced formative assessments may have the potential to save teachers' time (e.g., time spent on grading), allowing the instructor to spend more time engaged in helping students. AI-enhanced assessments may also benefit teachers if they provide detailed insights about student strengths or needs that may not be visible and if they support instructional adaptation or improvement by suggesting a small set of evidence-based recommendations for helping students master content. Such assessments may also be helpful outside of the classroom if it can provide feedback when the teacher is not available, for example, in completing homework or practicing a concept during study hall. As we discussed in the *Teaching* section, an essential aspect of deploying AI-based formative assessment must be centering teachers in system design.

Insight: AI Can Enhance Feedback Loops

The term "formative assessment" does not singularly mean a test or a measurement. Assessment becomes formative when it results in useful reflections and changes to the course of teaching, learning, or both.[56] The term "feedback loops" emphasizes that measurement is only part of the process. Feedback loops that lead to instructional improvement—including adaptations in teaching and learning—yield the strongest outcomes for students.

We also use "feedback loops" as a plural term because there are many types and levels of loops that are important. Students can benefit from feedback when they work individually, as a member of a small group, or in a classroom discussion. Feedback loops are valuable "in the moment"—for example, as a student practices a skill. Further, feedback loops are valuable when they cover larger spans of effort and reflections, such as at the end of presenting a project or term paper. In addition, feedback loops can assist teachers, for example, helping them notice

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[53] Mostow, J., Aist, G., Burkhead, P., Corbett, A., Cuneo, A., Eitelman, S., Huang, C., Junker, B., Sklar, M.B., & Tobin, B. (2003). Evaluation of an automated reading tutor that listens: Comparison to human tutoring and classroom instruction. *Journal of Educational Computing Research, 29(1),* 61–117. https://doi.org/10.2190/06AX-QW99-EQ5G-RDCF

[54] Shute, V.J., Ventura, M., & Kim, Y.J. (2013). Assessment and learning of qualitative physics in Newton's Playground. *The Journal of Educational Research*, 106(6), 423–430. https://doi.org/10.1080/00220671.2013.832970

[55] Shute, V J. (2008). Focus on formative feedback. *Review of Educational Research, 78(1),* 153–189. https://doi.org/10.3102/0034654307313795

[56] Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, *21(1),* 5-31. https://doi.org/10.1007/s11092-008-9068-5

their own patterns of responding to students' ideas. Moreover, feedback loops are critical to the continuous improvement of products and the implementation of programs.

Due to the importance of feedback loops, formative assessment could be a leading area for schools' explorations of powerful uses of AI in teaching and learning. Educators can build upon alignments between their long-standing visions for formative assessment and the emerging capabilities that AI holds. Further, the professional assessment community brings a toolkit for asking and answering questions about topics like bias and fairness. The psychometric toolkit of methods is a strong start toward the questions that must be asked and answered because it already contains ways to measure bias and fairness and, more generally, to benchmark the quality of formative assessments. But as our discussion reveals, AI can only make feedback loops better if we keep a firm eye on the weaknesses of AI and how AI introduces new concerns.

An Example: Automated Essay Scoring

One instructive example is Automated Essay Scoring (AES). To become strong writers, which is a valuable life skill, students need regular and specific feedback. However, reviewing and providing feedback on essays is very time consuming for humans. Hence, Ellis Page provided a first vision for *computer programs that could review and provide feedback on student essays* in 1966[57], and much effort has gone into AES technologies in the intervening 56 years. Many research review articles are available to summarize the progress, which has been impressive.[58] Further, some of today's applications of AES technologies will be familiar to readers, such as Grammarly, Turnitin, and the various essay analysis engines used by publishers and assessment companies. Also note that while the traditional AES functionality emphasizes scoring or rating essays, newer AI-enabled products focus more on providing students with constructive criticism and developing their skills as writers. Writing is a life skill that is important to the pursuit of college and career ambitions, and developing writers require comprehensive feedback. If developers could inexpensively augment human feedback to developing writers with AI feedback, it's possible that support for learning to write could become more equitable.

And yet, AES is an instructive example because researchers have analyzed limitations, too.[59] AES technologies in AI can analyze some features of student essays but can also be misled by the length of an essay, by a student who places appropriate keywords in sentences that don't make sense, and other flaws that a human reader would easily notice. In a telling quote, one team that reviewed the state of the art wrote this:

The authors further note that while human and AI judgements of essays may correlate, people and computers are not noticing the same things in student writing. Due to these limitations, we must continue to emphasize a human in the loop foundation for AI-enhanced formative assessment. AI may support but not replace high-quality, human-led processes and practices of formative assessment in schools.

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[57] Page, E.B. (1966). The imminence of grading essays by computer. *Phi Delta Kappan, 47(5),* 238–243

[58] Ke, Z., & Ng, V. (2019). Automated essay scoring: A survey of the state of the art. In *Proceedings of the Twenty-Eighth International Joint Conference on Artificial Intelligence,* 6300–6308. https://doi.org/10.24963/ijcai.2019/879

[59] Doewes, A. & Pechenizkiy, M. (2021). On the limitations of human-computer agreement in automated essay scoring. In *Proceedings of the 14th International Conference on Educational Data Mining (EDM21).* https://educationaldatamining.org/EDM2021/virtual/static/pdf/EDM21_paper_243.pdf

"Nevertheless, the time when AES systems will be able to operate on a par with human judges, with similar levels of connoisseurship for such features as meaning, emotion, originality, creativity, fluency, sense of audience and so on, arguably remains a long way off."
—Gardner, O'Leary, and Yuan[60]

Key Opportunities for AI in Formative Assessment

Based on the listening sessions we held, we see three key areas of opportunity in supporting formative assessment using AI systems and models.

First, we recommend a strong focus on **measuring what matters**[61] and particularly those things that have not been easily measured before and that many constituents would like to include in feedback loops. The example above, AES, was chosen because writing remains a valuable academic, workplace, and life skill. Looking at community goals through the lens of their visions for their high school graduates, we see that families/caregivers, students, and community leaders want to nurture graduates who solve problems adaptively, who communicate and collaborate well, who persevere and self-regulate when they experience challenges. "What matters" today reaches beyond a sole focus on the core academic content measured by large-scale summative assessments, to support students and teachers with actionable feedback that nurtures the broader skills students need to succeed and thrive. Further, within core academic content, AI may help us to provide feedback on the more realistic and complex aspects of doing math, for example, or investigating scientific phenomena, understanding history, or discussing literature.

Second, we'd like to see a strong focus on **improving help-seeking and help-giving**.[62] Asking for and giving help is crucial to learning[63] and practicing a growth-mindset and central to the notion of human feedback loops. Students may not always know when they need help. In one example, computer algorithms can detect a student who is "wheel spinning" (working hard on mastering content but not making progress).[64] A student who is working hard may not feel like they need help, and the teacher may not be aware that the student is struggling if he or she appears to be "on task." AI may also be helpful by highlighting for students and teachers what forms of assistance have been most useful to the student in the recent past so that an educator can expand access to specific assistance that works for that individual student. Finally, educators may learn things from AI-enabled systems and tools that give feedback and hints during the completion of

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[60] Gardner, J., O'Leary, M. & Yuan, L. (2021). Artificial intelligence in educational assessment: "Breakthrough? Or buncombe and ballyhoo?" *Journal of Computer Assisted Learning, 37(5),* 1207–1216. https://doi.org/10.1111/jcal.12577

[61] Merrill, S. (2020). In schools, are we measuring what matters? *Edutopia*. https://www.edutopia.org/article/schools-are-we-measuring-what-matters

[62] Roll, I., Aleven, V., McLaren, B.M., Koedinger, K.R. (2011). Improving students' help-seeking skills using metacognitive feedback in an intelligent tutoring system, *Learning and Instruction, 21(2),* 267–280. https://doi.org/10.1016/j.learninstruc.2010.07.004.

[63] Webb, N.M., & Farivar, S. (1994). Promoting helping behavior in cooperative small groups in middle school mathematics. *American Educational Research Journal, 31(2),* 369–395. https://doi.org/10.3102/00028312031002369

[64] Kai, S., Almeda, M.V., Baker, R. S., Heffernan, C., & Heffernan, N. (2018). Decision tree modeling of wheel-spinning and productive persistence in skill builders. *Journal of Educational Data Mining,* 10(1), 36–71. https://doi.org/10.5281/zenodo.3344810

homework, utilizing that feedback to later reinforce concepts in direct instruction and strengthen the one-on-one support provided to students.[65] AI-enabled systems and tools can provide teachers with additional information about the students' recent work, so their instructor has a greater contextual sense as they begin to provide help.

Third, we advocate for **teachers and students to be strongly involved in designing feedback loops** as developers produce AI-enhanced formative assessments so they can directly voice what would make assessments less onerous and more convenient and valuable to them.[66] Earlier in the *Teaching* section, we emphasized how important it is to involve teachers in designing, selecting, and evaluating AI-enhanced technologies. Students need to be centered, too. They are experiencing AI in their everyday lives, and they have strong opinions on what is valuable and safe. There are local and cultural variations in how people provide and receive feedback, so adjusting feedback to align with community norms is important.

Key Recommendation: Harness Assessment Expertise to Reduce Bias

Bias and fairness are important issues in assessment design and administration,[67] and they hold relevance for the area of AI-enabled assessment. In traditional assessment, a test item might be biased if unnecessary details are included that differentially advantage some students (e.g., a story-based item that references a sport that only boys play regularly may be less helpful to girls). As discussed earlier, with AI, we now must worry about algorithmic discrimination which can arise due to the manner in which AI algorithms are developed and improved from large datasets of parameters and values that may not represent all cohorts of learners.

Algorithmic discrimination is not just about the measurement side of formative assessment; it is also about the feedback loop and the instructional interventions and supports that may be undertaken in response to data collected by formative assessments. There is a question both about access to such interventions and the quality or appropriateness of such interventions or supports. When an algorithm suggests hints, next steps, or resources to a student, we have to check whether the help-giving is unfair because one group systematically does not get useful help which is discriminatory. Fairness goes beyond bias as well. In AI-enabled formative assessment, both the opportunity to learn through feedback loops, as well as the quality of learning in and outside of such loops, should be addressed. Issues of bias and fairness have arisen in traditional assessments, and the field of psychometrics has already developed valuable tools to challenge and address these issues.[68] Assessment as a field may have a head start on tackling bias and fairness for AI in education. And yet the issues expand with AI, so the work is not done. Strong and deliberate attention to bias and fairness is needed as future formative assessments are developed.

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[65] Walker, E., Rummel, N. & Koedinger, K.R. (2015). Adaptive intelligent support to improve peer tutoring in algebra. *International Journal of Artificial Intelligence in Education, 24*, 33–61 https://doi.org/10.1007/s40593-013-0001-9

[66] Swiecki, Z., Khosravi, H., Chen, G., Martinez-Maldonado, R., Lodge, J.M., Milligan, S., Selwyn, B. & Gašević,D. (2022). Assessment in the age of artificial intelligence. *Computers and Education: Artificial Intelligence, 3*. k https://doi.org/10.1016/j.caeai.2022.100075

[67] Reynolds, C.R., & Suzuki, L.A. (2012). Bias in psychological assessment: An empirical review and recommendations. *Handbook of Psychology, Second Edition*. https://doi.org/10.1002/9781118133880.hop210004

[68] Kaplan, R.M., & Saccuzzo, D.P. (2017). *Psychological testing: Principles, applications, and issues*. Cengage Learning.

Related Questions

As indicated, formative assessment is an area in which AI is expanding along a continuum that can be guided by visions already in place, such as the 2017 NETP. It is an area in which AI is poised to grow, especially with capabilities that power more feedback loops in student learning. As this growth takes place, we suggest ongoing attention to the following questions:

- Is formative assessment bringing benefits to the student learning experience and to the efficacy of classroom instruction?
- Are humans being centered in AI-enabled formative assessment and feedback loops?
- Are we providing empowering professional development to teachers so they can leverage feedback loops and safeguard against concerns?
- To what extent are the developers and implementers of AI-enabled systems and tools tackling new sources of algorithmic bias and continuing to make assessment fairer?
- Are governance policies regarding who owns, controls, and can view or use AI-enabled formative assessment data appropriate and adequate?
- Do we have sufficient guardrails against misuse of formative assessment data or automatically generated interpretations of student achievement and learning, such as on dashboards?
- Is trust in an AI-enabled assessment system, feedback loops, and data generated by such assessments growing or diminishing?

Research and Development

Policy relies upon research-based knowledge; likewise, improving practice depends on feedback loops that analyze empirical evidence. Consequently, the 2010 NETP specified a series of "grand challenges" which were "R&D problems that might be funded and coordinated at a national level." One 2010 NETP grand challenge was to create personalized learning systems that continuously improve as they are used:

> *"Design and validate an integrated system that provides real-time access to learning experiences tuned to the levels of difficulty and assistance that optimize learning for all learners and that incorporates self-improving features that enable it to become increasingly effective through interaction with learners."*[69]

Since 2010, much R&D has addressed this challenge. Conferences about learning analytics, educational data mining, and learning at scale have blossomed. Developers have created platforms that use algorithms and the analysis of big data to tune learning experiences. The challenge has not been fully achieved, and further work on this challenge is still relevant today.

Insight: Research Can Strengthen the Role of Context in AI

Despite the relevance of 2010's grand challenges, it has become apparent that the R&D community is now looking to expand their attention. The 2010 challenges were stated as technical problems. Today's researchers want to more deeply investigate context, and today's tech companies want to develop platforms that are responsive to the learners' characteristics and situations more broadly—not just in terms of narrow cognitive attributes. We see a push to transform R&D to address context sensitivity. We look forward to new meanings of "adaptive" that broaden outward from what the term has meant in the past decade. For example, "adaptive" should not always be a synonym of "individualized" because people are social learners. Researchers therefore are broadening "adaptivity" to include support for what students do as they learn in groups, a form of learning that is prevalent in schools across the U.S.

The focus on context is not an accident. Context is a traditional challenge in AI.[70] Thus, researchers and developers are wise to prioritizing context. Unless we invest more in AI that is context-sensitive, it is quite likely that AI will break and fail to achieve educational goals.

Agreeing to prioritize context won't be easy. As illustrated above in Figure 12, there will be a tension between depth of context and pace of technological advances in AI R&D. On the one hand, AI is sometimes presented as a race to be the first to advance new techniques or scale new applications—innovation is sometimes portrayed as rapidly going to scale with a minimally viable product, failing fast, and only after failure, dealing with context. On the other hand, researchers and developers see that achieving good innovations with AI in education will clearly

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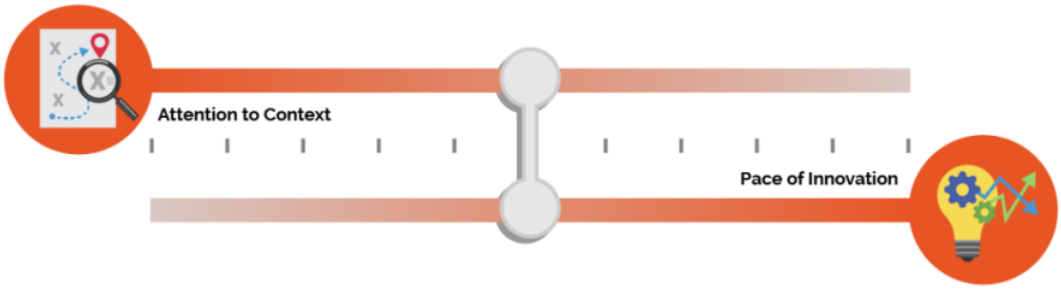
[69] U.S. Department of Education, Office of Educational Technology. (2010). *Transforming American Education: Learning Powered by Technology.* U.S. Department of Education. p. 78

[70] Boden, M.A. (2018). *Artificial intelligence: A very short introduction*. Oxford. ISBN: 978-0199602919

require bringing more context into the process early and often. For example, researchers highlight that humans must be continually adjusting the goals for technology and have noted that when we set forth goals, we often don't yet fully understand context; and as we learn about context, the goals must change.[71] This suggests that context must be prioritized early and habitually in R&D; we don't want to win a race to the wrong finish line.

Figure 12: The tension between depth of context and pace of technological advances in AI



Further, intensifying focus on context in this work will change the nature of the R&D. There won't be just one type of change in R&D because context has multiple meanings. Attendees in our listening sessions described four types of context necessary for the future.

We list these four types of context below and then expand on each one in its own section. These four types emerged as topics of provocations to think differently about R&D but certainly do not exhaust the important ways of investigating context.

1. **Focus on the Long Tail:** How could we use big data and AI to pay more attention to the "long tail" of edtech use—going beyond a few "most typical" ways of using emerging technology and instead solving for digital equity and inclusion?
2. **Partnership in Design-Based Research:** How can we change who is involved and influential in designing the future of AI in education to more centrally include students, teachers, and other educational constituents?
3. **Connect with Public Policy:** How can work on AI in education build on general advances in AI ethics, safety, and regulation and contribute additional advances specific to educational policy?
4. **Rethink Teacher Professional Development:** How can we solve for new systems of teacher professional development (both pre-service and in-service) that align to the increasingly core role of technology in the teaching profession?

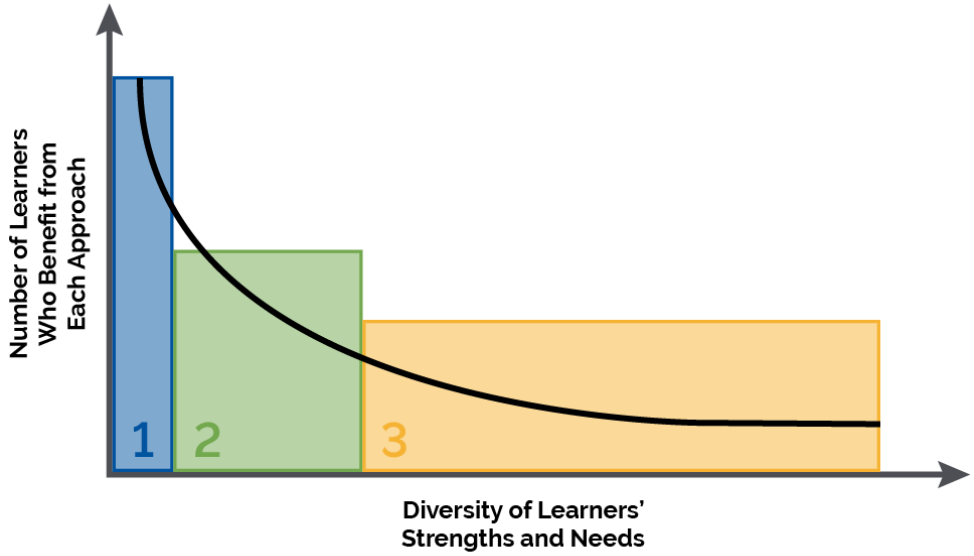
[71] Russell, S. (2019). Human compatible: Artificial intelligence and the problem of control. Penguin. ISBN: 9780525558637

"We can't necessarily always apply traditional research methodologies to this topic because educational technology changes so quickly."
—Kristina Ishmael, Office of Educational Technology

Attention to the Long Tail of Learner Variability

At the core of R&D of AI in education, innovators will be building models that fit available data. The increasing scale and prevalence of technologies means that the data is coming from and including a wide range of different contexts and varied ways that people in those contexts engage in teaching and learning. Researchers in our listening sessions drew attention to the promise of AI for addressing "context" by reference to the long tail of learner variability.

Figure 13: The long tail of learner variability



As depicted in Figure 13, learners vary in their strengths and needs. The most frequently occurring mix of strength and needs (also known as "teaching to the middle") is depicted leftmost, with less frequently occurring mixes spreading to the right. Rising upward, the figure depicts the number of learners who benefit from a particular learning design, pathway, or approach. We argue that AI can bring opportunities to address a wider spectrum of strengths and needs but only if developers and innovators focus on the long tail and not only "teaching to the middle."

For the sake of argument, the figure indicates three zones. In a first zone, curricular resources are mostly standardized, with perhaps a dimension or two of adaptivity. For example, many existing products adapt based on the correctness of student answers and may also provide options to read or hear text in a second language. However, the core of the instructional approach is highly standardized. In a second zone, there is greater balance between how much standardization and how much adaptivity students can access. Universal Design for Learning (UDL) is one set of recommendations for providing learning opportunities in multiple formats and for

accommodating different learning progressions.[72] UDL can enable accommodating more ways in which learners vary, and as teachers know, there are many more important ways to adapt to students than found in today's edtech products.

Students are neurodiverse. They bring different assets from their experiences at home, in their communities, and in their cultures. They have different interests and motivations. And they learn in varied settings—classrooms and schools differ, and at-home students learn in informal settings in ways that could complement school learning. These are all important dimensions of "context." Zone 3 indicates highly adaptive learning, where standardization is less successful and where we need to discover a wider variety of approaches to engage learners and sustain powerful learning. Researchers in our listening sessions noted the promise of Zone 3 because AI's ability to recognize patterns in data can extend beyond the most common patterns and because AI's ability to generate customized content can extend beyond what people can reasonably generate on their own.

Notice that although the Zone 1 bar appears to be the tallest, and thus tends to attract initial attention, there are more students in Zones 2 and 3, the regions where AI can provide more help. Thus, it's important to ask where AI researchers and developers are directing their attention. When we say a model "fits," are we saying it fits the most common and typical uses by teachers and learners? This sort of R&D is easier to do. However, machine learning and AI also can tailor a model to the less common and more culturally specific contexts, too. Therefore, how can constituents cultivate interdisciplinary expertise to direct attention among researchers and developers to focus on the long tail? If we do, the quality of what we do for those represented in that tail can be more adaptive and more context-sensitive. And to be most effective, it will require the integration of contextual, content, and technical expertise.

Within the long-tail challenge, the community is wondering how we can get to research insights that are both general and specific enough. When research produces very general abstractions about learning, it often doesn't give developers enough guidance on exactly how to adjust their learning environments. Conversely, when research produces a specific adaptive algorithm that works on one educational platform, it often remains hard to apply to additional platforms; research can be too detailed as well. The research community is also thinking about new partnerships that could bring more data and more diverse perspectives to the table, the topic of the next section.

Focusing on the long tail of learner variability is particularly important to addressing a long-standing key research question: *"Do new AI-enhanced approaches work to improve learning, and for whom and under what conditions?"*

Partnership in Design-Based Research

Of course, teachers must be included in rethinking their own professional development. This thought leads to another priority aspect of context: partnership in design-based research. With regard to inclusive design, attendees in our listening sessions brought up a variety of co-design[73]

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[72] Rose, D. (2000). Universal design for learning. *Journal of Special Education Technology*, *15*(4), 47-51. https://doi.org/10.1177/016264340001500407

[73] Roschelle, J., Penuel, W., & Shechtman, N. (2006). Co-design of innovations with teachers: definition and dynamics. In *Proceedings of the 7th International Conference on Learning Sciences*, Bloomington, IN. https://doi.dx.org/10.22318/icls2006.606

and other participatory processes and goals that can be used in R&D.[74] By co-design, they mean sharing power with non-researchers and non-developers through all the phases of design and development, which would result in more influence by teachers, students, and other constituents in the shape of AI-enabled edtech. The shift toward co-design was palpable throughout our listening sessions, but as researchers and developers have not standardized on one particular co-design method, we share some representative examples.

- Youth can powerfully participate in design when researcher methods include participant co-design. Such research can investigate how to improve edtech while educating students. A listening session attendee asked about developing students' awareness of what data are being collected and how data are being used by developers.
- There is a near future need to go beyond representation so that co-designed solutions consider more generous contexts for broader possibilities, according to attendees.
- The shift of power dynamics is another research-worthy interest of the panel and attendees to understand the balance between a teacher's agency and a machine's suggestions.
- Likewise, such longitudinal research will require both the infrastructure and institutional support to fund necessary experimentation and requisite failures to elicit positive results and safe innovation.
- There is a desire for rapid cycle evaluations with inclusive feedback loops that return to the educators themselves as essential relative to traditional research approaches.
- Many researchers also mentioned a focus on explainable AI as essential to enable participation in the design and evaluation of emerging AI approaches in education.

The conversations raised this question: how can co-design provide an empowering form of participation in design and thus achieve digital inclusion goals? Such digital inclusion can span many layers of design, including diverse representation in design of policies around data, design of adaptivity, and other user experiences in AI systems, design of plans for cultivating AI literacy for users of new platforms, and lastly, the design of plans to evaluate systems.

Re-thinking Teacher Professional Development

With regard to teachers as professionals, both researchers and other educators attending our listening sessions were highly concerned about the disconnect between how teachers are prepared versus how they are expected to work with emerging technology. When we discuss learning, teachers are central actors, and thus the contexts in which they are prepared is centrally important to their ability to do great work in current and emerging technological environments.

Teacher professional development, professional learning, and leadership (PD or PL) for emerging technologies was seen as an area needing intense re-thinking, and research could lead the way. Today, few who prepare to become a teacher in an established pre-service program learn about the effective use of educational technology in schools and classrooms; those who do

[74] Center for Integrative Research in Computing and Learning Sciences (CIRCLS). (2022, Feb.). From Broadening to Empowering: Reflecting on the CIRCLS'21 Convening. https://circls.org/circls21report

have the opportunity to investigate technology rarely think about the structures that shape its use in the classroom and in educational leadership. Consequently, a troubling dichotomy arises between a small set of investigators who specifically consider educational technology in their research on teaching and a broader group of educators who see educational technology as a generic instructional resource. The challenge is high because teacher professional development will remain highly varied by local contexts. Yet insufficient attention to teachers as leaders in the use and further development of effective educational technology is widespread in teacher professional development research.

One response can be in terms of investigating how to nurture greater AI literacy for all teachers. AI literacy is not only important to protect educators and students from possible dangers but also valuable to support teachers to harness the good and do so in innovative ways. A panelist reminded the group that this work implies how we prepare educators with a baseline AI literacy and understanding. More transparency and authentic dialogue can foster trust, which was mentioned by a researcher as a chief concern for all teachers and students.

This is not to suggest that AI literacy is a complete or even a simple fix. Researchers want to ask fundamental questions about what it means for teachers to be professionals, especially as emerging technologies gain ground in schools and classrooms—our teachers' professional workplaces. Researchers want to broadly reconceptualize teacher professionalism and to stop treating technology as an add-on element of professional development.

Connecting with Public Policy

Defining human-centered AI for education requires the embrace of a human-centered principle and foundation for developing and formulating policies that govern the application and use of AI more generally throughout society. For example, power dynamics that arise between companies and consumers in society around issues like data ownership will also arise in the education-specific ecosystem. Further, the public discourse in which people are discussing ethics, bias, responsibility, and many other necessary concepts will be happening simultaneously in public policy and in educational ecosystems.

One clear implication in our listening sessions was that efforts to improve AI literacy in education could be important and helpful to society more generally. For example, one panelist said that an overarching goal of improving AI literacy is necessary if they are to contribute to how those technologies are designed. Another researcher was interested in how edtech can provide environments where students can experience having difficult discussions across perspectives, an issue which is endemic to present society. A third researcher noted the insufficiencies of prior efforts to contend with algorithmic bias, ethics, and inclusion due to a classroom's complex social dynamics.

Researchers want to take a lead in going beyond checkbox approaches to take these issues seriously. And they also acknowledge that engaging with policy is often a new form of context for edtech and AI researchers, many of whom don't have long experiences in policy arenas. Likewise, developers often do have experience with some policy issues, such as data privacy and security, but are now needing to become part of new conversations about ethics, bias,

transparency, and more, a problem that the EdSAFE AI Alliance is addressing through multi-sector working groups and policy advocacy.[75]

Key Recommendation: Focus R&D on Addressing Context

Attendees who have participated in listening sessions leading up to this report were exceptionally clear that their view of future R&D involved a shift from narrow technical questions to richer contextual questions. This expansive shift toward context, as detailed below, is the foundational orientation that the listening session attendees saw as being necessary to advancing R&D. Attendees included these as dimensions of context:

- learner variability, e.g., in disabilities, languages spoken, and other relevant characteristics;
- interactions with peers, teachers, and others in the learning settings;
- relationships across home, school, and community settings, including cultural assets;
- instructional resources available while learning;
- teacher preparation; and
- policies and systems that structure teaching and learning.

To more fully represent the context of teaching and learning, including these and other dimensions of text, researchers will have to work in partnership with others to understand which aspects of context are most relevant to teaching and learning and how they can be usefully incorporated into AI models.

Ongoing Questions for Researchers

As mentioned earlier, people are good at context; AI—not so much. R&D investment in context-rich edtech thus could serve multiple national interests because finding ways to do a better job with context would be a fundamental advancement in AI. Indeed, questions like these reverberate across all applications of AI in society, and education is a centrally good context for investigating them:

- Are AI systems moving beyond the tall portions of the "long tail" to adapt to a greater range of conditions, factors, and variations in how people learn?
- To what extent are AI technologies enhancing rather than replacing human control and judgment of student learning?
- How will users understand the legal and ethical implications of sharing data with AI enabled technologies and how to mitigate privacy risks?
- To what extent does technology account for the complex social dynamics of how people work and learn together, or is technology leading humans to narrow or oversimplify?
- How can we more clearly define what we mean by a context-sensitive technology in terms that are both concrete and broad enough? How can we measure it?

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[75] Nentrup, E. (2022). How Policymakers Can Support Educators and Technology Vendors Towards SAFE AI. EdSAFE AI Alliance. https://www.edsafeai.org/post/how-policymakers-can-support-aied

- To what extent are technical indicators and human observations of bias or unfairness working together with human observations? How can concerns about ethics and equity in AI technologies become actionable both in R&D, and later, when AI is widely used?
- Are we learning for whom and under what conditions AI systems produce desired benefits and impacts and avoid undesirable discrimination, bias, or negative outcomes?

Desired National R&D Objectives

Attendees sought immediate progress on some key R&D issues, such as these:

- Clarifying and achieving a consensus on the terms that go beyond data privacy and data security, including ideas like human-centered, value-sensitive, responsible, ethical, and safe so constituents can advocate for their needs meaningfully and consistently
- Creating and studying effective programs for AI literacy for students, teachers, and educational constituents in general, including literacy with regard to the ethics and equity issues specific to AI in educational settings
- Advancing research and development to increase fairness, accountability, transparency, and safety in AI systems used in educational settings
- Defining participatory or co-designed research processes that include educators in the development and conduct of research related to the development, use, and efficacy of AI-enabled systems and tools
- Highlighting and advancing R&D efforts that empower the participation and voices of youth regarding research, data, and design of AI applications for teaching and learning

Longer term desires for a national R&D program include some of the following objectives:

- Funding sustainable partnerships that uncover what context means and how it can be addressed over longer periods of time
- Better connecting goals for "broadening participation" (for example, in STEM learning pathways) to strategies for addressing learner variability and diversity
- Prioritizing research to revitalize support for instructors in light of the increasingly technological nature of K-12, higher education, and workplace learning settings
- Creating infrastructure and new ways of working together beyond individual field-initiated grants so that R&D with big data and leveraging emerging AI capabilities becomes safer and more productive

Recommendations

Earlier, we asked two guiding questions:

1. What is our collective vision of a desirable and achievable educational system that leverages automation while protecting and centering human agency?

2. On what timeline will we be ready with necessary guidelines and guardrails along with convincing evidence of positive impacts, so that we can ethically and equitably implement this vision widely?

Answers to the first question are provided throughout the *Learning*, *Teaching*, *Assessment*, and *Research* sections. This section turns to a call to action to education leaders and to recommendations. Core to the Department's perspective is that education will need leadership specific to our sector. Leadership should recognize and build on prior accomplishments in edtech (such as strong prior work on student privacy and school data security) as well as broad frameworks for safe AI (such as the *Blueprint for an AI Bill of Rights*). Leadership must also reach beyond these accomplishments and frameworks to address emerging opportunities and risks that are specific to novel capabilities and uses of AI in education.

Insight: Aligning AI to Policy Objectives

Individual sections of this policy report provided insights in each of four areas—learning, teaching, assessment, and research. These insights, synthesized from extensive stakeholder consultation and listening sessions, show that the advances in AI can bring opportunities to advance the Department's policy objectives:

- In support of our objective of attracting and retaining teachers, our nation could focus on AI assistants that make teaching jobs better and provide teachers with the information they need to work closely and empathically with students. An emphasis on teachers in the loop could ensure that AI-enabled classroom technologies keep teachers in the know, in touch with their students, and in control of important instructional decisions. Keeping the teacher in the loop is important to managing risks, as well.

- In support of equitable learning, especially for those most affected by the pandemic, AI could shift edtech from a current deficit-based model to a strengths-based alternative. In addition to finding student weaknesses and assigning fixes, edtech could make recommendations based on strengths that students bring to learning and how adapting to the whole student—a cognitive, social, and self-regulating person—could enable more powerful learning. Adapting to the whole student should include supporting students with disabilities as well as English learners. With regard to equity, we must remain highly attuned to the challenges of bias (which are inherent to how AI systems are developed) and take firm action to ensure fairness.

- With regard to growth trajectories to successful careers, AI-enabled assessments could provide students and teachers with formative guidance on a wider range of valuable skills, focusing on providing information that enhances learning. Aligned with the human-centric view, we should take a systems view of assessments where students, teachers, and others remain at the center of instructional decision making.

- With regard to equity, as research advances and brings more context into AI, we will be better able to use AI to support goals that require customization of learning resources, such as enabling teachers to more easily transform materials to support neurodiverse learners and increase responsiveness to local communities and cultures.

Going forward, educational leaders need to bring these and their own policy priorities to the table at every discussion about AI, driving the conversation around human priorities and not only their excitement about what new technology might do. Fundamentally, AI seeks to automate processes that achieve goals, and yet, AI should never set goals. The goals must come from educators' vision of teaching and learning and educators' understanding of students' strengths and needs.

Calling Education Leaders to Action

We summarize seven recommendations for policy action. These recommendations are for education leaders. In the introduction, we note the necessity of involving education constituents in determining policies for AI. We also observed throughout our listening sessions that people coming from many different roles in education all have passion, knowledge, and insights to contribute. In our view, all types of constituents can be education leaders. We are reluctant to suggest any constituent role is more important to advance any of the recommendations, but we call out specific needs for action within some of the recommendations where it is warranted.

Recommendation #1: Emphasize Humans in the Loop

We start with a central recommendation throughout this report. This recommendation was a clear constituent favorite. Indeed, across more than 700 attendees in our listening sessions, the predominant discussion tackled how constituents can achieve a consensus vision for AI-enabled edtech where humans are firmly at the center. The *Blueprint for an AI Bill of Rights* similarly calls for "access to timely human consideration and remedy by a fallback and escalation process if an automated system fails, it produces an error, or you would like to appeal or contest its impacts…" Building on this consensus, we call upon all constituents to adopt "humans in the loop" as a key criterion for educational use of AI.

We envision a technology-enhanced future more like an electric bike and less like robot vacuums. On an electric bike, the human is fully aware and fully in control, but their burden is less, and their effort is multiplied by a complementary technological enhancement. Robot vacuums do their job, freeing the human from involvement or oversight.

Although teachers should not be the only humans involved in loops, Figure 5 provided examples of three types of teacher loops that are central to education and can be used to illustrate what "human in the loop" means. Here, we use the example of an AI chatbot to elaborate on the meaning of the loops. First, as students become involved in extended interactions with AI chatbots, teachers will need to educate students about safe AI use, monitor their use, and provide human recourse when things go astray. Second, teachers are beginning to use chatbots to plan personalized instruction for their students; they will need to be involved in loops with other teachers to understand effective prompts, to know how to analyze AI-generated lesson plans for flaws, and to avoid the human tendency to overly trust AI systems and underapply human judgement. Third, teachers need to be involved in the design and evaluation of AI systems before they are used in classrooms and when needs for improvement are observed. In one example, to design AI-generated homework support for students, teachers' in-depth understanding of the

cognitive, motivational, and social supports their students need will provide much-needed guidance as a homework-support chatbot is designed.

In framing AI in education, this report advances a key recommendation of "human in the loop" AI because the phrase readily communicates a criterion that everyone can use as they determine which AI-enabled systems and tools are appropriate for use in teaching and learning. In a rather technical field, human in the loop is an approachable and humanistic criterion. Rather than suggesting that AI-enabled systems and tools should replace teachers, this term instead solidifies the central role of educators as instructors and instructional decision makers, while reinforcing the responsibility of teachers to exercise judgement and control over the use of AI in education. It resonates with the important idea of feedback loops, which are highly important to how people teach and learn. It also aligns with the ideas of inspectable, explainable, severable, and overridable AI.

The Department agrees with listening session participants who argued that teachers should not be the only humans in the loop and calls upon parents, families, students, policy makers, and system leaders to likewise examine the "loops" for which they are responsible, critically analyze the increasing role of AI in those loops, and determine what they need to do to retain support for the primacy of human judgement in educational systems.

Recommendation #2: Align AI Models to a Shared Vision for Education

> *"All models are wrong, but some are useful."*
> *—George Box, Statistician*

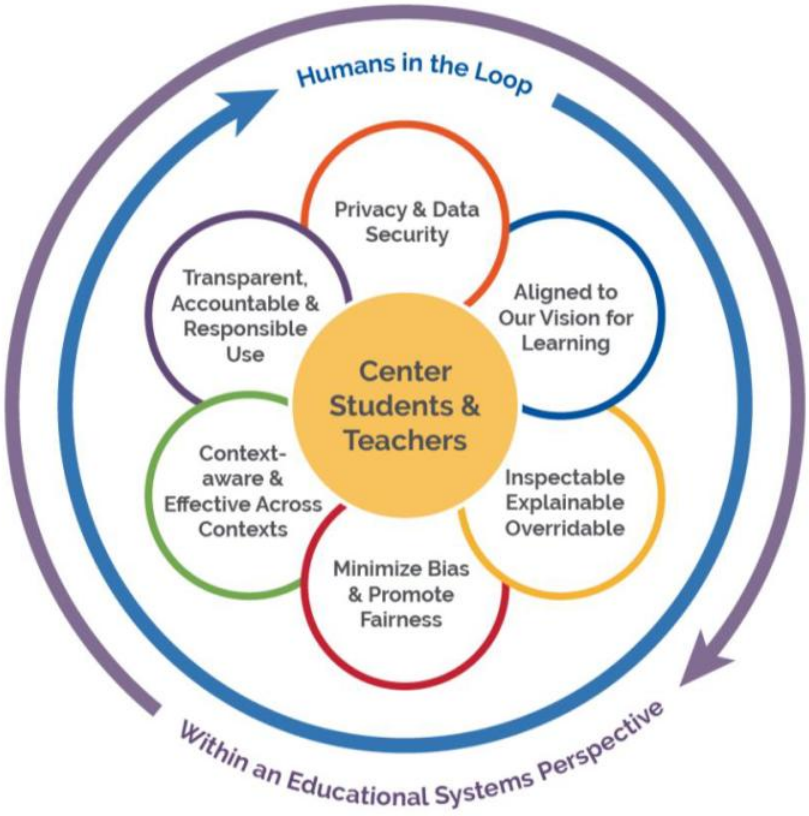
As we have discussed across every section of this report, AI technologies are grounded in models, and these models are inevitably incomplete in some way. It is up to humans to name educational goals and measure the degree to which models fit and are useful—or don't fit and might be harmful. Such an assessment of how well certain tools serve educational priorities may seem obvious, but the romance of technology can lead to a "let's see what the tech can do" attitude, which can weaken the focus on goals and cause us to adopt models that fit our priorities poorly.

Here we call upon educational policy and decision makers at the local, state, and federal level to use their power to align priorities, educational strategies, and technology adoption decisions to place the educational needs of students ahead of the excitement about emerging AI capabilities. We want to strengthen their attention to existing state, district, and school-level policies that guide edtech adoption and use, such as the four levels of evidence in ESSA, the privacy requirements of FERPA, and enhanced policies to come. Local education leaders know best what their urgent educational priorities are. Every conversation about AI (or any emerging technology) should start with the educational needs and priorities of students front and center and conclude with a discussion about the evaluation of effectiveness re-centered on those needs and priorities. Equity, of course, is one of those priorities that requires constant attention, especially given the worrisome consequences of potentially biased AI models.

We especially call upon leaders to avoid romancing the magic of AI or only focusing on promising applications or outcomes, but instead to interrogate with a critical eye how AI-enabled systems and tools function in the educational environment. We ask leaders to distrust broad claims and ask six types of questions, listed below. Throughout this report, we elaborated on

which characteristics of AI model use in education are most important to evaluate for alignment to intended educational goals. To aid leaders, we summarize our insights about AI models and their use in educational tools and systems in Figure 14.

Figure 14: Recommendation for desired qualities of AI tools and systems in education



In this figure, we center teaching and learning in all considerations about the suitability of an AI model for an educational use. Humans remain in the loop of defining, refining, and using AI models. We highlight the six desirable characteristics of AI models for education (elaborating from principles in the *Blueprint for an AI Bill of Rights* to fit the specifics of educational systems):

1. **Alignment of the AI Model to Educators' Vision for Learning**: When choosing to use AI in educational systems, decision makers prioritize educational goals, the fit to all we know about how people learn, and alignment to evidence-based best practices in education.

2. **Data Privacy:** Ensuring security and privacy of student, teacher, and other human data in AI systems is essential.

3. **Notice and Explanation:** Educators can inspect edtech to determine whether and how AI is being incorporated within edtech systems. Educators' push for AI models can explain the basis for detecting patterns and/or for making recommendations, and people retain control over these suggestions.

4. **Algorithmic Discrimination Protections:** Developers and implementers of AI in education take strong steps to minimizing bias and promoting fairness in AI models.

5. **Safe and Effective Systems:** The use of AI models in education is based on evidence of efficacy (using standards already established in education for this purpose) and work for diverse learners and in varied educational settings.

6. **Human Alternatives, Consideration and Feedback:** AI models that support transparent, accountable, and responsible use of AI in education by involving humans in the loop to ensure that educational values and principles are prioritized.

Although we first address our recommendation to interrogate how educational systems use AI models to educational leaders who adopt technologies, other leaders also have integral roles to play. Teachers and students, as well as their families/caregivers, contribute significantly to adoption decisions also. And leaders and parents must support educators when they question or override an AI model based on their professional wisdom. Developers of technologies need to be forthcoming about the models they use, and we may need policymakers to create requirements for disclosure so that the marketplace can function on the basis of information about AI models and not only by the claims of their benefits.

We also emphasize the need for a government role. AI models are made by people and are only an approximation to reality. Thus, we need policies that require transparency about the AI models that are embedded in educational systems, as well as models that are inspectable, explainable, and overridable. Our listening sessions featured constituent calls for government doing more to hold developers accountable for disclosing the types of AI models they employ in large-scale products and the safeguards included in their systems. Government leaders can make a positive contribution to market conditions that enable building trust as AI systems are procured and implemented in education. We discuss these guidelines more in recommendation #4, which is about building trust.

Recommendation #3: Design Using Modern Learning Principles

We call for the R&D sector to ensure that product designs are based on best and most current principles of teaching and learning. The first decade of adaptivity in edtech drew upon many important principles, for example, around how to sequence learning experiences and how to give students feedback. And yet the underlying conception was often deficit-based. The system focused on what was wrong with the student and chose pre-existing learning resources that might fix that weakness. Going forward, we must harness AI's ability to sense and build upon learner strengths. Likewise, the past decade of approaches was individualistic, and yet we know that humans are fundamentally social and that learning is powerfully social. Going forward, we must build on AI capabilities that connect with principles of collaborative and social learning and which respect the student not just for their cognition but also for the whole human skill set. Going forward, we also must seek to create AI systems that are culturally responsive and culturally sustaining, leveraging the growth of published techniques for doing so. Further, most early AI systems had few specific supports for students with disabilities and English learners. Going forward, we must ensure that AI-enabled learning resources are intentionally inclusive of these students. The field has yet to develop edtech that builds upon each student's ability to make choices and to self-regulate in increasingly complex environments. We have to develop edtech that expands students' abilities to learn in creative modes and to expand their ability to discuss, write, present, and lead.

We also call upon educators to reject uses of AI that are based solely on machine learning from data—without triangulation based on learning theory and knowledge from practice. Achieving

effective and equitable educational systems requires more than processing "big data," and although we want to harness insights from data, human interpretation of data remains highly important. We reject a technological determinism in which patterns in data, on their own, tell us what to do. Applications of AI in education must be grounded in established, modern learning principles, the wisdom of educational practitioners, and should leverage the expertise in the educational assessment community around detecting bias and improving fairness.

Recommendation #4: Prioritize Strengthening Trust

Technology can only help us to achieve educational objectives when we trust it. Yet, our listening sessions revealed the ways in which distrust of edtech and AI is commonplace. Constituents distrust emerging technologies for multiple reasons. They may have experienced privacy violations. The user experience may be more burdensome than anticipated. Promised increases in student learning may not be backed by efficacy research. They may have experienced unanticipated consequences. Unexpected costs may arise. Constituents may distrust complexity. Trust needs to incorporate safety, usability, and efficacy.

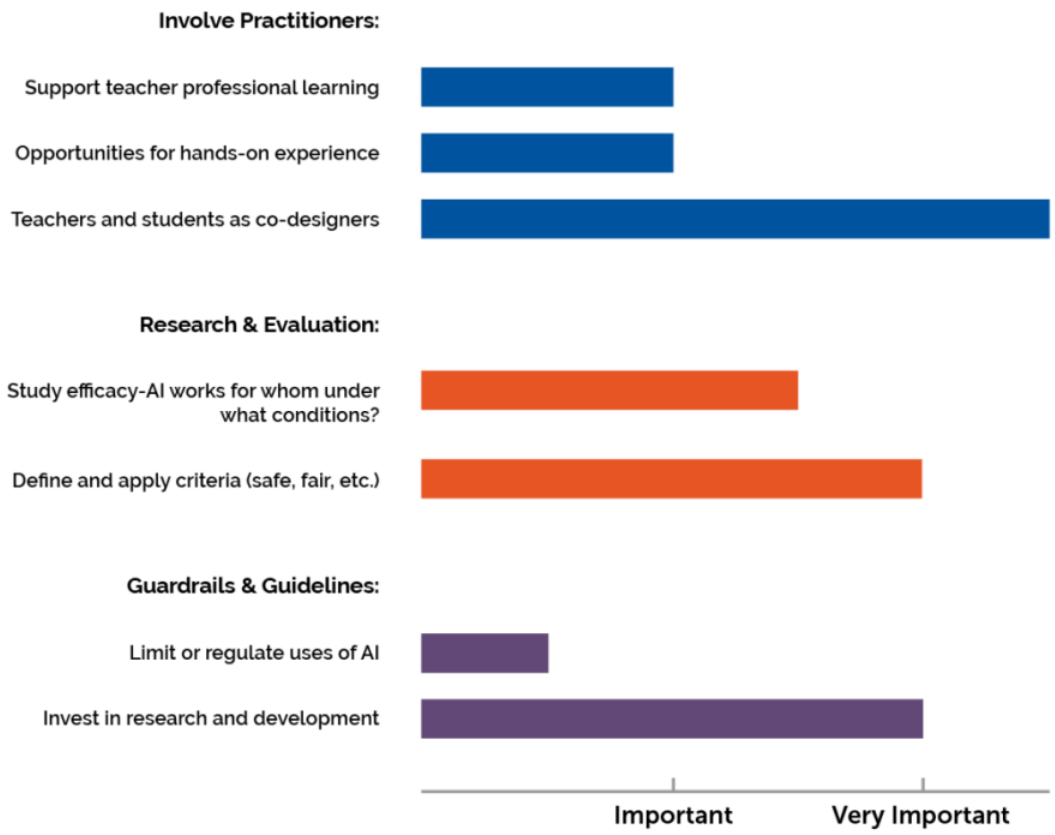
The Department firmly takes the stance that constituents want AI that supports teachers and rejects AI visions that replace teachers. And yet, teachers, students, and their families/caregivers need support to build appropriate levels of trust in systems that affect their work. In the broader ecosystem, trustworthy AI is recognized as a multidimensional problem (including the dimensions of Figure 14, above). If every step forward does not include strong elements of trust building, we worry that distrust will distract from innovation serving the public good that AI could help realize.

We expect that associations and societies have a key role in strengthening trust. Some important associations like the State Educational Technology Directors Association and the Consortium for School Network work with edtech leaders, and parallel organizations like EDUCAUSE work with postsecondary leaders. Other associations and societies work with teachers, education leaders, and education staff developers. Industry networks, like the EdSAFE AI Alliance, can bring together industry leaders to work together to foster trust. Additional societies bring researchers together. These societies and associations have the reach necessary to bring all parts of the educational ecosystem into discussions about trust and also the ability to represent the views of their constituents in cross-cutting policy discussions.

Recommendation #5: Inform and Involve Educators

Our listening sessions also asked for more specific direction on the question of what education leaders should do (see Figure 15). The most frequent responses fit three clusters: the need for guidelines and guardrails, strengthening the role of teachers, and re-focusing research and development. These are activities that constituents are asking for and that could expand trust. The recommendations that follow respond to these requests.

Figure 15: Listening session attendees prioritized involving practitioners, research, and evaluation and the need for guidelines and guardrails.



In particular, one concern that repeatedly arose in our listening sessions was the potential for AI to result in less respect for educators or less value for their skills. Across the nation, we are now responding to decreasing interest in entering or remaining in the teaching profession. Now is the time to show the respect and value we hold for educators by informing and involving them in every step of the process of designing, developing, testing, improving, adopting, and managing AI-enabled edtech. This includes involving educators in reviewing existing AI-enabled systems, tools, and data use in schools, designing new applications of AI based on teacher input, carrying out pilot evaluations of proposed new instructional tools, collaborating with developers to increase the trustworthiness of the deployed system, and raising issues about risks and unexpected consequences as the system is implemented.

We have already seen educators rise to the challenge of creating overall guidelines, designing specific uses of available AI-enabled systems and tools, and ferreting out concerns. And yet, the influence of educators in the future of AI-enabled products cannot be assumed; instead, constituents need policies that put muscle behind it. Could we create a national corps of leading educators representing every state and region to provide leadership? Could we commit to developing necessary professional development supports? Can we find ways to compensate educators so they can be at the forefront of designing the future of education? Our policies should enable educators to be closely involved in design of AI-enabled educational systems.

Although we know that the responsibility for informing and involving educators must be distributed at all levels of national and school governance, the Office of Educational Technology

can play a key role in informing and involving educators through its reports, events, outreach, and in a future NETP. Although examples above refer to K-12 teachers, higher education instructors must also be included. We also call on the edtech industry to involve educators throughout their design and development processes. For example, AI-enabled teaching assistants are only likely to help teachers do their job if teachers are thoroughly involved as the assistants are designed. We call upon institutions that prepare teachers to integrate technology more systematically into their programs; for example, the use of technology in teaching and learning should be a core theme across teacher preparation programs, not an issue that arises only in one course.

Recommendation #6: Focus R&D on Addressing Context and Enhancing Trust and Safety

Research that focuses on how AI-enabled systems can adapt to context (including variability among learners) in instructional approaches and across educational settings is essential to answering the question of, "Do specific applications of AI work in education, and if so, *for whom and under what conditions*?" The italicized phrase points to variability among learners and diversity in the settings for learning. We call upon innovators in R&D to focus their efforts to advance AI on the long tail of learning variability, where large populations of students would benefit from customization of learning. We also call on R&D to lead by establishing how trust can be strengthened in AI-enabled systems, building on the *Blueprint's* call for safe and effective systems yet also including education-specific requirements, such as how teachers can be meaningfully involved in design phases, not only in implementation and evaluation.

Although many products today are adaptive, some adapt on just one or a few dimensions of variability, such as student's accuracy in problem solving. As teachers know, there are many more important ways to adapt to students' strengths and needs. Students are neurodiverse and may have specific disabilities. They bring different assets from their experiences at home, in communities, and in their cultures. They have different interests and motivations. They are in different places in their journeys to master the English language. And they learn in varied settings. Classrooms and schools are different, and at home, students learn in informal settings in ways that could complement school learning. We recommend attention to "context" as a means for expressing the multiple dimensions that must be considered when elaborating the phrase "for whom and under what conditions." We also acknowledge the role of researchers in conducting evaluations, which must now consider not only efficacy but must also explore where harm may arise and the system problems that can occur through weak trust or over-trust in AI systems.

R&D must take the lead in making AI models more context-sensitive and ensuring that they are effective, safe, and trustworthy for use with varied learners in diverse settings. Although AI has capabilities to find patterns beyond the limited number of variables that people normally think about, AI is not particularly good at understanding and working with context in the ways people do. Over time, we've seen learning sciences grow to be less about individualistic cognitive principles and more encompassing first of social learning and then of the many dimensions of context that matter in learning. Our use of AI needs to follow this trajectory toward context to support educational applications.

To achieve human-centric vision, listening session attendees argued that teams will need time and freedom to explore how best to manage the tension between the pace of technological

advancement and the need for broader contextual insights—for trust and for safety. They will need time and freedom to pioneer new processes that better involve teachers and students as co-designers, with attention to balancing power dynamics. And they will need to shift attention from older ways of framing priorities (such as achievement gaps) to new ways of prioritizing digital equity. We call on R&D funders to focus resources on the long tail of learner variability, the need for AI-enabled systems that better incorporate context, and time required to get contextual considerations right. We call upon researchers and developers to prioritize challenges of context, trust, and safety in their work to advance AI.

Recommendation #7: Develop Education-Specific Guidelines and Guardrails

Our final recommendation is central to policymakers. A feature of the American educational system is the emphasis on local decision making. With technology growing in complexity at such a rapid pace, it is becoming difficult for local leaders to make informed decisions about the deployment of artificial intelligence. As we have discussed, the issues are not only data privacy and security but extend to new topics such as bias, transparency, and accountability. It will be harder to evaluate promising edtech platforms that rely on AI systems against this evolving, complex set of criteria.

Regulations related to key student and family data privacy laws like the Family Educational Rights & Privacy Act (FERPA), the Children's Internet Privacy Act (CIPA), and the Children's Online Privacy Protection Act (COPPA) warrant review and further consideration in light of new and emerging technologies in schools. Laws such as the Individuals with Disabilities Education Act (IDEA) may likewise be considered as new situations arise in the use of AI-enabled learning technologies. As discussed throughout this document, the *Blueprint for an AI Bill of Rights* is an important framework throughout this work.

The Department encourages parallel work by constituents in all levels of the educational system. In addition to the key federal laws cited immediately above, many states have also passed privacy laws that govern the use of educational technology and edtech platforms in classrooms. Further constituents can expect general frameworks for responsible AI in parallel sectors like health, safety, and consumer products to be informative but not sufficient for education's specific needs. Leaders at every level need awareness of how this work reaches beyond implications for privacy and security (e.g., to include awareness of potential bias and unfairness), and they need preparation to effectively confront the next level of issues.

Next Steps

We are heartened to see intensifying discussions throughout the educational ecosystem about the role of AI. We see progress that we can build upon occurring, as constituents discuss these three types of questions: What are the most significant opportunities and risks? How can we achieve trustworthy educational AI? How can we understand the models at the heart of applications of AI and ensure they have the qualities that align to educational aspirations?

The Department developed this report with awareness of contributions arising from many types of organizations and collectives. Internationally, we recognize parallel efforts to consider AI in the European Union, at the United Nations, and indeed throughout the world. We are aware of progress being led by organizations such as UNESCO, the EdSAFE AI Alliance, and research

organizations in many countries. We plan to continue cross-agency work, for example, by continuing to coordinate with the Office of Science and Technology Policy and other Federal agencies as agencies implement next steps guided by the *Blueprint for an AI Bill of Rights*. We see a broad and fertile context for necessary next steps:

- Working within this context and with others, the Department will consider specific policies and regulations so that educators can realize the opportunities of AI in edtech while minimizing risks. For example, the Department is developing a set of AI usage scenarios to strengthen the process of evaluating and enhancing policies and regulations. The principles and practices in the *Blueprint for an AI Bill of Rights* will be used to ensure the scenarios mitigate important risks and harms.

- Working with constituents (including education leaders; teachers, faculty, support staff, and other educators; researchers; policymakers; funders; technology developers; community members and organizations; and above all, learners and their families/caregivers), we will develop additional resources and events to increase understanding of AI and to involve those who will be most affected by these new technologies.

- Working across sectors, such as education, innovation, research, and policy, we will revise and update the NETP to guide all constituents toward safe, equitable, and effective AI in education in the United States, in alignment with our overall educational priorities.

Common Acronyms and Abbreviations

- AES: Automated Essay Scoring
- AI: Artificial Intelligence
- CIPA: Children's Internet Protection Act
- COPPA: Children's Online Privacy Protection Act
- Edtech: Educational Technology
- ESEA: Elementary and Secondary Education Act
- ESSA: Every Student Succeeds Act
- FERPA: Family Educational Rights and Privacy Act
- IA: Intelligence Augmentation
- IDEA: Individuals with Disabilities Education Act
- IEP: Individualized Education Program
- ITS: Intelligent Tutoring Systems
- NETP: National Education Technology Plan
- R&D: Research & Development

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Empowering Learners for the Age of AI

An AI Literacy Framework for Primary and Secondary Education

European Commission

OECD

With Support From

code.org

REVIEW DRAFT (May 2025)

Welcome!

Empowering Learners for the Age of AI: An AI Literacy Framework for Primary and Secondary Education (AILit Framework) is a joint initiative of the European Commission and the Organization for Economic Cooperation and Development (OECD). Code.org and leading international experts support its development. The AILit Framework contributes to the PISA 2029 Media & Artificial Intelligence Literacy assessment.

This draft framework also aligns with the broader European Commission efforts to promote quality education and skills provision for the digital transformation in the context of the Digital Education Action Plan 2021-2027. In particular, the framework responds to the 2023 Council Recommendations on digital education and skills. It complements the 2022 Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators and DigComp 2.2: The Digital Competence Framework for Citizens. More broadly, the EU AI Act, the first comprehensive legislation on AI in the world, promotes a human-centered and risk-based approach to the adoption of AI systems. In particular, Article 4 of the Act requires both providers and deployers of AI systems to ensure that their staff, and anyone using the systems on their behalf, have an adequate level of AI literacy.

This draft is intended to elicit feedback from educators and stakeholders. We hope it sparks a dialogue about what AI literacy means and how teaching and learning must evolve in an age of AI. We also look forward to engaging with stakeholders over the next several months and invite you to provide feedback at in-person and virtual events hosted by the European Commission, OECD, Code.org, and our network of international experts and organizations. Your input plays a crucial role in shaping the future of AI literacy.

With Support from

Co-funded by the European Union

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Expert Group

An international team of experts informed the development of this draft. Their insight ensures that the framework aligns with research and practice at the intersections of education, technology, and learning design.

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Empowering Learners for the Age of AI: An AI Literacy Framework for Primary and Secondary Education is a joint initiative of the European Commission and the Organization for Economic Cooperation and Development (OECD). Code.org and leading international experts support its development. The European Commission co-funded the framework and assisted with expertise built on previous work at the EU level. The development team was responsible for overall project management, hosting focus groups, conducting research, drafting versions of the framework for review, processing feedback, and designing the draft document and website.

Acknowledgements

The TeachAI community provided valuable insights to inform the development of this draft framework.

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Contents

01

Introduction

Why AI Literacy?

As artificial intelligence (AI) increasingly influences how we access information, communicate, and make decisions, AI literacy becomes essential for navigating daily life, creating with purpose, and preparing for the future of learning and work. AI literacy equips learners and educators to understand both the risks and opportunities that AI presents, and to make meaningful and ethical decisions about its use. It helps learners critically evaluate AI's impact on their lives, education, and communities while preparing them to shape the future. However, to fully realize the potential of AI literacy to shape learning, key barriers to implementation must be addressed, including:

- A lack of a shared understanding of what AI literacy is and how to teach it.
- Uncertainty about how AI fits into various subject areas.

This publication serves as a starting point for teachers, education leaders, education policymakers, and learning designers to understand AI literacy and decide how it fits their needs. Establishing a common language about AI literacy is instrumental for consistency across diverse educational settings.

Definition of AI Literacy

AI literacy represents the technical knowledge, durable skills, and future-ready attitudes required to thrive in a world influenced by AI. It enables learners to engage, create with, manage, and design AI, while critically evaluating its benefits, risks, and ethical implications.

This draft definition builds on existing definitions from the EU AI Act, OECD, UNESCO, and other organizations.

What is AI?

Artificial Intelligence (AI) is a "machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments" (OECD, 2024). As defined in the EU AI Act, and in alignment with the OECD definition, "AI system means a machine-based system that is designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment, and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments" (EU AI Act, 2024).

The term "AI" in this publication refers to a broad range of AI systems. When warranted, specific terms such as "generative AI" or "machine learning" are used.

Young People are Experimenting with AI and Need Guidance

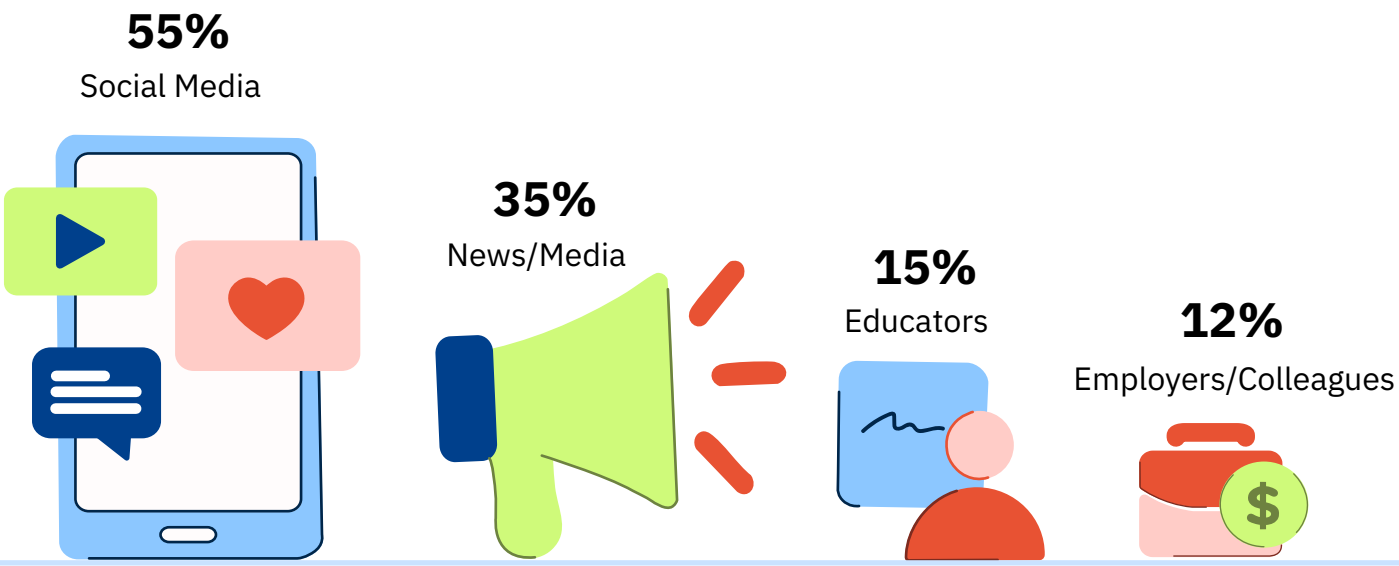
As young people begin using AI in more aspects of their lives, they need guidance to understand what it means, how it works, and how to use it responsibly. The majority of young people are already using AI, experimenting and practicing with AI in both structured and unstructured ways in their personal and professional lives (Merriman & Sanz Sáiz, 2024). But as they use AI, learners may encounter disinformation, misinformation, and bias, raising concerns over privacy and fairness. AI may also create skills and achievement gaps among peers and highlight a disconnect between what learners see as essential to their future and what schools currently provide (Vodafone Foundation, 2024).

AI literacy provides a clear understanding of how AI technologies work and what their responsible use entails, so that learners can make safe and informed decisions. Learners can also benefit from the opportunities AI brings to their lives, work, and studies. AI literacy must be grounded in trusted information, a focus on ethics, and a commitment to social good.

49% of 17- to 27-year-olds struggle with critically evaluating and identifying AI's shortfalls, such as whether AI systems can invent facts.

Source: Merriman & Sanz Sáiz, 2024

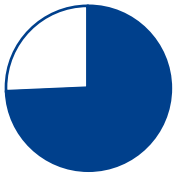
How Does Gen Z Learn About AI?



Source: How can we upskill Gen Z as fast as we train AI? (Merriman & Sanz Sáiz, 2024)
(5,218 respondents distributed globally)

The AI Skills Gap

A 2024 study of 12- to 17-year-olds across Europe reported that:



74%

Believe that AI will play a significant role in their professional lives.

46%

Think their schools adequately prepare them for AI.

44%

Perceive their teachers as well prepared to work with AI applications.

49%

Worry that AI could widen gaps in academic success among peers.

Source: AI in European Schools: A European report comparing seven countries (Vodafone Foundation, 2024) (7,000 students across Germany, Greece, Portugal, Romania, Spain, Türkiye, and the UK)

AI Literacy is an Educational Priority

This framework centers on the role of AI literacy in teaching and learning, as AI's emerging presence in education affects how learners research, write, and collaborate, as well as how educators plan lessons and provide feedback. A foundational understanding of AI supports educators in making their own decisions about when and how to use AI based on the students and content they know best. Without this support, learners may uncritically accept AI-generated content, adopt habits that compromise academic integrity, or neglect skills like critical thinking and empathetic judgment. They may also overlook the opportunities AI offers to enhance their own learning experiences and introduce new skills. Making AI literacy an educational priority ensures that students know how to evaluate, question, and apply AI responsibly in their academic lives, and thrive in contexts beyond the classroom.

Integrating AI literacy is a shared responsibility across the education ecosystem, rather than the duty of any individual educator. Educators are encouraged to embed AI literacy when and where it aligns with their subject and context. The competences outlined in this framework are intended to be developed across a learner's primary and secondary education experience, in formal and informal learning environments, including schools, homes, and community settings.

Intended Audience for the Framework

This framework is designed for teachers, education leaders, education policymakers, and learning designers. It outlines competences and learning scenarios to inform learning materials, standards, school-wide initiatives, and responsible AI policies for primary and secondary education settings.

Teacher

> I need to know how AI can help my students learn and how I can integrate AI literacy into my curriculum during my full school day.

Education Leader

> I want to develop AI literacy initiatives for my school or professional organization and am looking for easy-to-follow guidance.

Education Policymaker

> I help shape AI literacy initiatives to ensure learners and educators are ready for the age of AI, and I want practical, research-backed advice to guide policies.

Learning Designer

> I design instructional content and train teachers, and I want to include AI literacy as a key feature in my resources.

Provide Feedback on this Draft

Over the next few months, stakeholders from around the world are encouraged to share their feedback and insights. The final version of the framework will be released in 2026, accompanied by limited exemplars of AI literacy in curriculum, assessment, and professional learning.

We invite you to contribute to these efforts via the following link: teachai.org/ailiteracy/review

02

Foundations of the AILit Framework

Building on Existing Frameworks

The AILit Framework builds on ideas and practices from previous digital competence and AI literacy frameworks. Collectively, these frameworks ensured that the AILit Framework is internationally informed, relevant to educators, and grounded in the ethical, technical, and social dimensions of AI literacy.

The European Commission's Digital Competence Framework for Citizens (DigComp) competence categorization and emphasis on learner agency in its knowledge, skills, and attitudes influenced the content of the AILit Framework, while its realistic employment and learning use cases informed the framework's structure.

UNESCO's AI Competencies for Students and AI Competencies for Teachers influenced AILit Framework's focus on global relevance and implementation. UNESCO's work also prompted consideration for clear distinctions between learner-specific AI literacy outcomes and ways that educators can support these experiences in the classroom.

The Digital Promise AI Literacy Framework's interconnected Modes of Engagement, with cross-cutting AI Literacy Practices and enumerated Types of Use, provided a foundation for how the AILit Framework defines competences and frames learners' specific interactions with emerging technologies.

The AI4K12 5 Big Ideas in AI informed the technical aspects of the framework, including the nature of AI and role of data in the AI training process.

The AILit Framework builds on these efforts, emphasizing a durable foundation, interdisciplinary integration, practical application, and insights from a global community of experts. It outlines essential knowledge, skills, attitudes, and competences that will remain relevant as AI continues to evolve, with a focus on concepts that transcend specific tools or trends. The framework also supports interdisciplinary connections across subjects and empowers learners to engage with AI critically, ethically, and creatively.

The AILit Framework's primary and secondary education scenarios illustrate how AI literacy can be practically implemented in classrooms, and in some cases without the need for AI technologies. Developed in collaboration with international experts in education and learning sciences, the framework is designed to be foundational, adaptable, and globally applicable. Its implementation is supported by a diverse network of partners in curriculum development, research, assessment, and policy. The final version of the framework will be accompanied by classroom-ready exemplars and inform the development of the innovative domain of the PISA 2029 assessment.

Research Process and Themes

This draft is informed by research that included the review of existing frameworks on digital competence, media literacy, and AI literacy, and the analysis of curricula in computer science, data science, social sciences, and career education. It also incorporates multiple research methods such as literature reviews, expert interviews, and focus groups with potential users. Three key themes emerged from this process: technical knowledge, the human skills needed to collaborate effectively with AI, and ethical considerations.

Theme 1: How AI and Machine Learning Work

Understanding AI helps learners dispel misconceptions about the technology and enables a more informed evaluation of its implications. AI isn't magic or all-knowing: It processes data using statistical inferences and logic to produce outputs (Allen & Kendeou, 2023; Touretzky & Gardner-McCune, 2022). It has been trained by data that comes from publicly available information, user-generated content, databases, and real-time interactions collected through sensors and digital systems (AI4K12, 2022; aiEDU, 2024). AI models "learn" not through authentic understanding, but by adjusting statistical weights based on these datasets (Touretzky & Gardner-McCune, 2022). This produces sophisticated outputs but makes AI vulnerable to replicating the harmful and statistical biases embedded in its training data or introduced during development (AI4K12, 2022; aiEDU, 2024; Sparks et al., 2024). The AILit Framework emphasizes that learners must develop a strong understanding of AI's technical foundations, including its reliance on data, probabilities, and inputs. By demystifying these technical underpinnings, learners develop a comprehensive understanding of both AI's capabilities and limitations. Ultimately, they draw connections between how AI works and the ways it might impact themselves or others.

Theme 2: Human Skills to Emphasize for Successful Collaboration with AI Tools

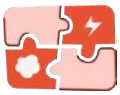
The AILit Framework emphasizes several skills and attitudes that support learners' successful collaboration with AI. Traditional learning competences such as metacognition and critical thinking remain highly relevant to interactions with AI. Communication, questioning, and perspective-taking skills assume new importance in interactions with AI and in broader discussions about its implementation (Thoman & Jollis, 2008; Kafai et al., 2019; aiEDU, 2024). Traditional computational thinking skills, such as abstraction, decomposition, and problem formulation, assume additional relevance beyond the computer science classroom, as students encounter technological challenges in their diverse everyday contexts (Allen & Kendeou, 2023; Dasgupta & Hill, 2021). This framework deliberately centers human capabilities within AI-specific competences, ensuring learners can effectively leverage AI tools while maintaining qualities that technology cannot replicate.

Theme 3: AI's Effects on Individuals, Society, and the Environment

Learners must think critically about how AI already affects them and how it will continue to shape their futures. Rather than treating ethics as a supplement to technical concepts, this framework emphasizes that values, context, and accountability are inseparable from learning with and about AI. This approach aligns with international research and existing policy recommendations and initiatives (European Commission 2020, 2022; Miao et al., 2024; Vuorikari et al., 2022). Learners must understand that AI exists within social and political systems and that algorithmic outputs can reinforce existing patterns of unfairness if not critically examined. This also includes considerations about the ethics of how training data was collected and classified (Buolamwini & Gebru, 2018; Noble, 2018; TeachAI, 2024). Throughout their interactions with AI, learners must reflect on its real-world implications: who can benefit or be harmed by AI systems; what perspectives are represented and excluded in both training data and AI-generated outputs; and, how AI systems influence personal autonomy, ownership, and access to information (White & Scott, 2024; Miao et al., 2024). The AILit framework reinforces ethical consideration through practical competences, mirroring calls to treat ethical evaluation as a core skill in one's digital life. Cultivating AI literacy helps learners navigate a world where technological decisions are deeply intertwined with power, equity, and accountability. It equips them to ask not only what AI can do, but also what it should do and whom it serves.

Additionally, the AILit Framework compels learners to weigh the environmental cost of using AI systems with AI's relevance to specific tasks. At the time of publication, AI systems require significant amounts of energy, materials, and water, while contributing to global carbon emissions (Zewe, 2025; Bashir et. al., 2024). Ongoing efforts to improve sustainability in computing focus on AI's potential to increase energy efficiency or address unique climate-related problems that other technologies cannot (Bashir et. al., 2024). While AI's long-term effects on natural resources have yet to be fully realized, this represents an opportunity for learners to think more broadly about the relationship between the digital and physical world.

The AILit Framework Development Principles



Interdisciplinary

Integrate AI literacy into a wide range of subjects and educational settings.

Foundational

Define a core set of competences needed to demonstrate proficiency in AI literacy.

Illustrative

Include scenarios and exemplars that bring AI literacy to life.

Global

Incorporate insights from educators, researchers, and AI experts worldwide.

Practical

Make AI literacy manageable and attainable in various classroom contexts.

Durable

Identify knowledge and skills that will remain relevant as AI evolves.

The Role of Teachers and Educators

Teachers and educators play a key role in developing learners' AI literacy by integrating AI concepts into concrete classroom practice. They help learners connect abstract ideas to specific subject matter, guide inquiry into how AI systems function, and create a supportive space for discussions about fairness, bias, and real-world impacts (Allen & Kendeou, 2023; Chiu et. al., 2021). The primary and secondary education scenarios that accompany each competence in the framework highlight ways that students can develop and demonstrate AI literacy in educational settings. However, it is up to educators to decide when to introduce AI tools, how to scaffold understanding, and what it means to assess student learning in a rapidly-changing technological landscape (Allen & Kendeou, 2023; Chiu & Chai, 2020; European Commission, 2022; Miao & Cukurova, 2024). Even more, they promote the responsible use of AI based on available guidelines from their education system, and use their expertise to make age-appropriate decisions about its use (Miao & Cukurova, 2024). These decisions stem from an educator's unique relationship with their students and their content expertise.

Educators need targeted support to build their own AI competences and to develop effective pedagogies for guiding students through this learning journey. The AILit Framework offers different ways for educators to introduce AI literacy to their learning environments. Its knowledge statements emphasize a clear understanding of AI's technical foundations, equipping educators to approach AI literacy with confidence and accuracy. The accompanying skills and attitudes, grounded in learning theory, metacognition, and recognition of uniquely human capacities, ensure that AI literacy can be meaningfully integrated into existing classroom practices. Learner-centered competences and education scenarios help teachers identify and prioritize relevant AI literacy outcomes that can take place in their classrooms. To further support implementation, the final version of the AILit Framework will also include a limited number of teaching and learning exemplars. Ultimately, educators' long-term success in teaching AI literacy depends on integrating new learning goals with existing priorities and having access to high-quality initial teacher training and continuous professional development that builds AI-informed pedagogy.

Learner Personas: What Does AI Literacy Look Like in Action?

These personas illustrate what it looks like when learners put AI literacy skills into action. They serve as starting points for imagining an AI-literate world, reflecting the many ways these skills take shape.

Sofia

10 years

AI in Action!

With her mother's guidance, Sofia uses generative AI to explore different plots and experiment with dialogue for stories she writes. She describes her own ideas and possible themes to the AI tool, then reflects on whether each suggestion feels right for her characters before making changes to her work. Sofia appreciates that AI introduces new ideas to consider, but trusts her own creative vision.

Jun

13 years

AI in Action!

Jun helps organize a school volunteering event by collecting availability, scheduling the day, and managing last-minute changes. He uses AI to draft schedules, then assigns volunteers himself based on classmates' personalities and strengths. AI automates logistics for Jun, helping him focus on building effective, collaborative teams for the event.

Omar

15 Years

AI in Action!

Omar set up an AI voice assistant for his parents to help them with everyday tasks, such as creating the family's schedule or grocery list. When he started seeing specific product recommendations on his social media feeds, Omar changed his account settings to prevent the system from using his family's information for targeted advertising.

Anika

18 Years

AI in Action!

As part of her studies, Anika is experimenting with designing a wellness app that uses an AI model to suggest mental health resources. While testing the app, she notices that it sometimes recommends options that reinforce gender stereotypes. Before going further with the app she makes a point to refine the model's responses to prompts and reviews the content it recommends.

03

Framework Structure

The Four Domains of AI Literacy

The four domains of the AILit Framework represent different ways in which learners interact with AI. Learners can build proficiency across multiple domains without developing full proficiency in any single one. The four domains encompass 22 competences.

Engaging with AI involves using AI as a tool to access new content, information, or recommendations. These situations require learners to first recognize AI's presence, then evaluate the accuracy and relevance of AI outputs. Learners must develop a fundamental understanding of AI's technical foundations in order to critically analyze its capabilities and limitations.

Creating with AI consists of collaborating with an AI system in a creative or problem-solving process. It involves guiding and refining AI output through prompts and feedback, while ensuring the content remains fair and appropriate. It also involves ethical considerations related to content ownership, attribution, and the responsible use of existing materials.

Managing AI requires intentionally choosing how AI can support and enhance human work. This includes assigning structured tasks to AI, such as organizing information, so humans can focus on areas requiring creativity, empathy, and judgment. AI systems can simulate a variety of roles, acting as an analyst, debate partner, or career guide. Learners who manage AI's actions learn to delegate tasks thoughtfully, guide AI outputs with clear instructions, and assess whether AI's role aligns with their goals and values. This domain helps learners build agency, ensuring that AI works for them and that its use remains ethical and human-centered.

Designing AI empowers learners to understand how AI works and connect it to its social and ethical impacts by shaping how AI systems function. Through hands-on exploration in an education context, students examine how data, design choices, and model behavior influence the fairness, usefulness, and impact of AI systems. The goal is not to develop commercial products or put them into service, but to build the confidence and capacity to shape AI for human good by understanding the principles underpinning the design of AI from an early age.

Knowledge, Skills, and Attitudes

While competences may evolve over time or in different contexts, the framework's knowledge, skills, and attitudes provide a durable foundation for AI literacy. They prepare learners to responsibly interact with existing technologies and navigate new ones as they arise. Each competence includes primary and secondary education learning scenarios that apply to various subject areas and educational contexts. These scenarios provide practical starting points for educators to include AI literacy in their own classrooms, with and without direct access to AI. Find the full text of the knowledge, skills, attitudes, competences, and learning scenarios in Sections 4 and 5.

Knowledge

The knowledge statements in the framework focus on conceptual knowledge, outlining the technical and societal understandings that learners need to apply and engage with AI systems. These concepts include how AI processes data, how AI differs from human thinking, and how bias can emerge in AI systems.

Skills

The skills demonstrate how fundamental abilities, such as critical thinking, creativity, and computational thinking, apply in an AI context. They guide learners in using AI effectively and ethically, ensuring that learners actively shape how AI fits into their lives.

Attitudes

The attitudes reflect mindsets and dispositions that prepare learners to engage with AI, not only with technical skills, but also with an awareness of AI's impact on themselves and others. These include a sense of curiosity and adaptability in using AI systems, as well as a readiness to question outputs and a commitment to using AI responsibly.

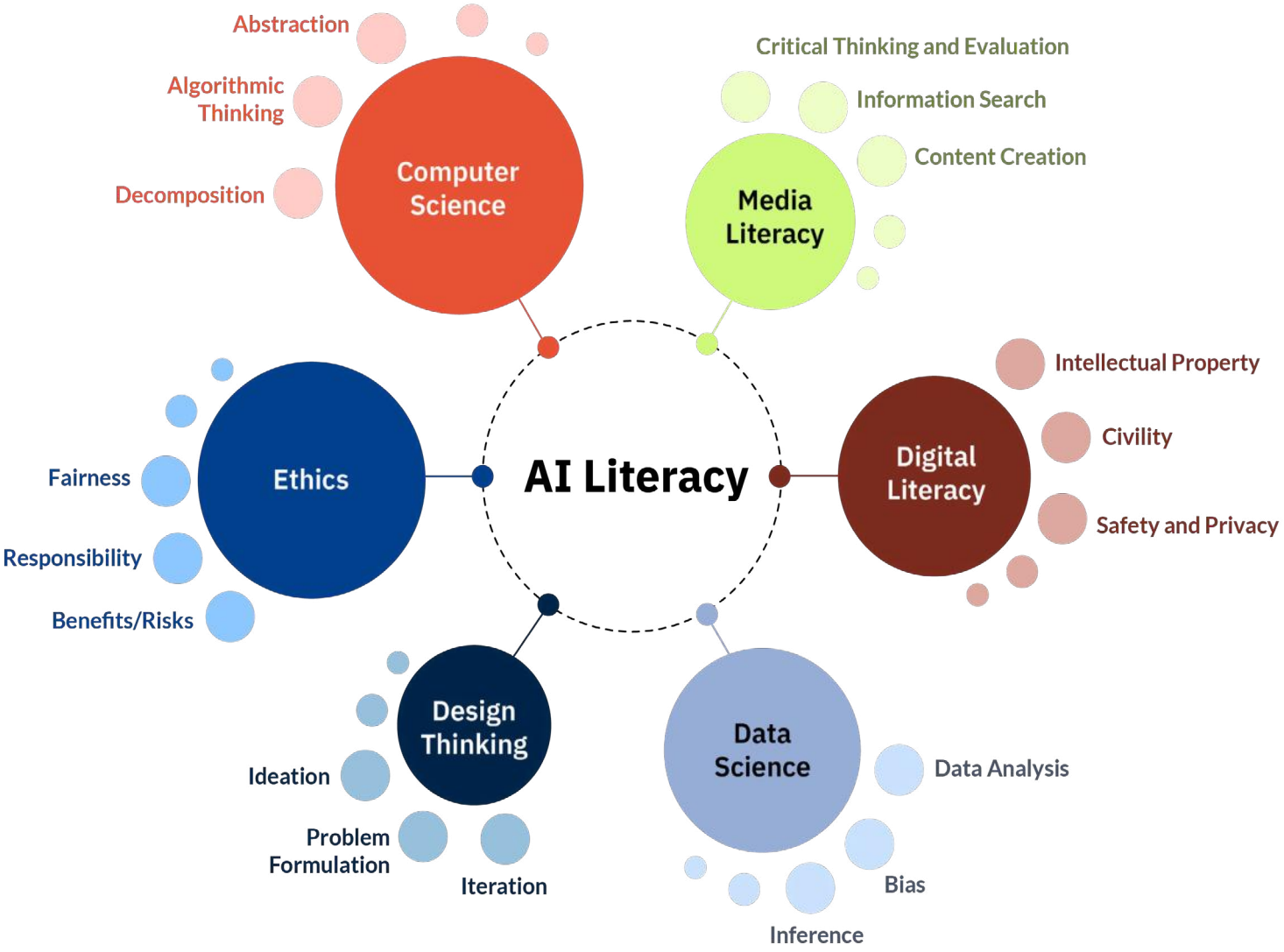
Ethics in the Framework

Ethical principles appear throughout the framework's knowledge, skills, and attitudes, and are reflected in multiple competences. For example, the competence "Evaluate whether AI outputs should be accepted, revised, or rejected." requires learners to recognize that AI's ability to generate human-like content introduces risks, such as misinformation, disinformation, or manipulation. Learners must apply critical thinking to detect misleading outputs and adopt a responsible attitude to ensure AI is used ethically.

> ***"The EU AI Act reminds us that AI literacy is key for educators as they empower students to navigate the benefits and risks of AI. By prioritizing AI literacy, we are empowering this generation of students with critical thinking and informed decision-making skills that will tap into AI's potential and help them thrive in a rapidly changing world.***
>
> - Romina Cachia, Team Leader and Scientific Researcher, Joint Research Centre - European Commission

Relationship to Other Topics and Disciplines

The AILit Framework reflects relevant knowledge, skills, and attitudes found across multiple topics and disciplines. AI literacy draws from areas such as ethics, computer science, media and digital literacy, data science, and design thinking—connecting technical understanding with critical evaluation, responsible use, and creative problem-solving. These interdisciplinary links reinforce the idea that AI literacy is a foundation for navigating and shaping the role of AI across contexts.



04

Knowledge, Skills, and Attitudes

Knowledge

The Nature of AI

AI Reflects Human Choices and Perspectives

AI Reshapes Work and Human Roles

AI's Capabilities and Limitations

AI's Role in Society

Skills

Critical Thinking: Evaluate AI-generated content.

Creativity: Collaborate with AI to create and refine ideas.

Computational Thinking: Decompose problems and provide instructions.

Self and Social Awareness: Recognize AI's influence.

Collaboration: Work effectively with AI and humans.

Communication: Explain how AI is used.

Problem Solving: Determine when and how to use AI.

Attitudes

Responsible

Curious

Innovative

Adaptable

Empathetic

Knowledge

The knowledge statements in the framework include facts, concepts, ideas, and processes reflecting disciplinary, interdisciplinary, epistemic, and procedural knowledge. They outline the technical and societal understandings that learners need to apply and engage with AI systems.

The Nature of AI

K1.1: AI systems use algorithms that combine step-by-step procedures with statistical inferences (e.g., weights and biases) to process data, detect patterns, and generate probable outputs.
K1.2: Machines "learn" by inferring how to generate outputs such as predictions, content, and recommendations that influence physical or virtual environments, in response to information from the input they receive. They do so with varying levels of autonomy and adaptiveness after deployment.
K1.3: Generative AI uses probabilities to generate human-like outputs across various modalities (e.g., text, audio, visuals) but lacks authentic understanding and intent.
K1.4: AI systems operate differently depending on their purpose, whether to create, predict, recommend, or respond.

Explanation: AI systems—including, but not limited to, classifiers, recommenders, predictive models, generative AI, and autonomous agents – operate by processing vast datasets to identify statistical patterns. As a broad class of technology, AI simulates intelligent behavior. Whether generating content, sorting information, making predictions, or executing sequences of actions, these systems aim to produce outputs that are statistically most likely to meet a given objective. While these systems can produce highly sophisticated and human-like outputs, they do so without comprehension, awareness, or intent. Understanding this distinction dispels the misconception that AI is all-knowing or consistently correct, and helps learners assess its reliability, limitations, and potential impact.

AI Reflects Human Choices and Perspectives

K2.1: Building and maintaining AI systems relies on humans to design algorithms, collect and label data, and moderate harmful content. These systems reflect human choices, assumptions, and labor practices, shaped by unequal global conditions.
K2.2: AI is trained on vast datasets sourced from publicly available information, user-generated content, curated databases, and real-world data collected through sensors, interactions, and digital systems.
K2.3: AI systems gather new data from interactions with users; decisions, processes, and outputs may be directly influenced by inputs in real time.
K2.4: AI systems are trained to identify patterns among data elements that humans have selected, categorized, and prioritized.
K2.5: Bias inherently exists in AI systems, which can also reflect societal biases embedded in its training data or algorithm design. Humans can perpetuate or mitigate harmful biases in AI systems during the design, development, or testing process.

Explanation: AI is not neutral; it is shaped by the decisions of those who build it. Humans select training data, which may have been collected unethically or feature inaccurate and incomplete representations of individuals and perspectives. They also impart judgment during the classification of that training data, which informs the algorithms that produce AI systems' outputs. While statistical and societal biases may exist undetected in training data or be reinforced in other aspects of the training

process, AI's prevalence in decision-making and everyday life can replicate those biases in ways that harmfully affect different groups of people. This makes ethics, algorithmic fairness, representation, explainability, and accountability essential to AI literacy.

AI Reshapes Work and Human Roles

K3.1: AI systems automate structured tasks, augment decision-making, and transform industries, requiring humans to adapt, reskill, and upskill.
K3.2: AI integration requires individuals to determine which tasks are best suited for machines and which require human intervention or expertise.
K3.3: While AI can support analysis and prediction, humans must be responsible for decisions that reflect human judgment and ethical considerations.

Explanation: The impact of AI across industries emphasizes the importance of adaptability and lifelong learning. While AI systems can increase efficiency for many types of tasks, these tools might not always be the best choice; humans must hone their knowledge of AI's capabilities and their domain expertise to manage AI systems effectively. Success in an AI-integrated workforce entails developing fluency in a range of technologies, staying current with new tools and techniques, and leveraging human judgment in decision-making starting from early ages, in and outside of formal education. This combination ensures that AI complements human skills and augments human capacities, rather than replaces them.

AI's Capabilities and Limitations

K4.1: AI excels at pattern recognition and automation but lacks emotions, ethical reasoning, context, and originality.
K4.2: AI requires vast amounts of computing power and data, which consumes energy, thus demanding limited natural resources and increasing carbon emissions. AI's long-term sustainability impact, both positive and negative, largely depends on how it is implemented and utilized.
K4.3: The capability of generative AI, particularly large language models (LLMs), to generate human-like content can make it difficult to distinguish fact from fabrication, increasing the potential to generate misinformation, deepfakes, or manipulative materials.

Explanation: AI lacks a true grasp of real-world context, human values and behaviors, and nuance—even when systems modify their own outputs to respond to a user's complex emotional states. While AI systems can analyze enormous amounts of data, they are prone to bias, confabulation, and misuse and rely on vast but finite natural resources. A human must make judgments about specific contexts that AI systems cannot, including whether the benefits of an AI tool is worth the environmental or societal cost. AI literacy requires critical thinking about when, where, and how AI should be applied to ensure it serves human needs equitably.

AI's Role in Society

K5.1: AI plays an increasingly prevalent role in decision-making that impacts humans, from hiring practices to healthcare to criminal justice.
K5.2: AI systems must be understood, audited, and regulated to ensure that their use leads to more benefits than harm for individuals and society.
K5.3: Generative AI and Large Language Models create content based on existing materials in training data, which includes copyright-protected work, thereby raising questions about authenticity,

authorship, and ownership.
K5.4: Ethical AI design encompasses fairness, transparency, explainability, accountability, respect for privacy, and legal compliance.

Explanation: AI systems do not exist in isolation; their use reflects, reinforces, and reshapes societal values and decisions. Without careful oversight, AI-driven decision-making can amplify bias and cause widespread harm. AI systems introduce implications for how learners should think about truth, authorship, and ownership in digital spaces. Individual and system-level guidance and regulations can help address areas where AI intersects with fundamental rights, such as surveillance and data privacy. Familiarity with ethical AI design principles helps learners to critically assess how AI systems are built and deployed. Without the understanding, learners risk accepting AI outputs at face value rather than asking whom they benefit or harm. To ensure AI serves society responsibly, we must continuously question and evaluate its effects and guide its use to mitigate its risks.

Skills

These skills represent fundamental human abilities applied to an AI context. They guide learners in using AI ethically and ensure that learners actively shape how AI fits into their lives.

Critical Thinking: Evaluate AI-generated content for accuracy, fairness, and bias to make informed and ethical decisions.

How can I check the accuracy of AI-generated outputs and reduce the risk of harmful bias? How do I know if AI is relevant or appropriate?

Practicing critical thinking in an AI context involves verifying whether the information provided by an AI system is accurate, relevant, and fair. Because AI systems can generate convincing but incorrect or biased content, learners must actively work to identify potential misinformation and weigh outputs with other sources of information. These actions result in a greater awareness of AI's impact on the broader information system. This process uncovers hidden biases or gaps and ensures AI outputs support ethical decision-making. By developing these skills, learners exercise media literacy, digital literacy, and digital citizenship, while becoming more discerning users of AI.

Creativity: Collaborate with AI to create and refine original ideas while considering issues of ownership, attribution, and responsible use.

How can I use AI responsibly to bring my creative visions to life?

Exercising creativity when using AI involves interacting with AI systems to brainstorm, generate, and refine original ideas. As learners use AI systems to explore possibilities beyond what they had originally envisioned, they must consider AI's impacts on originality, ownership, attribution, and copyright. By engaging creatively and responsibly with AI systems, learners stay accountable for the ideas they shape and share.

Computational Thinking: Decompose problems and provide instructions in ways that allow AI systems to effectively contribute to solutions.

How do I frame my problem so that AI can help solve it?

Computational thinking skills help approach and frame problems in ways that leverage the capabilities of AI and account for its limitations. This involves decomposing, or breaking down complex problems into structured components, and communicating goals and constraints in a manner that AI systems can effectively process (e.g., prompt engineering). By providing use cases, counterexamples, and expected outcomes to AI systems, learners refine their own communication skills, engage with metacognitive strategies, and make progress toward their goals.

Self and Social Awareness: Recognize how AI influences personal choices, relationships, and communities, and reflect on its broader societal and environmental impact.

How does AI impact me and others?

Self and social awareness are vital when interacting with AI. This skill begins with recognizing AI's presence in daily life and understanding how it influences decisions in both the digital and physical worlds. This extends beyond mere identification and applies to thoughtful consideration of AI's broader effects on individuals, communities, and the environment. Learners might also engage metacognitively with AI's effects on their own behaviors, thoughts, and learning processes. By recognizing AI's influence, learners are better equipped to evaluate AI-generated content and monitor how these technologies influence their thoughts and behaviors over time.

Collaboration: Work effectively with AI and humans by communicating clearly, giving feedback, and navigating shared tasks.

How can I collaborate transparently and ethically with AI to accomplish a goal?

Collaboration with AI relies on positive and productive interactions between humans and AI systems. This requires the ability to both give feedback and ask for help in and outside of the digital world. As learners collaborate with AI systems, they demonstrate agency alongside metacognition. By collaborating tactfully, assessing strengths in context, and honing relationship-building skills, learners develop the ability to navigate new and complex situations.

Communication: Explain how AI is used in a way that promotes transparency, avoids anthropomorphism, and encourages responsible use.

How do I describe AI use for myself and others?

Communicating about AI involves explaining when and how AI systems are used, including how they may have shaped content or contributed to decisions that impact others. This skill emphasizes that AI-literate learners have a responsibility to accurately describe how AI works in ways that do not

mischaracterize or assign human traits to its capabilities. When learners choose their words to promote transparency and responsible use of AI systems, they uphold ethical practices and encourage informed conversation about AI's implications.

Problem Solving: Determine when and how to use AI for a task by assessing its capabilities, risks, and ethical implications.

How do I choose the right type of tool for the task at hand?

Using AI to address a problem begins with thoughtful reflection on the task at hand and includes thorough consideration of whether AI's capabilities meet the task's technical and ethical requirements. To do this, learners might test specific AI systems for reliability and potential to replicate harmful bias. Learners problem-solve with AI when they ask themselves how AI systems might add value, where human judgment should come into play, and when to avoid AI use altogether.

Attitudes

These attitudes reflect the mindsets and dispositions that prepare learners to engage with AI, not only with technical skills, but also with an awareness of AI's impact on themselves, others, and society.

Responsible

Learners think carefully about how they use AI and are accountable of their choices. They consider both the intended and the potential unintended effects of their actions, and are committed to preventing harm to others. They believe everyone has the right to understand how AI affects them and to make informed decisions about its use.

Curious

Learners are eager to explore what AI can do today and how it might evolve in the future. They want to understand how AI affects their personal lives and future careers. They consider learning to be an ongoing process and enjoy experimenting, believing that meaningful discoveries happen through exploration.

Innovative

Learners seek to use AI to address real-world challenges and embrace new opportunities. They experiment, try different approaches, and think creatively to solve a problem. They believe AI can be a powerful tool for creating positive change in their own lives and the lives of others.

Adaptable

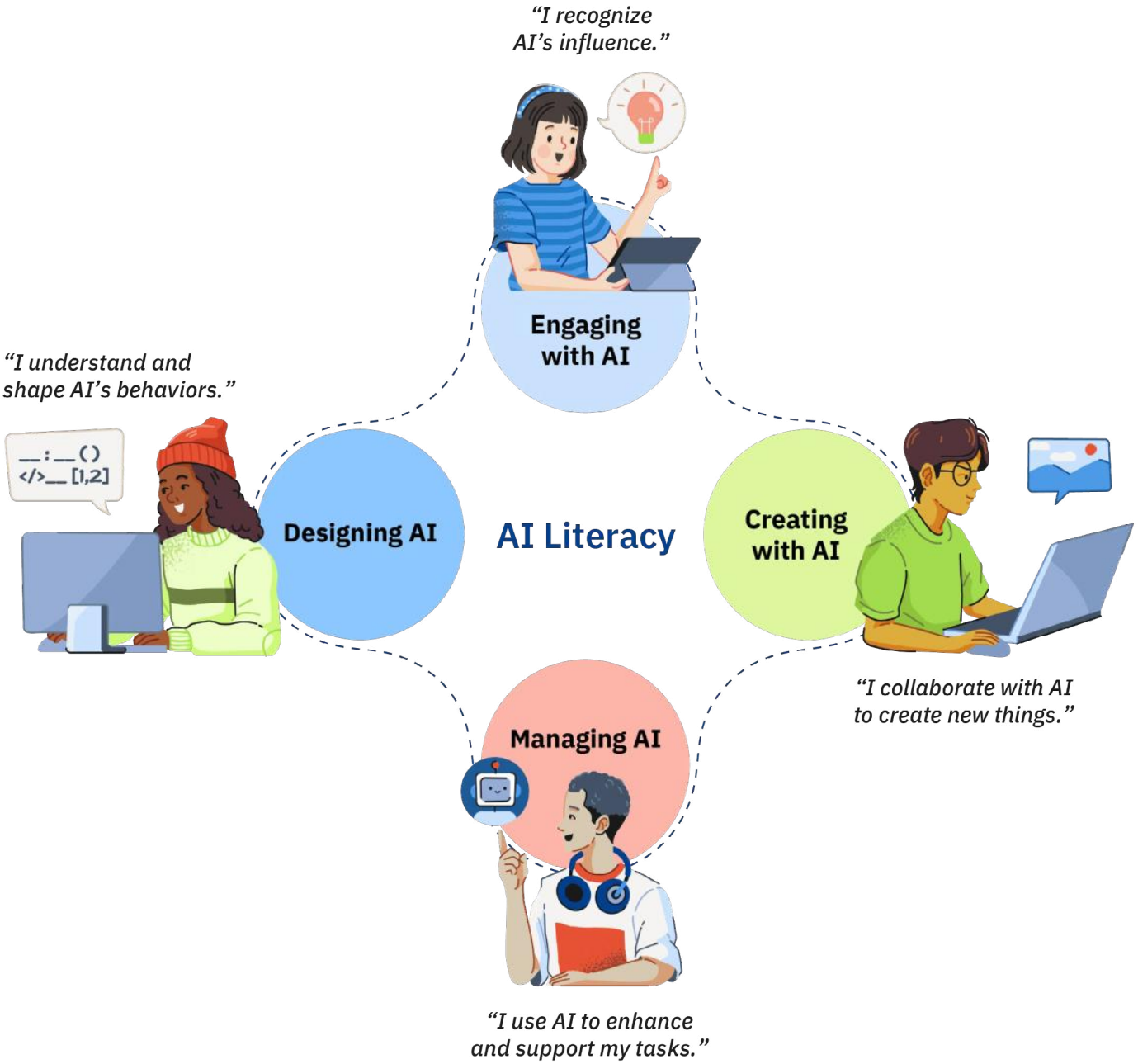
Learners show perseverance and flexibility when working with AI. They are open to diverse ideas, perspectives, and approaches. They understand that collaborating with AI is an iterative process shaped by feedback and revision.

Empathetic

Learners thoughtfully examine how AI impacts individuals, communities, and the environment. They weigh both the benefits and potential risks of using AI, understanding that its impact can vary for different groups of people.

05

Competences



The Anatomy of a Competence

Each competence is a learning expectation that reflects technical knowledge, durable skills, and future-ready attitudes. Although skills and attitudes have broad applicability, the framework highlights combinations that best support each competence. Each competence is accompanied by primary and secondary education scenarios that illustrate how learners can develop the respective competence in the classroom, under the guidance of a teacher.

Skills

Problem Solving: Determine when and how to use AI for a task by assessing its capabilities, risks, and ethical implications.
Computational Thinking: Decompose problems and provide instructions in ways that allow AI systems to effectively contribute to solutions.

Attitudes

Responsible; Innovative

"Decide whether to use AI systems based on the nature of the task."

Knowledge

K4.1: AI excels at pattern recognition and automation but lacks emotions, ethical reasoning, context, and originality.
K5.4: Ethical AI design encompasses fairness, transparency, explainability, accountability, respect for privacy, and legal compliance.

Primary Education Scenario

Consider everyday tasks (e.g., writing a birthday card) and assess when AI use is appropriate, considering the need for individuality, creativity, or human judgment.

Secondary Education Scenario

Determine whether specific AI systems should be avoided, or used to complete specific tasks, based on how well each option aligns with an assignment's learning objectives.

Engaging with AI

Engaging with AI in daily life involves using AI as a tool to access new content, information, or recommendations. These situations require learners to first recognize AI's presence, then evaluate the accuracy and relevance of AI outputs. Learners must develop a fundamental understanding of AI's technical foundations in order to critically analyze its capabilities and limitations.

“

Engaging with AI is more than just having digital skills—it demands critical thinking, media literacy, and the ability to challenge AI outputs, identify misinformation, and understand how data and ideas are used.

- Kari Kivinen, Education Outreach Expert, European Intellectual Property Observatory

Engaging with AI Competences

1 Recognize AI's role and influence in different contexts.

Knowledge: K1.4, K5.1 **Skills:** Self and Social Awareness **Attitudes:** Curious, Responsible

Learners identify the presence of AI in everyday tools and systems and consider its purpose in various situations, such as content recommendations or adaptive learning. They reflect on how AI influences their choices, learning, and perceptions.

Primary Education Scenario

List familiar digital interactions (e.g., using a web camera, video recommendations) and discuss if and how each uses AI.

Secondary Education Scenario

Explore how an online math platform uses real-time data to present content at different levels of difficulty.

2 Evaluate whether AI outputs should be accepted, revised, or rejected.

Knowledge: K4.1, K4.3 **Skills:** Critical Thinking **Attitudes:** Responsible

Learners critically assess the accuracy and fairness of AI-generated content, recognizing that AI can generate misinformation or biased outputs. They decide whether to trust, modify, or override AI outputs by considering their potential impact on themselves and others.

Primary Education Scenario

Compare an AI tool's step-by-step math solution to a learner's explanation to determine if the AI's process aligns with techniques that students have already learned.

Secondary Education Scenario

Prompt a language model with questions about historical events and evaluate the accuracy and bias of its responses by cross-referencing with reliable sources.

3 Examine how predictive AI systems provide recommendations that can inform and limit perspectives.

Knowledge: K1.1, K4.3 **Skills:** Self and Social Awareness **Attitudes:** Curious

Learners explore how AI uses data patterns to offer suggestions (e.g., what to watch, buy, or read) and consider how those recommendations may both support learning or decision-making and reinforce narrow viewpoints or biases.

Primary Education Scenario

Count by 2s, 5s, and 10s to introduce how humans recognize and predict sequences, then explore how AI generates recommendations based on patterns.

Secondary Education Scenario

Examine how social media algorithms can contribute to spreading disinformation or misinformation about a public health issue and compare the responsibilities of individuals and platforms in addressing the harm.

4 Explain how AI could be used to amplify societal biases.

Knowledge: K2.1, K2.5 **Skills:** Critical Thinking, Self and Social Awareness, Problem Solving **Attitudes:** Empathetic, Responsible

Learners investigate how AI systems, such as facial recognition or hiring algorithms, reflect human decisions and data, and identify ways that bias in data or design can lead to unfair outcomes for different groups of people.

Primary Education Scenario

Split several characters from different stories into categories, then discuss how using rules or data to group people can be useful or treat some people unfairly.

Secondary Education Scenario

Examine how an AI system was trained to recognize faces, evaluate potential sources of bias in the training data, and suggest steps developers could take to improve fairness.

5 Describe how AI systems consume energy and natural resources.

Knowledge: K4.2 **Skills:** Self and Social Awareness **Attitudes:** Responsible

Learners explore the environmental impact of AI, including its energy and data infrastructure, and consider how responsible design and use can support sustainability.

Primary Education Scenario

Create an infographic illustrating AI's environmental impacts, including the electricity it consumes, the devices it operates on, and the materials required to manufacture those devices.

Secondary Education Scenario

Compare AI's environmental costs with efforts to reduce them, then debate whether using AI in specific scenarios is environmentally responsible.

6 Analyze how well the use of an AI system aligns with ethical principles and human values.

Knowledge: K1.4, K3.3, K5.4 **Skills:** Self and Social Awareness, Critical Thinking, Problem Solving **Attitudes:** Responsible

Learners assess whether using AI in a given situation, such as surveillance cameras in public spaces or moderating online content, supports values such as fairness, transparency, and privacy. They reflect on whether its use is appropriate, beneficial, or potentially harmful.

Primary Education Scenario

Evaluate if AI is used kindly, fairly, and respectfully in multiple scenarios, such as editing or sharing someone's photo without permission.

Secondary Education Scenario

Use an AI writing assistant to revise a personal narrative, then reflect on whether its suggestions supported authentic voice or changed the story undesirably.

7 Connect AI's social and ethical impacts to its technical capabilities and limitations.

Knowledge: K2.1, K5.2 **Skills:** Self and Social Awareness, Problem Solving **Attitudes:** Curious, Empathetic, Responsible

Learners explore how AI's strengths and weaknesses affect how it's used in society. They connect the design and function of AI systems to real-world impact on people, communities, and systems.

Primary Education Scenario

Discuss why a smartphone voice assistant sometimes doesn't understand commands or questions, and when to turn to another source for information.

Secondary Education Scenario

Investigate how predictive AI calculates credit scores or loan eligibility. Then explore which data is used, what bias might appear, and how mathematical models can reinforce inequality.

Creating with AI

Creating with AI consists of collaborating with an AI system in a creative or problem-solving process. It involves guiding and refining AI output through prompts and feedback, while ensuring the content remains fair and appropriate. It also involves ethical considerations related to content ownership, attribution, and the responsible use of existing materials.

“

Where does creativity come from? We want to think it’s all in one person’s head. But even at professional design schools, they put people in groups in these big, colorful rooms with sticky notes because having those things helps you to be more creative. It helps you to get out more ideas. So, LLMs used well can be similar. If I have a thought partner that I can improvise with, that could actually be a great creativity amplifier.

- Victor R. Lee, Associate Professor of Learning Sciences and Technology Design, Stanford University

Creating with AI Competences

1 Use AI systems to explore new perspectives and approaches that build upon original ideas.

Knowledge: K4.1 **Skills:** Creativity **Attitudes:** Innovative, Adaptable

Learners experiment with AI to expand their thinking, generate new ideas, or consider alternative viewpoints. They stay accountable for the final content while letting AI support their creative process.

Primary Education Scenario

Evaluate AI-generated images to create story settings based on learner ideas (e.g., "a jungle in space"), then write new stories inspired by unexpected results.

Secondary Education Scenario

Use AI to develop counterarguments for a class debate to anticipate and address opposing viewpoints.

2 Visualize, prototype, and combine ideas using different types of AI systems.

Knowledge: K1.4 **Skills:** Collaboration, Creativity **Attitudes:** Curious, Adaptable

Learners try out AI tools that operate in different formats (text, images, music, etc.) to explore and refine new ideas. They combine outputs into a meaningful product or solution.

Primary Education Scenario

Use an AI music tool to create a short song to describe a season, then experiment with different moods, instruments, and lyrics, and combine learners' favorite parts into a final track.

Secondary Education Scenario

Use AI tools to explore different formats (e.g., text, graphics, music) for a public awareness campaign and combine elements from each with existing ideas to create a final product.

3 Collaborate with generative AI systems to elicit feedback, refine results, and reflect on thought processes.

Knowledge: K2.3 **Skills:** Computational Thinking, Creativity **Attitudes:** Innovative, Adaptable

Learners engage in an iterative process with AI by testing prompts and refining AI-generated outputs, and then reflect on how the interaction shaped their thinking and choices.

Primary Education Scenario

Use an AI writing tool to improve a class story, by choosing which suggestions support their creative vision, and discussing how their ideas changed through the process.

Secondary Education Scenario

Use an AI coding assistant to fix errors and modify code for a video game, then reflect on how the tool affected the debugging process.

4 Analyze how AI can safeguard or violate content authenticity and intellectual property.

Knowledge: K5.3 **Skills:** Problem Solving, Self and Social Awareness **Attitudes:** Empathetic, Responsible

Learners explore how AI-generated content may borrow from or replicate existing work, and consider when that use is fair, original, or in need of attribution. They reflect on the ethical implications of AI-assisted creation.

Primary Education Scenario

Compare original student work to AI-generated poems, then discuss what makes something "original" and how to give credit when AI tools help create content.

Secondary Education Scenario

Research how certain artists' styles appear in AI-generated art, then debate whether the use of the artists' content is fair or requires consent.

5 Explain how AI systems perform tasks using precise language that avoids anthropomorphism.

Knowledge: K1.3, K1.4 **Skills:** Communication **Attitudes:** Responsible

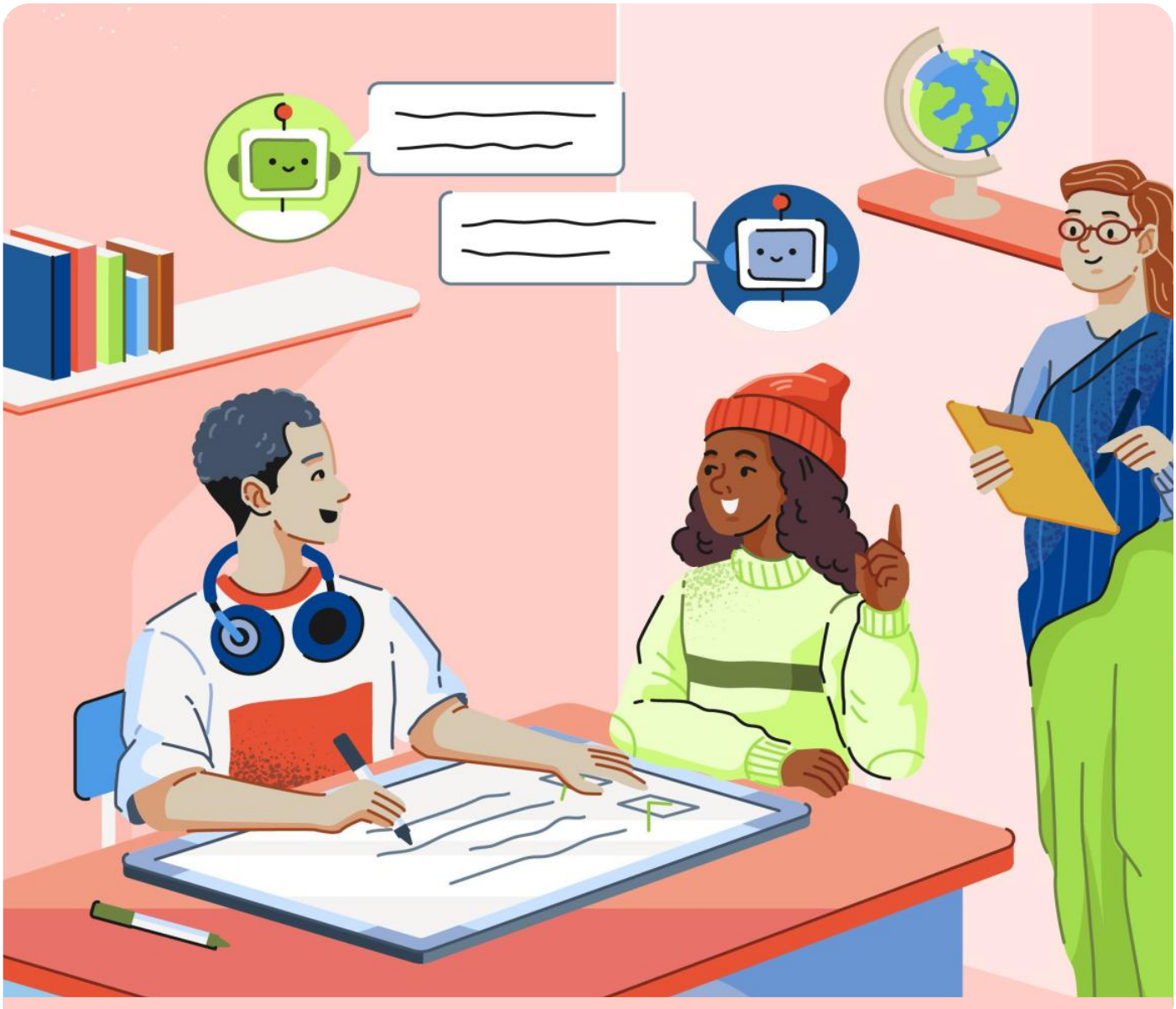
Learners describe how AI operates in realistic, accurate terms, avoiding language that suggests AI has human feelings or understanding. They understand that their language can either clarify or perpetuate misconceptions about AI.

Primary Education Scenario

Compare art created by a human with art generated by AI, and discuss how artists express themselves while generative AI uses patterns in existing data.

Secondary Education Scenario

Describe how a generative AI system can create a song based on prompts, learned patterns, and training data, without assigning it intent, emotion, or creativity.



Managing AI

Managing AI requires intentionally choosing how AI can support and enhance human work. This includes assigning structured tasks to AI, such as organizing information, so humans can focus on areas requiring creativity, empathy, and judgment. AI systems can simulate a variety of roles, acting as an analyst, debate partner, or career guide. Learners who manage AI's actions learn to delegate tasks thoughtfully, guide AI outputs with clear instructions, and assess whether AI's involvement aligns with their goals and values. This domain helps learners build agency, ensuring that AI works for them and that its use remains ethical and human-centered.

"

Effectively managing AI starts with students deciding if AI is truly needed. This requires setting clear learning goals, decomposing problems, and distributing work appropriately with AI tools being used to augment human capacity. Students must be able to communicate transparently about their use of AI and follow guidelines that ensure fairness while centering justice and human judgment.

- Pati Ruiz, Senior Director, EdTech and Emerging Technologies, Digital Promise

Managing AI Competences

1 Decide whether to use AI systems based on the nature of the task.

Knowledge: K4.1, 5.4 **Skills:** Problem Solving, Computational Thinking **Attitudes:** Responsible, Innovative

Learners assess whether AI is the right tool for a specific situation. They consider factors like the complexity of the task, the need for human judgment, and the ethical implications.

Primary Education Scenario

Consider everyday tasks (e.g., writing a birthday card) and assess when AI use is appropriate, considering the need for individuality, creativity, or human judgment.

Secondary Education Scenario

Determine whether specific AI systems should be avoided, or used to complete specific tasks, based on how well each option aligns with an assignment's learning objectives.

2 Decompose a problem based on the capabilities and limitations of both AI systems and humans.

Knowledge: K4.1 **Skills:** Collaboration, Computational Thinking, Problem Solving **Attitudes:** Innovative, Adaptable

Learners break down a complex task and decide which parts can be handled by AI and which require human involvement. They distribute tasks based on their nature and human and AI strengths.

Primary Education Scenario

Use AI to brainstorm science fair ideas and gather background information, while the class votes on the best project, designs and carries out the experiment, and interprets the results.

Secondary Education Scenario

Examine a historical question using AI to summarize primary sources and commentaries, while students assess context, detect bias, discuss resources and make new interpretations.

3 Direct generative AI systems by providing specific instructions, appropriate context, and evaluation criteria.

Knowledge: K1.3, K2.3 **Skills:** Collaboration, Computational Thinking **Attitudes:** Innovative, Adaptable

Learners practice prompt engineering by giving AI clear, structured inputs to guide outputs that meet expectations and goals.

Primary Education Scenario

Construct a prompt that another student could use to draw a poster, including the poster topic, what not to do, and what a quality result should look like.

Secondary Education Scenario

Experiment with instructing an AI chatbot to take on the role of a debate partner by engineering prompts that define its purpose, tone, and task. Then test and evaluate how effectively it supports learning goals.

4 Delegate tasks to AI systems to appropriately automate or augment human workflows.

Knowledge: K3.1 **Skills:** Collaboration, Problem Solving **Attitudes:** Innovative

Learners identify opportunities to offload repetitive or structured tasks to AI, allowing people to focus on creativity, ethics, or decision-making.

Primary Education Scenario

Plan a writing process where AI helps with spelling corrections and synonym suggestions, while learners focus on storytelling, character development, and creative plot twists.

Secondary Education Scenario

Use AI to generate variations of a concept based on a group's initial ideas, while team members evaluate the options, refine the final version, and present their rationale.

5 Develop and communicate guidelines for using AI systems that align with human values, promote fairness, and prioritize transparency.

Knowledge: K5.4 **Skills:** Communication, Critical Thinking, Self and Social Awareness **Attitudes:** Responsible, Empathetic

Learners create or reinforce responsible guidelines for AI use in academic contexts. They consider existing guidelines from local, national, or international organizations, such as the European Commission or the OECD.

Primary Education Scenario

Create a classroom poster outlining fair ways to use an AI tool, such as crediting sources and seeking a teacher's approval before using it for assignments.

Secondary Education Scenario

Lead a workshop for peers on common AI tools, sharing guidelines for AI use that promote honesty, respect for intellectual property, and critical thinking.

Designing AI

Designing AI empowers learners to understand AI's social and ethical impacts and how AI works by shaping how AI systems function. Through hands-on exploration in an education context, students examine how data, design choices, and model behavior influence the fairness, usefulness, and impact of AI systems. The goal is not to develop commercial products or put them into service, but to build the confidence and capacity to shape AI for human good by understanding the principles underpinning the design and behavior of AI from an early age.

> ***Students don't need to be AI engineers to design AI. Even simple, age-appropriate explorations of how AI systems work can spark powerful learning — and help students see they can shape technology, not just be shaped by it.***
>
> - Cathy Adams, Professor of Educational Computing, University of Alberta

Designing AI Competences

1 Describe how AI systems can be designed to support a solution to a community problem.

Knowledge: K2.3, K3.2 **Skills:** Collaboration, Problem Solving, Self and Social Awareness **Attitudes:** Curious, Innovative Responsible

Learners explore how AI can solve real-world problems by identifying a community need that could be addressed with AI, considering how to design AI to contribute to a solution, and evaluating the potential benefits, risks, and limitations.

Primary Education Scenario

Develop a method for sorting healthy vs. unhealthy snacks for the school cafeteria by gathering images of real snack items from home or the cafeteria, labeling them, and testing how the method classifies new items.

Secondary Education Scenario

Propose how AI could help recommend after-school activities based on interests by exploring what data would be needed, how the AI would make decisions, and what parts of the solution should involve human input.

2 Compare the capabilities and limitations of AI systems that follow algorithms created by humans with those that make predictions based on data.

Knowledge: K1.2, K1.4 **Skills:** Computational Thinking, Problem Solving **Attitudes:** Curious

Learners examine the difference between systems that follow fixed rules (or manually programmed logic) and machine learning models to understand the value of machine learning and determine when each approach is most useful or appropriate.

Primary Education Scenario

Compare a method for organizing animals based on physical characteristics with one that groups animals based on habitat and behavior, then discuss when each approach is useful.

Secondary Education Scenario

Program a simple chatbot using conditional logic (e.g., to help people select a book), and compare its capabilities to those of a machine learning–based system handling the same task.

3 Collect and curate data that could be used to train an AI model by considering relevance, representation, and potential impact.

Knowledge: K1.2, K2.2, K2.4 **Skills:** Computational Thinking, Self and Social Awareness **Attitudes:** Innovative, Responsible

Learners discover how data is labeled, selected, and prepared to train an AI model. They learn how data quality and representation affect the model's performance and potential effect on people.

Primary Education Scenario

Label and sort building blocks based on specific features (e.g., shape, color), then create a decision tree to categorize new blocks.

Secondary Education Scenario

Explore how a basic AI model can be trained to recognize recyclable materials from photos taken in real life or collected online, then describe the impact the data had on the model's performance.

4 Evaluate AI systems using defined criteria, expected outcomes, and user feedback.

Knowledge: K1.2, K2.3 **Skills:** Collaboration, Computational Thinking **Attitudes:** Innovative, Adaptable

Learners set criteria for a successful AI system, test it with various inputs, and evaluate its performance to make improvements. They use an iterative process shaped by feedback from diverse users.

Primary Education Scenario

Use a generative AI tool to create a joke or riddle by defining what makes a good joke, rating the system's responses, and trying new prompts to improve results.

Secondary Education Scenario

Evaluate AI systems by testing different types of AI models with the same datasets for the same task, then discuss and propose ways to improve them that includes user feedback.

5 Describe an AI model's purpose, intended users, and its limitations.

Knowledge: K1.2, K2.1 **Skills:** Communication, Problem Solving, Self and Social Awareness **Attitudes:** Curious, Responsible

Learners describe the purpose of an AI model, the data used to train it, and what it can or cannot do well. They help others develop a realistic understanding of the model's capabilities and limitations.

Primary Education Scenario

Direct a classmate, who is role-playing as a robot, to sort snacks or animals by color, size, or shape, and observe how changing the rules creates confusion.

Secondary Education Scenario

Create a model card (brief, structured document) to summarize how a machine learning model works, its training data, intended uses, and possible limitations.

06

What's Coming Next?

During the review period, a public online survey, as well as a series of focus groups and stakeholder discussions, will be conducted to gather feedback on the draft framework. These sessions will engage policymakers, teachers, educators, school leaders, NGO representatives, academics, and other relevant stakeholders. Consultations will also take place at the European Commission's Digital Education Stakeholder Forum and through the European Digital Education Hub. Blogs, webinars, and announcements will be shared by the European Commission, OECD, and Code.org throughout the process.

The final version of the framework will reflect international input and will be published in 2026, alongside a limited set of AI literacy exemplars.

Over the next few months, we invite feedback from stakeholders worldwide. To provide feedback, visit teachai.org/ailiteracy/review.

Click to Review

Use AI to Explore the AILit Framework!

Click for Prompt

A large language model (LLM) is an AI model specialized for tasks like natural language processing, text generation, and translation. A prompt is a carefully crafted set of directions for an LLM-based chatbot and can be used to help explore a document, ask critical questions, and reflect on the content. Follow the directions to explore the AILit Framework using an LLM-based chatbot:

Navigate to the sample prompt via the button above or visit teachai.org/ailiteracy/prompt. On this page, you will find the prompt text along with step-by-step instructions.

- Click the "Copy the Prompt" button to copy the prompt.
- Paste the prompt text into the chat interface.
- After pasting the prompt, upload the PDF of the AILit Framework into the chatbot.
- Finally, interact with the chatbot by asking it questions and following the guidance to explore AILit Framework.

Within the inherent limitations of an LLM, this prompt and these directions are designed to create accurate, document-based responses that include exact quotations with proper citations. Please use the chatbot in accordance with all relevant guidelines.

07

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Empowering Learners for the Age of AI

An AI Literacy Framework for Primary and Secondary Education

REVIEW DRAFT (May 2025)

European Commission

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Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for Educators

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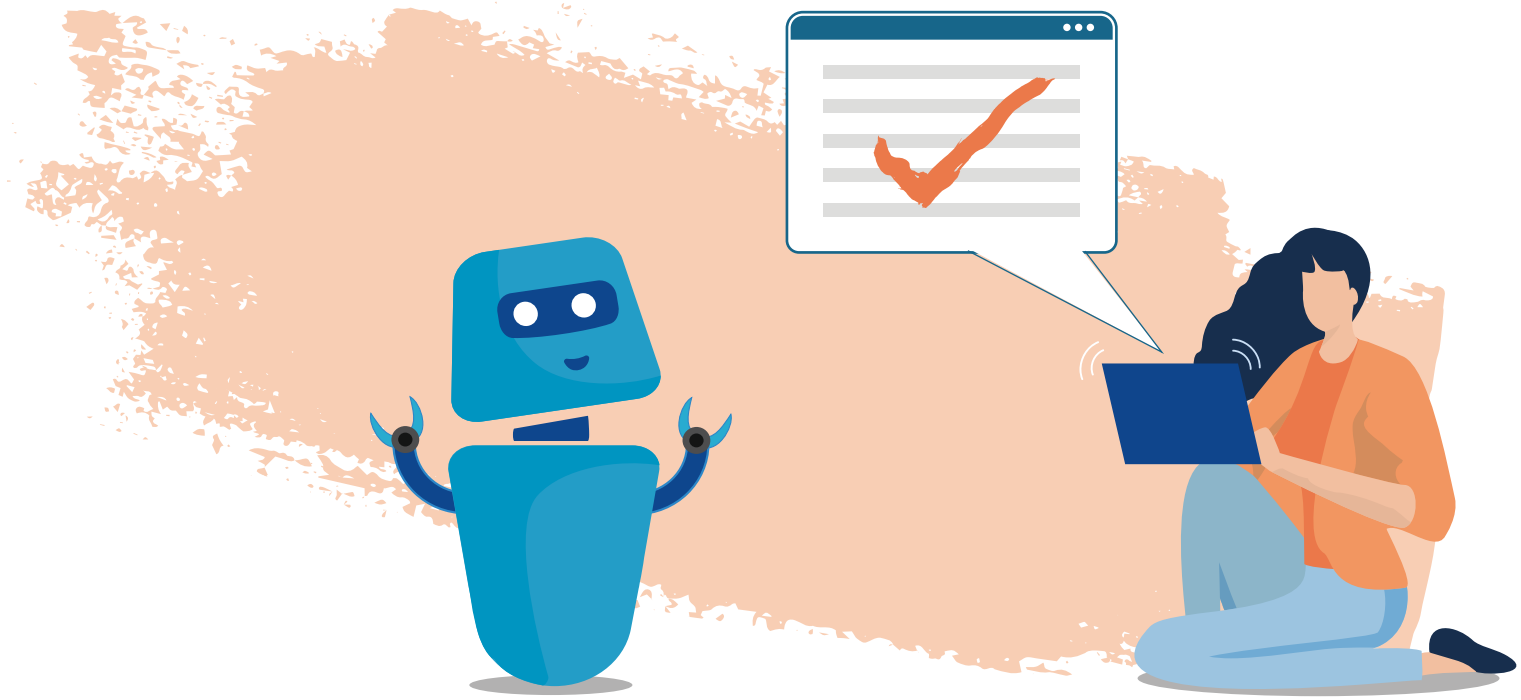



Ethical guidelines

Contents

Foreword

From the way we stay informed to the way we make decisions, artificial intelligence (AI) is becoming ubiquitous in our economy and society. Naturally, it has reached our schools as well. AI in education is no longer a distant future. It is already changing the way schools, universities and educators work and our children learn. It is making educational settings more responsive by helping teachers address each learner's specific needs. It is fast becoming a staple in personalised tutoring and in assessment. And it is increasingly showing its potential to provide valuable insights in student development. The impact of AI on our education and training systems is undeniable, and will grow further in the future.

Students and educators already benefit from AI in their everyday lives, in many cases without being aware of its presence. Online learning environments often span several continents – often without users being entirely aware how and where their data is used. This raises specific ethical challenges when using AI and processing large amounts of data in education. It goes without saying: we must ensure that teachers and educators understand the potential AI and big data can have in education – while being aware of the associated risks.

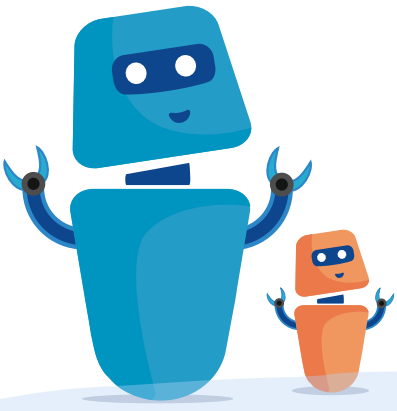
It is for this reason that I am pleased to share with you the present Ethical Guidelines on the use of AI and data in teaching and learning for educators. The Guidelines will undoubtedly help our teachers and educators reflect on how they can use AI and data in their daily practices – and empower them to act accordingly.

I am grateful for the valuable contribution of the Expert Group set up by the European Commission to the preparation of these Guidelines. This group brought together a wide range of experts: from practitioners to researchers in AI, data, ethics and education, as well as representatives of various international organisations, such as UNICEF, UNESCO and OECD.

The Expert Group offered rich knowledge and expertise building on the Ethics Guidelines for Trustworthy AI and The Assessment List for Trustworthy AI (ALTAI), areas that have been already high on EU's political agenda. Focusing on both the ethics of education and the ethics of AI and Data, the Group also took into account the proposed legal framework for AI (Artificial Intelligence Act), the General Data Protection Regulation (GDPR), and the proposals for a Data Act and for an EU Declaration on digital rights and principles.

These Guidelines are to be used in schools across Europe and we shall actively promote them through the Erasmus+ programme. Collectively or individually, teachers and school leaders will now have a solid basis to venture out and expand their use of these technologies in a considerate, safe and ethical way.

These Guidelines, along with their use on the ground, are fundamental to our ongoing efforts to achieve the European Education Area, while supporting the work being carried out by EU Member States. The Guidelines are part of a longer journey, while the EU is negotiating and preparing for a comprehensive and effective regulatory framework for trustworthy AI, to be implemented across all sectors in the EU, including education. And our work does not stop here. As we move forward, we will continue to develop a better understanding of how to apply these technologies, allowing educators to be even more inclusive and pragmatic, especially in primary and secondary education.



Therefore, I would invite all European teachers and educators to take advantage of these guidelines, and to share their feedback on their practical application and experience, as this will support our ongoing efforts regarding the digital transition in education. We shall also strongly benefit from the views and experience of our pupils, their families, and all stakeholders in the field of education about the use and impact of AI in their daily work and how to make it further beneficial while avoiding risks and negative effects to human rights and our fundamental EU values.

Our joint work on AI and data in education shows a shared commitment to the education community, to our learners, to their development and well-being. These Guidelines are an important starting point. It is now up to all of us to promote them and put them into practice. I am counting on you.

My warmest thanks to the experts of this Group who made this happen. Your ideas and dedication come to life in the pages that follow. Thank you

Mariya Gabriel

The Context for these Guidelines

Digital Education Action Plan

The Digital Education Action Plan (2021-2027) is the renewed European Union (EU) policy initiative to support the sustainable and effective adaptation of the education and training systems of EU Member States for the digital age.

The Digital Education Action Plan:

- offers a long-term strategic vision for high-quality, inclusive and accessible European digital education;
- addresses the challenges and opportunities of the COVID-19 pandemic, which has led to the unprecedented use of technology for education and training purposes;
- seeks stronger cooperation at the EU level on digital education and underscores the importance of working together across sectors to bring education into the digital age;
- presents opportunities, including improved quality and quantity of teaching concerning digital technologies, support for the digitalisation of teaching methods and pedagogies and the provision of infrastructure required for inclusive and resilient remote learning.

The Digital Education Plan puts forward two strategic priorities, each of which have a number of actions for the period 2021-2027:

The Digital Education Action Plan (2021-2027) has two strategic priorities

1 To foster high-perfoming digital education ecosystems, we need:

- **infrastructure**, **connectivity** and **digital equipment**
- **effective digital capacity planning and development**, including effective end up-to-date organisational capabilities
- **digital-competent** and **confident educators** and **education & training staff**
- **high-quality content, user friendly tools and secure platforms**, respecting privacy and ethical standards

2 To enhance digital skills and competences for the digital age:

- support **the provisions of basic digital skills and competences** from an early age:
  - digital literacy, including management of information overload and recognising disinformation
  - computing education
  - good knowledge and understanding of data-tensive technologies, such as AI
- **boost advanced digital skills**: enhancing the number of digital specialises and of girls and women in digital studies and careers

Under Priority 1: Fostering the development of a high-performing digital education ecosystem, the Digital Education Action Plan outlines a set of actions to foster the development of a high-performing digital education ecosystem. This includes a specific action to develop ethical guidelines on the use of AI and data in education and training to be shared with educators and school leaders.

Artificial Intelligence and Data Use

What is Artificial Intelligence?

Throughout Europe, learners and educators increasingly use Artificial Intelligence (AI) systems, sometimes without realising it. Search engines, smart assistants, chatbots, language translation, navigation apps, online videogames and many other applications use Artificial Intelligence in our everyday lives. AI systems rely on data, which is collected in different modalities (e.g. sound, images, text, posts, clicks) and all together form our digital traces.

AI has great potential to enhance education and training for learners, educators and school leaders. AI systems are currently helping some educators to identify specific learning needs, providing learners with personalised learning experiences, and helping some schools to make better decisions, so that they can more effectively use the teaching resources available to them.

As AI systems continue to evolve and data usage increases, it is of utmost importance to develop a better understanding of their impact on the world around us, particularly in education and training. Educators and school leaders need to have at least a basic knowledge of AI and data usage in order to be able to engage positively, critically, and ethically with this technology and to properly use it to exploit its full potential.

The definition of an Artificial Intelligence system (AI system) proposed in the draft AI Act is "software that is developed with one or more of the techniques and approaches (listed below) and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments it interacts with".

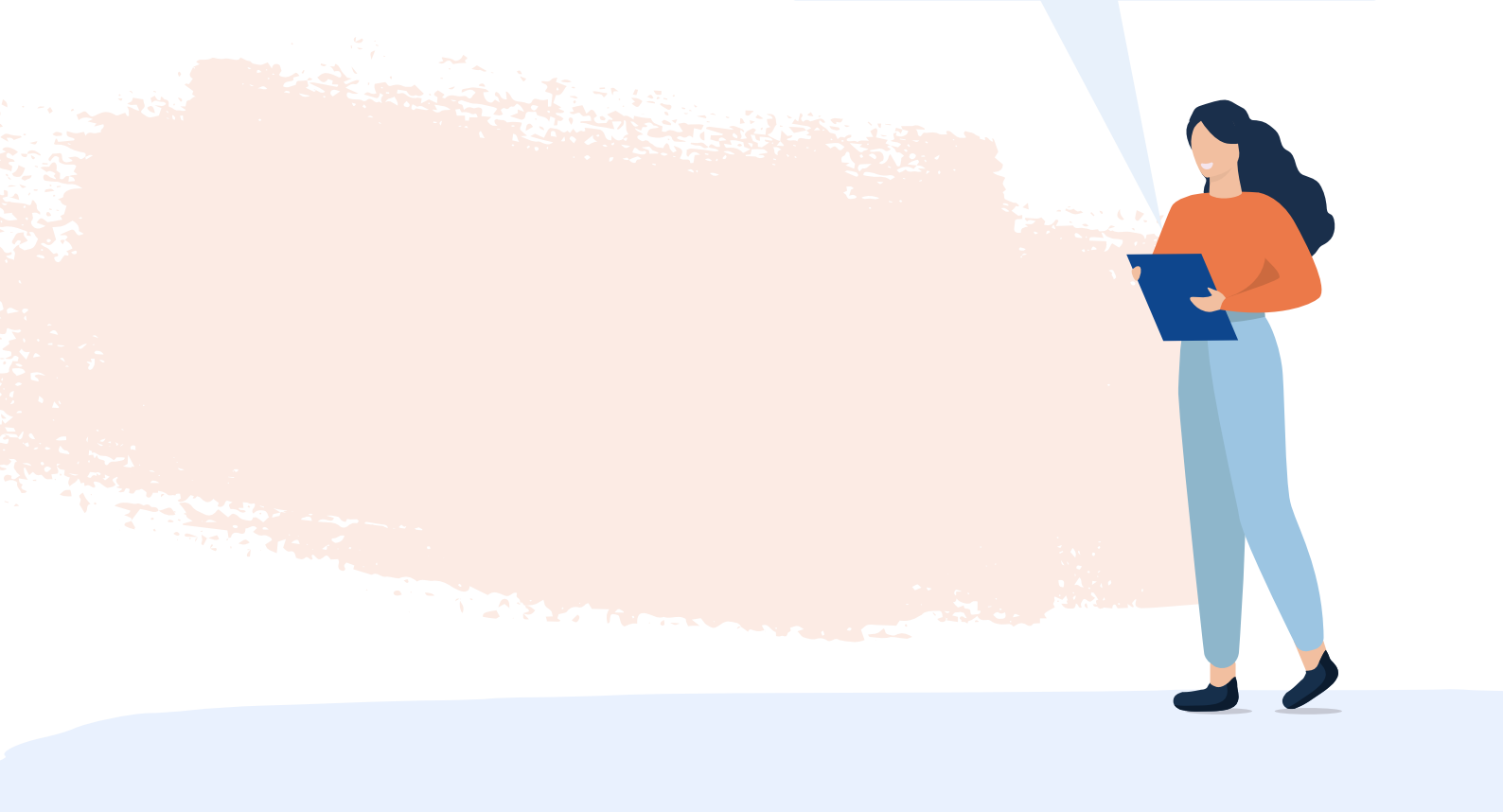
The listed AI techniques and approaches are:

a) Machine learning approaches, including supervised, unsupervised and reinforcement learning, using a wide variety of methods including deep learning;

b) Logic and knowledge-based approaches, including knowledge representation, inductive (logic) programming, knowledge bases, inference and deductive engines, (symbolic) reasoning and expert systems;

c) Statistical approaches, Bayesian estimation, search and optimisation methods.

When we talk about AI systems, we are referring to software in computers or machines that are programmed to perform tasks that usually require human intelligence, e.g. learning or reasoning. Using data, certain AI systems can be "trained" to make predictions, provide recommendations or decisions, sometimes without any human involvement.



What do we mean by AI and data use in Education?

Schools typically process substantial amounts of educational data including personal information about students, parents, staff, management and suppliers. Data collected, used, and processed in education is often referred to as "educational data". These consist of data recorded in student information systems for example, educational achievements, parent names, assessment grades, as well as micro-level data generated when digital tools are used. When students interact with digital devices, they generate digital traces such as mouse clicks, data on opened pages, the timing of interaction events, or key presses. In the same way when using intelligent tutoring systems (ITS) in classrooms, learning mathematics or modern languages produce learning activity traces. All this data can be combined to capture each student's online behaviour. This type of trace data (digital usage and learning activity traces) is often used for learning analytics (LA). Data in student information systems can be further used for resource and course planning and to predict dropout and guidance.

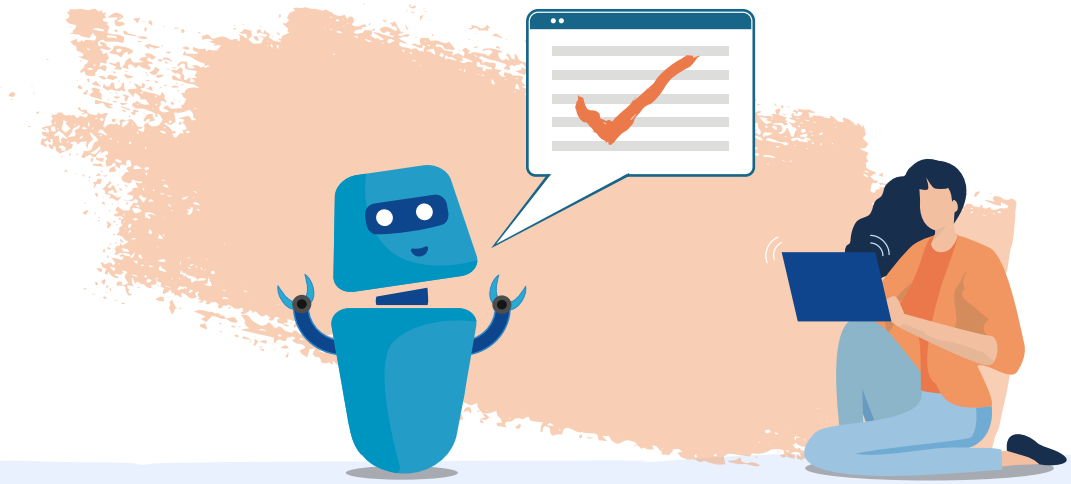
Given the large amount of data needed to train AI systems, the automating nature of algorithms and the scalability in its applications, the use of AI raises important questions in relation to personal data, data protection and privacy.

Schools are required to ensure that any data that they process is stored confidentially and securely and need to have appropriate policies and procedures in place for the protection and ethical use of all personal data, in compliance with the General Data Protection Regulation (GDPR).

Why do we need these guidelines?

The use of AI systems can potentially enhance teaching, learning and assessment, provide better learning outcomes and help schools to operate more efficiently. However, if those same AI applications are not properly designed or used carelessly, this could lead to harmful consequences. Educators need to be aware and ask questions whether AI systems they are using are reliable, fair, safe and trustworthy and that the management of educational data is secure, protects the privacy of individuals and is used for the common good. "Ethical AI" is used to indicate the development, deployment and use of AI that ensures compliance with ethical norms, ethical principles and related core values.

These ethical guidelines on AI and data usage in teaching and learning are designed to help educators understand the potential that the applications of AI and data usage can have in education and to raise awareness of the possible risks so that they are able to engage positively, critically and ethically with AI systems and exploit their full potential.



EU Policy on Artificial Intelligence and Regulatory Framework Proposal

As part of its digital agenda, on the basis of the "Ethics Guidelines for Trustworthy AI" presented in 2019 by the High-Level Expert Group on AI (AI HLEG), the European Commission proposed in 2021 a comprehensive legal framework for AI (AI Act) laying down mandatory requirements for "high-risk" AI systems in several areas, including education and vocational training. Built on the EU regulatory and policy developments on AI and data, which include GDPR and the proposal for a Data Act, the present guidelines, taking into account the specific context of education and training, provide awareness and practical guidance for educators who are increasingly confronted with the use of AI in their teaching practice.

To understand better the EU policy context on trustworthy AI, please refer to: the proposed Regulatory framework on Artificial Intelligence[1]; the work of the AI HLEG which includes the Ethics Guidelines for Trustworthy AI and the Assessment List for Trustworthy AI (ALTAI)[2]; as well as to the EU Commission work in the area of Data[3].

Common Misconceptions about AI

There are many assumptions and concerns about AI and its short and long-term impacts on our education systems and on society in general. Here some of the most common misconceptions about the use of AI and data in the education context are addressed.

AI is too difficult to understand

Many people who don't have a computer science background are put off by jargon associated with AI and data systems. Even those who do have the relevant background can struggle to fully understand how AI works, as it is a broad and complex domain. This is sometimes referred to as the 'black box' problem as it is difficult to understand the AI system's inner workings. Artificial Intelligence is not a specific thing but a collection of methods and techniques to build an AI system. Rather than trying to understand the full functionality of AI systems, it is more important that educators are aware of the basic mechanisms and limitations of AI systems and how AI systems can be used to support teaching and learning in a safe and ethical way. These guidelines are designed to provide some basic questions one should ask when considering the use of an AI system and provide easy to understand use scenarios from education as well as a glossary to help with the terminology that is used to describe these systems and what they do.

AI has no role in education

AI is already changing how we learn, work and live and education is being impacted by this development. Everyone should be able to contribute to the development of AI and also benefit from it. By making ethical principles a key focus of the conversation about the role of AI in education, we can open the way for AI systems and solutions to be developed and used in an ethical, trustworthy, fair and inclusive way.

AI is not inclusive

AI can result in new forms of inequalities or discrimination and exacerbate existing ones. However, if properly designed and used, it can also offer opportunities to improve access and inclusion - in everyday life, in work, and in education. There is also significant potential for AI to provide educational resources for young people with disabilities and special needs. For example, AI-based solutions such as real-time live captioning can assist those with impaired hearing, while audio description can make access easier and more effective for people with low levels of vision.

1 Regulatory framework on Artificial Intelligence. https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai
2 High-level expert group on artificial intelligence. https://digital-strategy.ec.europa.eu/en/policies/expert-group-ai
3 Shaping Europe's digital future: Data. https://digital-strategy.ec.europa.eu/en/policies/data

AI systems can't be trusted

As AI systems become more powerful, they will increasingly supplement or replace specific tasks performed by people. This could raise ethical and trust issues regarding the ability to make fair decisions using AI, as well as protecting the data collected and used to support those decisions. The complexity of the legal area can be a real challenge for educators. However, the proposed EU AI Act will help to ensure that certain AI systems classified as "high-risk" (in view of the risks that they may pose to the health, safety and fundamental rights of individuals) are developed by providers according to mandatory requirements to mitigate such risks and ensure their reliability. Education authorities and schools should therefore be able to verify that AI systems comply with the AI regulatory framework and focus on the ethical use of AI and data to support educators and learners in teaching, learning and assessment, while also adhering to the applicable data protection regulations.

AI will undermine the role of the teacher

Many teachers fear that as the use and impact of Artificial Intelligence in education broadens in the future, these systems will diminish their role or even replace them. Rather than replacing teachers, AI can support their work, enabling them to design learning experiences that empower learners to be creative, to think, to solve real-world problems, to collaborate effectively, and provide learning experiences that AI systems on their own cannot do. Moreover, AI can automate repetitive administrative tasks allowing more time to be dedicated to the learning environment. In this way the role of the teacher is likely to be augmented and evolve with the capabilities that new innovations for AI in education will bring. However, this requires dilligent governance of the development and use of AI applications and focus on sustaining teacher agency.

AI and Data Use Examples in Education

The use of AI systems in classrooms across Europe is growing and AI is being used in different ways to support teaching, learning and assessment practices.

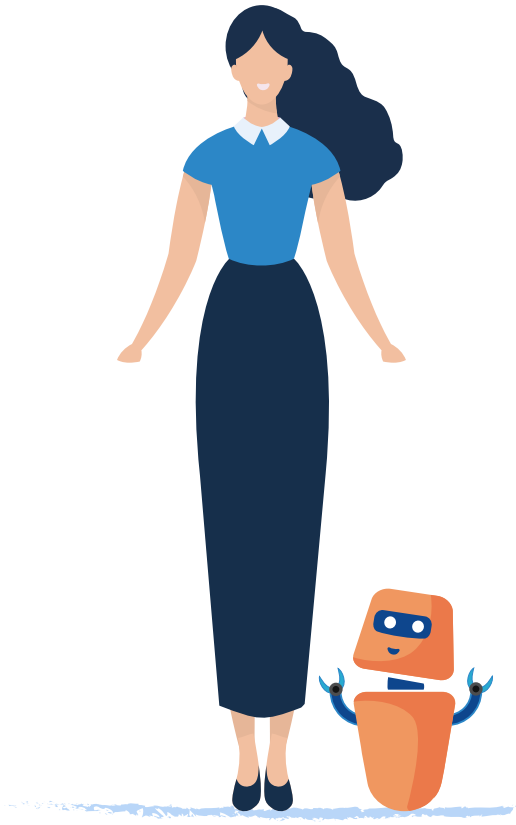
AI has great potential to enhance teaching and learning practices and help schools improve the way they are organised and how they operate. However, evidence-based research on the impact of AI in education is still limited so it is important to maintain a critical and supervised attitude.

Sometimes, AI systems can be used in different ways to support teaching or facilitate learning. When we talk about the types of AI systems that are used for teaching, learning, assessment and school administration, a common distinction is made between "student-facing," "teacher-facing," and "system-facing" AI systems.

Here we provide four use-cases which are categorised as:

- **Student Teaching** – Using AI to teach students (student-facing);
- **Student Supporting** - Using AI to support student learning (student-facing);
- **Teacher Supporting** – Using AI to support the teacher (teacher-facing);
- **System Supporting** – Using AI to support diagnostic or system-wide planning (system-facing).

The use cases described below provide some insight into how AI systems are being used by educators and learners to support the teaching, learning and assessment process.



STUDENT TEACHING
Using AI to teach students

Intelligent tutoring system	The learner follows a step-by-step sequence of tasks and gets individualised instruction or feedback without requiring intervention from the teacher.
Dialogue-based tutoring systems	The learner follows a step-by-step sequence of tasks through conversation in natural language. More advanced systems can automatically adapt to the level of engagement to keep the learner motivated and on task.
Language learning applications	AI-based learning apps are used in formal and non-formal education contexts. They support learning by providing access to language courses, dictionaries and provide real-time automated feedback on pronunciation, comprehension and fluency.

STUDENT SUPPORTING
Using AI to support student learning

Exploratory learning environments	Learners are offered multiple representations that help them identify their own routes to achieving the learning goals.
Formative writing assessment	Learners are provided with regular automatic feedback on their writing/assignments.
AI-supported collaborative learning	Data on each learner's work style and past performance is used to divide them into groups with the same ability levels or suitable mix of abilities and talents. AI systems provide inputs/suggestions on how a group is working together by monitoring the level of interaction between group members.

TEACHER SUPPORTING
Using AI to support the teacher

Summative writing assessment, essay scoring	AI is used to evaluate and grade learners' written work automatically. AI and machine learning techniques identify features such as word usage, grammar and sentence structure to grade and provide feedback.
Student forum monitoring	Key words in student forum posts trigger automatic feedback. Discussion analytics provide insights to students' forum activity and can highlight students who may need help or are not participating as expected.
AI teaching assistants	AI agents or chatbots provide answers to commonly asked questions by learners with simple instruction and directions. Over time, the AI system is able to broaden the range of answers and options provided.
Pedagogical resource recommendation	AI recommendation engines are used to recommend specific learning activities or resources based on each student's preferences, progress and needs.

SYSTEM SUPPORTING

AI to support diagnostic or system-wide planning

Educational data mining for resource allocation	Schools gather student data which are analysed and used to plan how available resources can be best allocated for tasks like creating class groupings, assigning teachers, timetabling, and highlighting students who may require additional learning support.
Diagnosing learning difficulties	Using learning analytics, cognitive skills such as vocabulary, listening, spatial reasoning, problem-solving, and memory are measured and used to diagnose learning difficulties, including underlying issues that are hard for a teacher to pick up but might be detected early using AI systems.
Guidance services	AI based guidance services provide ongoing prompts or choice to create pathways for future education. Users can form a competence profile including previous education and include their own interests. From this data, combined with up-to-date course catalogue or study opportunity information, relevant study recommendations can be created using natural language processing.

“Ethical guidelines on the use of AI and data in teaching and learning are an incremental process of continuous deliberation and learning.”

Expert Group on AI and data in education and training

Ethical Considerations and Requirements Underpinning the Ethical Guidelines

Ethical Considerations

In developing these guidelines, four key considerations have been identified that underpin the ethical use of AI and data in teaching, learning, and assessment. These are human agency, fairness, humanity, and justified choice.

Human agency relates to an individual's capability to become a competent member of society. A person with agency can determine their life choices and be responsible for their actions. Agency underpins widely used concepts such as autonomy, self-determination, and responsibility.

Fairness relates to everyone being treated fairly in the social organisation. Clear processes are required so that all users have equal access to opportunity. These include equity, inclusion, non-discrimination, and fair distribution of rights and responsibilities.

Humanity addresses consideration for the people, their identity, integrity, and dignity. We need to consider the well-being, safety, social cohesion, meaningful contact, and respect that is necessary for a meaningful human connection. That connection implies, for example, that we approach people with respect of their intrinsic value and not as a data object or a means-to-an-end. It is at the essence of the human-centric approach to AI.

Justified choice relates to the use of knowledge, facts, and data to justify necessary or appropriate collective choices by multiple stakeholders in the school environment. It requires transparency and is based on participatory and collaborative models of decision-making as well as explainability.

These ethical considerations are intrinsically valuable and worth striving for in education. They guide educators and school leaders in their decisions about the use of AI systems in education. The key ethical requirements introduced below can help ensure that AI systems used in education and training are trustworthy and address relevant concerns.

Key Requirements for Trustworthy AI

The AI Act proposed by the Commission will lay down legally binding requirements for AI systems considered as "high-risk" in view of their intended purpose[4]. This will include certain AI systems used in the area of education and vocational training. When the AI Act becomes applicable, education institutions as users of AI systems will be able to rely on the trustworthiness of these "high-risk" AI systems based on the accompanying certification ensured by the provider, while having to comply with certain obligations.

Irrespective of whether the AI systems will fall under the scope of the legal framework, companies developing and providing AI systems (system providers) are encouraged to implement and apply ethical requirements for trustworthy AI to their design and development processes. At the same time, it is important that schools and educators are aware of these and are able to formulate relevant questions in order to better reflect on them.

The below requirements, which are based on the AI HLEG Ethics Guidelines for Trustworthy AI, are therefore recommendable for any AI system deployed and used in education. They address important concerns, such as the risk of bias or error affecting educational outcomes:

Human agency and oversight including fundamental rights, children's rights, human agency, and human oversight.

Transparency including traceability, explainability and communication.

Diversity, non-discrimination, and fairness including accessibility, universal design, the avoidance of unfair bias, and stakeholder participation, which allows use regardless of age, gender, abilities, or characteristics - with a particular focus for students with special needs.

Societal and environmental wellbeing including sustainability and environmental friendliness, social impact, society, and democracy.

Privacy and data governance including respect for privacy, quality and integrity of data, and access to data.

4 The proposed requirements are related to risk management, the training and testing data of the AI system and data governance, provision of technical documentation, record-keeping, transparency and provision of information to users, human oversight, and robustness, accuracy and cybersecurity.

Technical robustness and safety including resilience to attack, security and general safety, accuracy, reliability, and reproducibility.

Accountability including auditability, minimisation and reporting of negative impact, trade-offs, and redress. The considerations and requirements can help educators, school leaders and technology providers to adequately assess the impact, address the potential risks, and realise the benefits of an AI system deployed and used in education. As such they guide the development, deployment and use of trustworthy AI systems.

Guiding Questions for Educators

When considering the use of an AI system, while it may not be necessary to understand how the AI system works, it is important that the school or educator is able to formulate some relevant questions and engage in a constructive dialogue with AI systems providers or with the responsible public bodies (such as market surveillance authorities, education ministries, regional and local education authorities and school authorities). The guiding questions below are based on the key requirements for trustworthy AI systems and serve the purpose of enabling a constructive dialogue on their ethical use in education and training. Some of them are focussed more on practical implementation issues and others on ethical considerations.

While the guiding questions offer orientation and aim to initiate reflection by educators in their professional practices, they cannot replace a comprehensive legal or ethical assessment. The latter should be conducted on the basis of the Assessment List for Trustworthy AI (ALTAI) as well as the future AI Act. Nevertheless, the questions will help educators to deal better with a complex and highly innovative technology and develop awareness.

1 Human Agency and Oversight

- Is the teacher role clearly defined so as to ensure that there is a teacher in the loop while the AI system is being used? How does the AI system affect the didactical role of the teacher?
- Are the decisions that impact students conducted with teacher agency and is the teacher able to notice anomalies or possible discrimination?
- Are procedures in place for teachers to monitor and intervene, for example in situations where empathy is required when dealing with learners or parents?
- Is there a mechanism for learners to opt-out if concerns have not been adequately addressed?
- Are there monitoring systems in place to prevent overconfidence in or overreliance on the AI system?
- Do teachers and school leaders have all the training and information needed to effectively use the system and ensure it is safe and does not cause harms or violate rights of students?

2 Transparency

- Are teachers and school leaders aware of the AI methods and features being utilised by the system?
- Is it clear what aspects AI can take over and what not within the system?
- Do teachers and school leaders understand how specific assessment or personalisation algorithms work within the AI system?
- Are the system processes and outcomes focussed on the expected learning outcomes for the learners? How reliable are the predictions, assessments and classifications of the AI system in explaining and evaluating the relevance of its use?
- Are the instructions and information accessible and presented in a way that is clear both for teachers and learners?

3 Diversity, non-Discrimination and Fairness

- Is the system accessible by everyone in the same way without any barriers?
- Does the system provide appropriate interaction modes for learners with disabilities or special education needs? Is the AI system designed to treat learners respectfully adapting to their individual needs?
- Is the user interface appropriate and accessible for the age level of the learners? Has the usability and user-experience been tested for the target age group?
- Are there procedures in place to ensure that AI use will not lead to discrimination or unfair behaviour for all users?
- Does the AI system documentation or its training process provide insight into potential bias in the data?
- Are procedures in place to detect and deal with bias or perceived inequalities that may arise?

4 Societal and Environmental Wellbeing

- How does the AI system affect the social and emotional wellbeing of learners and teachers?
- Does the AI system clearly signal that its social interaction is simulated and that it has no capacities of feeling or empathy?
- Are students or their parents involved in the decision to use the AI system and support it?
- Is data used to support teachers and school leaders to evaluate student wellbeing and if so, how is this being monitored?
- Does use of the system create any harm or fear for individuals or for society?

5 Privacy and Data Governance

- Are there mechanisms to ensure that sensitive data is kept anonymous? Are there procedures in place to limit access to the data only to those who need it?
- Is access to learner data protected and stored in a secure location and used only for the purposes for which the data was collected?
- Is there a mechanism to allow teachers and school leaders to flag issues related to privacy or data protection?
- Are learners and teachers informed about what happens with their data, how it is used and for what purposes?
- Is it possible to customise the privacy and data settings?
- Does the AI system comply with General Data Protection Regulation?

6 Technical Robustness and Safety

- Is there sufficient security in place to protect against data breaches?
- Is there a strategy to monitor and test if the AI system is meeting the goals, purposes and intended applications?
- Are the appropriate oversight mechanisms in place for data collection, storage, processing, minimisation and use?
- Is information available to assure learners and parents of the system's technical robustness and safety?

7 Accountability

- Who is responsible for the ongoing monitoring of results produced by the AI system and how the results are being used to enhance teaching, learning and assessment?
- How is the effectiveness and impact of the AI system being evaluated and how does this evaluation consider key values of education?
- Who is responsible and accountable for final decisions made regarding the procurement and implementation of the AI system?
- Is there a Service Level Agreement in place, clearly outlining the support and maintenance services and steps to be taken to address reported problems?

Guidance for Educators and School Leaders

Artificial Intelligence could play a key role in enhancing teaching, learning and assessment practices for educators and learners. Whether it is at the system-wide, school or classroom level, it is important that careful consideration is given to the ethical use of AI and data systems. This should be done on a continuous basis and led by the school management. Here are a number of basic steps that educators and school leaders can take to review how AI and data is being, or can be used throughout the school, so that it leads to improved outcomes for all learners while being mindful of the ethical considerations.

Using the Guiding Questions

The guiding questions can be used in different ways when reviewing an AI system prior to it being set up in a school or while it is being used. The questions can be asked of the educators themselves, of those making the decision at management level, or of the system providers. The questions can also inform discussion with learners, parents and the wider school community.These school case scenarios provide examples of how the guiding questions can inform how AI systems are used in an ethical and responsible way. While all the guiding questions can be considered for each case, three questions are highlighted as examples based on their relevance to the proposed AI solution in response to a given objective. Notably, some of these school case scenarios will become subject to the regulatory framework on AI and the respective regulated AI systems will be subject to mandatory requirements and obligations.

Using adaptive learning technologies to adapt to each learner's ability

A primary school is using an Intelligent Tutoring System to automatically direct learners to resources specific to their learning needs. The AI based system uses learner data to adapt problems to the learner's predicted knowledge levels. As well as providing constant feedback to the learner, the system provides real-time information on their progress on a teacher dashboard.

The following guiding questions highlight areas that require attention:

- Are the system processes and outcomes focussed on the expected learning outcomes for the learners? How reliable are the predictions, assessments and classifications of the AI system in explaining and evaluating the relevance of its use? **Transparency**
- Does the system provide appropriate interaction modes for learners with disabilities or special education needs? Is the AI system designed to treat learners respectfully adapting to their individual needs? **Diversity, non-Discrimination and Fairness**
- Are there monitoring systems in place to prevent overconfidence in or overreliance on the AI system? **Human agency and oversight**

Using student dashboards to guide learners through their learning

A post-primary school is considering the use of a personalised online student dashboard which will provide feedback to learners and support the development of their self-regulation skills. Instead of focusing on what the learner has learned, the visualisations provide the student with a view of how they are learning.

The following guiding questions highlight areas that require attention:

- Does the AI system clearly signal that its social interaction is simulated and that it has no capacities of feeling or empathy? Societal and environmental wellbeing
- Is access to learner data protected and stored in a secure location and used only for the purposes for which the data was collected? Privacy and data governance
- Is there a Service Level Agreement in place, clearly outlining the Support and Maintenance Services and steps to be taken to address reported problems? Accountability

Providing individualised interventions for special needs

A school is considering how AI systems can help reduce barriers for students with special educational needs. The school is currently trialling an AI system to detect student support demands early on and provide tailored instructional support. By detecting patterns of corresponding characteristics from measures such as learning performance, standardised tests attention span or reading speed, the system suggests probabilities of specific diagnoses and related recommendations for interventions.

The following guiding questions highlight areas that require attention:

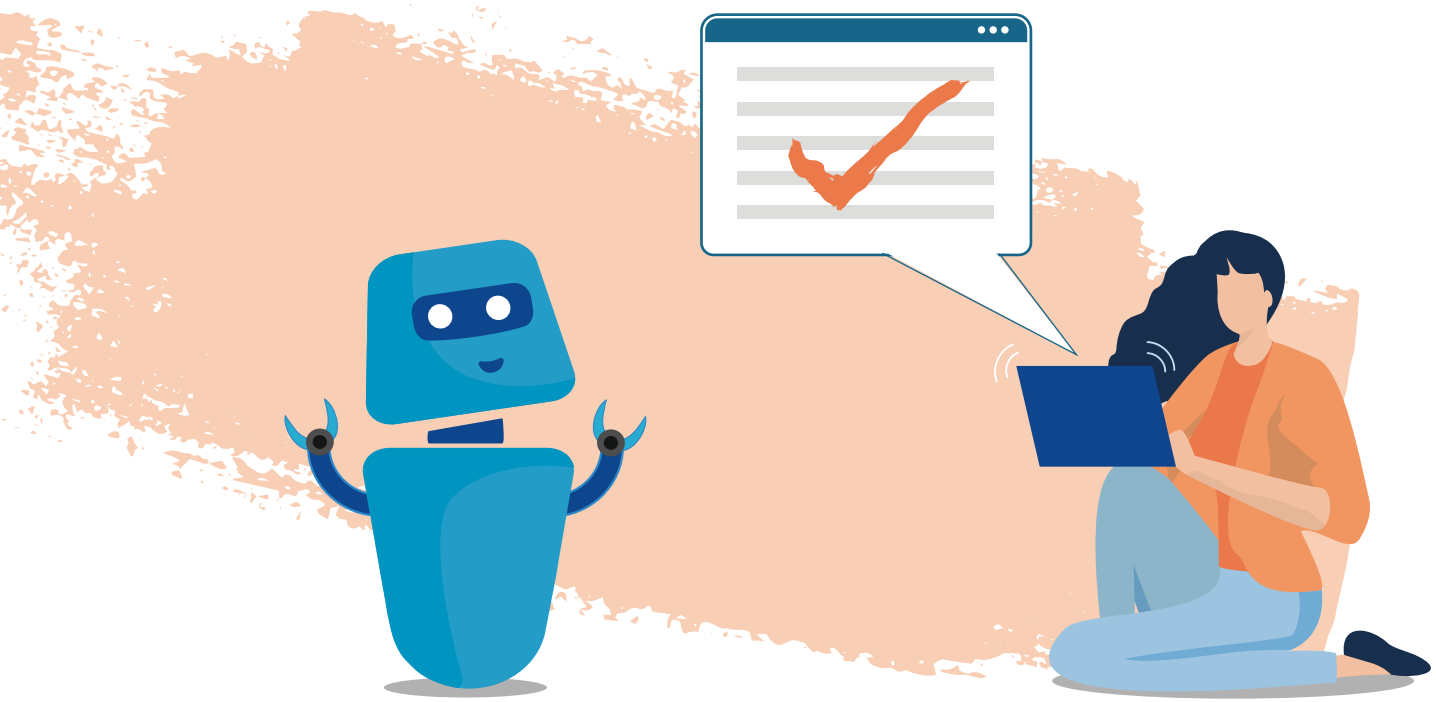
- Are procedures in place for teachers to monitor and intervene, for example in situations where empathy is required when dealing with learners or parents? Human agency and oversight
- Is information available to assure learners and parents of the system's technical robustness and safety? Technical robustness and safety
- Is the teacher role clearly defined so as to ensure that there is a teacher in the loop while the AI system is being used? How does the AI system affect the didactical role of the teacher? Human agency and oversight

Scoring essays using automated tools

A school is looking at how AI systems can support the assessment of student written assignments. A provider has recommended an automated essay scoring system which uses large natural language models to assess various aspects of text with high accuracy. The system can be used to check student assignments, automatically identify errors, and assign grades. The system can also be used to generate sample essays. Over time, the system can train large artificial neural networks with historical cases that contain various types of student mistakes to provide even more accurate grading. The system has a plagiarism detection option which can be used to automatically detect instances of plagiarism or copyright infringement in written work submitted by students.

The following guiding questions highlight areas that require attention:

- Are there procedures in place to ensure that AI use will not lead to discrimination or unfair behaviour for all users? Diversity, non-discrimination and fairness
- Who is responsible for the ongoing monitoring of results produced by the AI system and how the results are being used to enhance teaching, learning and assessment? Accountability
- Do teachers and school leaders understand how specific assessment or personalisation algorithms work within the AI system? Transparency



Managing student enrolment and resource planning

A school uses the data collected when students enrol to predict and better organise the number of students who will attend in the coming year. The AI system is also used to assist with forward planning, resource allocation, class allocations and budgeting.
This has enabled the school to consider more student attributes than before, for example, to increase gender parity and student diversity. The school is now considering using prior grades and other metrics like standardised tests to develop targets for their students to achieve and to support educators to predict student success on a per subject basis.

The following guiding questions highlight areas that require attention:

- Who is responsible for the ongoing monitoring of results produced by the AI system and how the results are being used to enhance teaching, learning and assessment? **Accountability**
- Are there mechanisms to ensure that sensitive data is kept anonymous? Are there procedures in place to limit access to the data only to those who need it? **Privacy and data governance**
- How is the effectiveness and impact of the AI system being evaluated and how does this evaluation consider key values of education? **Accountability**

Using chatbots to guide learners and parents through administrative tasks

A school uses a chatbot virtual assistant on its website to guide learners and parents through administrative tasks such as enrolment for courses, paying course fees or logging technical support issues. The system is also used to help students to find learning opportunities, provide feedback on pronunciation or comprehension. The virtual assistant is also used to support students with special educational needs through administrative tasks.

The following guiding questions highlight areas that require attention:

- Does the AI system clearly signal that its social interaction is simulated and that it has no capacities of feeling or empathy? **Societal and environmental wellbeing**
- Is there a strategy to monitor and test if the AI system is meeting the goals, purposes and intended applications? **Technical robustness and safety**
- Is there a mechanism to allow teachers and school leaders to flag issues related to privacy or data protection? **Privacy and data governance**

Planning for Effective Use of AI and Data in School

When considering the use of AI and data, it is important that the school prepares and puts in place a collaborative and reflective process of internal school review. This requires educators to examine how they can use AI systems to positively support their teaching and student learning. Predicting the consequences and the impact of the use of data and AI in education can be very difficult. Therefore, an incremental approach to the development and deployment of these technologies and their assessment is needed. The idea is to gradually introduce these tools into their contexts and to constantly monitor the societal effects that can emerge, leaving open the possibility to step back when unintended consequences occur. Ethical application of AI in education requires agency at the student, educator, school management and institutional level.

Review current AI systems and data use

The questions provided in these guidelines can be used as the starting point to inquire about the AI systems that are already in place, or as a basis for discussion if considering the future use of AI and data within a school. When carrying out a review, it is useful to list what data is being gathered by the school and clarify what purpose this serves. Schools should consider if there is less specific information that could be gathered to achieve the same outcome. They should also consider how long the data will be needed for and how the school might be able to retain it for as little time as possible. The European Union General Data Protection Regulation (GDPR) requires this kind of analysis.

Initiate policies and procedures

Prior to implementing an AI system, school wide policies and procedures need to be put in place to establish expectations and to provide guidance on how to consistently deal with issues when they arise. These could include measures for:

- ensuring public procurement of trustworthy and human-centric AI;
- implementing human oversight;
- ensuring that input data is relevant to the intended purpose of the AI system;
- the provision of appropriate staff training;
- monitoring the operation of the AI system and taking corrective actions; and,
- complying with relevant GDPR obligations, including carrying out a data protection impact assessment.

This will provide direction regarding what is appropriate as well as inappropriate or unacceptable behaviour and will help ensure that people are treated fairly and equally. It is important that policies and procedures are communicated to educators, learners, and parents so that they understand what is expected of them.

Carry out a pilot of the AI system

Before introducing new AI systems across the school, it can be useful to trial the system with a particular learner cohort. It is important to have a clear vision of what the school wants to achieve with the new technology so that an informed decision can be made involving students and their parents. Specific evaluation criteria are required so that an informed judgement can be made on the effectiveness of the AI system in terms of improvement of learning outcomes, value for money and ethical use. This will also highlight some of the key questions that may need to be asked of the supplier before purchasing the system.

Collaborate with the AI system provider

It is important to maintain contact with the AI system provider prior to deployment and throughout the lifecycle of the AI system. Look for clear technical documentation and seek clarification on any aspects that are unclear. A Service Level Agreement (SLA) should be agreed with the provider setting out the support and maintenance services and steps to be taken to address reported problems. Assurances should be sought from the provider in terms of their adherence to applicable legal obligations. The school should also consider future dependence on the provider if, for example, it seeks to change provider in the future, or move to a different AI system altogether. It is also important that any human oversight measures identified by the provider are implemented by the school while the AI system is being used.

Monitor the operation of the AI system and evaluate the risk

The use of the AI system should be monitored on an ongoing basis to evaluate the impact on learning, teaching, and assessment practices. At school level it will be important to decide how monitoring will be organised and carried out, who will be responsible for monitoring and how progress will be determined and reported. The evidence gathered, as a result of ongoing monitoring, should inform and influence the future use of AI systems or the decision not to use them in particular circumstances.

Raising Awareness and Community Engagement

Discuss with colleagues

Collaboration between educators contributes to school improvement and student success. Educators often draw support from each other and can delegate tasks in ways that help them collectively to be more effective. Working collaboratively can help to make more informed decisions and helps ensure a more consistent approach to using AI and data systems across the school.

Collaborate with other schools

Collaboration between schools is an effective way to share experiences and best practices and learn how other schools have implemented AI systems. This can also be useful in identifying and dealing with reliable providers of AI and data systems that adhere to the key requirements for trustworthy AI. It is important that schools participate in supervised projects and experiments organised at regional, national, or European level through initiatives such as Erasmus+. These provide opportunities for educators and school leaders to participate collaboratively in a process of applied research and inform future use and development of AI and data use in schools.

Communicate with parents, learners and school community

Involving parents and learners in discussions and decision making will lead to better understanding and trust in what the school is aiming to achieve through the use of AI systems. Careful consideration needs to be given to explain what data is being collected, what is being done with the data, how and why it is being collected, and how this is protected. It will be important to share these explanations with learners and parents and to provide opportunities for them to provide their feedback and voice possible concerns. Learners, depending on their age, might require different approaches in order to engage them so that they can participate in informed decision making.

Keep up to date

As AI systems continue to evolve and data usage increases, it is very important to develop a better understanding of their impact on the world around us, including in education and training. Educators will need to continue to keep informed of new innovations and development through participation in continuing professional learning and involvement in communities of practice. School leaders will need to provide opportunities for staff to upskill and continue to develop competences for ethical use of AI and data.

Emerging Competences for Ethical use of AI and data

Educators and school leaders play a central role in the successful adoption of AI systems and in realising the potential benefits of digital data in education. Because of this, it is important that teachers and school leaders are aware of and appreciate the opportunities and challenges of employing AI systems and how they can enhance teaching, learning and assessment practices. This will lead to the development of new digital competences to be considered in the context of the European Framework for the **Digital Competence of Educators (DigCompEdu)** which provides a general reference framework to support the development of educator-specific digital competences in Europe. Here are some potential indicators of the emerging educator and school leader competences for ethical use of AI and data in teaching and learning.

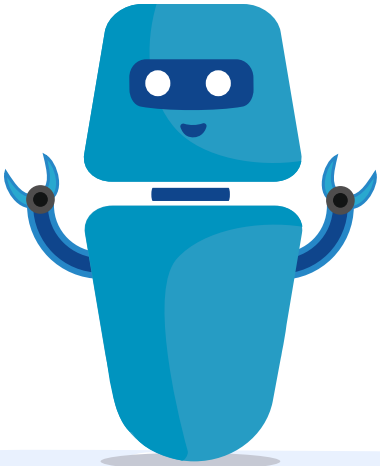
Area 1: Professional Engagement

Using digital technologies for communication, collaboration, and professional development

Competence element	Potential Indicators
Is able to critically describe positive and negative impacts of AI and data use in education	• Takes an active part in continuous professional learning on AI and learning analytics and their ethical use. • Able to give examples of AI systems and describe their relevance. • Knows how the ethical impact of AI systems is assessed in the school. • Knows how to initiate and promote strategies across the school and its wider community that promote ethical and responsible use of AI and data.
Understand the basics of AI and learning analytics	• Aware that AI algorithms work in ways that are usually not visible or easily understood by users. • Able to interact and give feedback to the AI system to influence what it recommends next. • Aware that sensors used in many digital technologies and applications generate large amounts of data, including personal data, that can be used to train an AI system. • Aware of EU AI ethics guidelines and self-assessment instruments.

Area 2: Digital resources
Sourcing, creating, and sharing digital resources

Competence element	Potential Indicators
Data governance	• Aware of the various forms of personal data used in education and training. • Aware of responsibilities in maintaining data security and privacy. • Knows that the processing of personal data is subject to national and EU regulation including GDPR. • Knows that processing of personal data usually cannot be based on user consent in compulsory education. • Knows who has access to student data, how access is monitored, and how long data are retained. • Knows that all EU citizens have the right to not be subject to fully automated decision making. • Able to give examples of sensitive data, including biometric data. • Able to weigh the benefits and risks before allowing third parties to process personal data especially when using AI systems.
AI governance	• Knows that AI systems are subject to national and EU regulation (notably AI Act to be adopted). • Able to explain the risk-based approach of the AI Act (to be adopted). • Knows the high-risk AI use cases in education and the associated requirements under the AI Act (when adopted). • Knows how to incorporate AI edited/manipulated digital content in one's own work and how that work should be credited. • Able to explain key principles of data quality in AI systems.



Area 3: Teaching and Learning
Managing and orchestrating the use of digital technologies in teaching and learning

Competence element	Potential Indicators
Models of learning	• Knows that AI systems implement designer's understanding of what learning is and how learning can be measured; can explain key pedagogic assumptions that underpin a given digital learning system.
Objectives of education	• Knows how a given digital system addresses the different social objectives of education (qualification, socialisation, subjectification).
Human agency	• Able to consider the AI system impact on teacher autonomy, professional development, and educational innovation. • Considers the sources of unacceptable bias in data-driven AI.
Fairness	• Considers risks related to emotional dependency and student self-image when using interactive AI systems and learning analytics.
Humanity	• Able to consider the impact of AI and data use on the student community. • Confident in discussing the ethical aspects of AI, and how they influence the way technology is used.
Participates in the development of learning practices that use AI and data	• Can explain how ethical principles and values are considered and negotiated in co-design and co-creation of learning practices that use AI and data (linked to learning design).

Area 4: Assessment
Using digital technologies and strategies to enhance assessment

Competence element	Potential Indicators
Personal differences	• Aware that students react in different ways to automated feedback.
Algorithmic bias	• Considers the sources of unacceptable bias in AI systems and how it can be mitigated.
Cognitive focus	• Aware that AI systems assess student progress based on pre-defined domain-specific models of knowledge. • Aware that most AI systems do not assess collaboration, social competences, or creativity.
New ways to misuse technology	• Aware of common ways to manipulate AI-based assessment.

Area 5: Empowering Learners

Using digital technologies to enhance inclusion, personalisation, and learners' active engagement

Competence element	Potential Indicators
AI addressing learners' diverse learning needs	• Knows the different ways personalised learning systems can adapt their behaviour (content, learning path, pedagogical approach). • Able to explain how a given system can benefit all students, independent of their cognitive, cultural, economic, or physical differences. • Aware that digital learning systems treat different student groups differently. • Able to consider impact on the development of student self-efficiency, self-image, mindset, and cognitive and affective self-regulation skills.
Justified choice	• Knows that AI and data use may benefit some learners more than others. • Able to explain what evidence has been used to justify the deployment of a given AI system in the classroom. • Recognises the need for constant monitoring of the outcomes of AI use and to learn from unexpected outcomes.

Area 6: Facilitating learners' digital competence

Enabling learners to creatively and responsibly use digital technologies for information, communication, content creation, wellbeing and problem-solving

Competence element	Potential Indicators
AI and Learning Analytics ethics	• Able to use AI projects and deployments to help students learn about ethics of AI and data use in education and training.

Glossary of AI and Data Terms

The words associated with AI and data use might sound unfamiliar or strange. Here are the most common terms associated with AI and data use and explanation of how it can apply to education.

The explanations provided here are written to be accessible to those involved in schools and should not be considered as full technical definitions. The Assessment List For Trustworthy Artificial Intelligence (ALTAI)[5] and the Commission's Glossary of human-centric Artificial Intelligence[6].

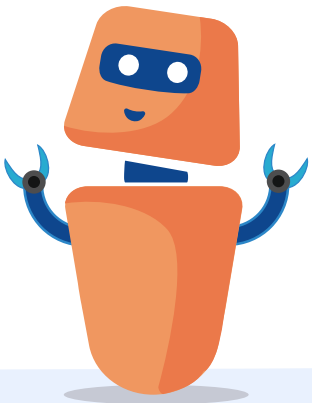
.AI Term	What it means	How it can apply to education
ALGORITHM	A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.	AI algorithms can uncover patterns in students' performance and can help teachers optimise their teaching strategies/methodologies to personalise learning and improve outcomes.
AUGMENTED REALITY (AR)	AR is an interactive experience where real-world environments and objects are supplemented by computer-generated 3D models and animated sequences which are displayed as if they are in a real-world environment. AR environments can employ AI techniques.	AR creates opportunities for teachers to help students grasp abstract concepts through interaction and experimentation with virtual materials. This interactive learning environment provides opportunities to implement hands-on learning approaches that increase engagement and enhance the learning experience.
AUTOMATION	The computer system performs a function that normally requires human involvement. A system that can perform tasks without needing continuous human supervision is described as autonomous.	Schools and teachers can use software to perform many repetitive and time-consuming tasks like timetabling, attendance, and enrolment. Automating such tasks can allow teachers to spend less time on routine tasks and more time with their students.

5 ALTAI. https://digital-strategy.ec.europa.eu/en/library/assessment-list-trustworthy-artificial-intelligence-altai-self-assessment

6 Estevez-Almenzar, M., Fernández-Llorca, D., Gomez, E., Martinez-Plumed, F., Glossary of human-centred artificial intelligence, Publications Office of the European Union, Luxembourg, 2022

.AI Term	What it means	How it can apply to education
BIAS	Bias is an inclination of prejudice towards or against a person, object, or position. Bias can arise in many ways in AI systems. For example, in data-drive AI systems, such as those produced through machine learning, bias in data collection and training can result in an AI system demonstrating bias. In logic-based AI, such as rule-based systems, bias can arise due to how a knowledge engineer might view the rules that apply in a particular setting. It does not necessarily relate to human bias or human-driven data collection. It can arise, for example, through the limited contexts in which a system is used, in which case there is no opportunity to generalise it to other contexts. Bias can be good or bad, intentional or unintentional. In certain cases, bias can result in discriminatory and/or unfair outcomes (i.e. unfair bias).	Assumptions made by AI algorithms, could amplify existing biases embedded in current education practices i.e., bias pertaining to gender, race, culture, opportunity, or disability status. Bias can also arise due to online learning and adaptation through interaction. It can also arise through personalisation whereby users are presented with recommendations or information feeds that are tailored to the user's tastes.
BIG DATA	Datasets so large that they cannot be collected, stored and analysed using traditional data processing applications. Big data refers not only to the volume of data but also to the capacity to search, aggregate, and cross-reference large data sets.	Through big data analysis, educators can potentially identify areas where students struggle or thrive, understand the individual needs of students, and develop strategies for personalised learning.
CHATBOT	A program that communicates with people through text or voice commands in a way that mimics human-to-human conversation.	Chatbots can be virtual advisors for learners and in the process adapt to their learning pace and so help personalise their learning. Their interactions with students can also help identify subjects with which they need help.
DATA MINING	The analysis of a large volume of data to bring out models, correlations and trends.	Educational Data Mining (EDM) based systems can use data mining, machine learning, and statistics to better understand learners and the settings in which they learn.
DATASET	A collection of related data points, usually with a uniform order and tags.	Datasets in education are mainly provided and used to support new educational research, and in the sharing and application of existing research.
DATABASE	A computer file containing a collection of independent works, data or other materials arranged in a systematic or methodical way and individually accessible by electronic or other means.	School administration systems contain databases of student information in including personal profiling and learning attainment data. These are sometimes linked timetabling, assessment and learning management systems.

.AI Term	What it means	How it can apply to education
DEEP LEARNING	Deep learning techniques are part of machine learning methods and are based on artificial neural networks. They are applied in different tasks, e.g., to recognize objects in images or words in speech.	Deep learning AI systems have the potential to predict minute aspects of educational performance which can aid in the development of strategies for personalised learning.
INTERNET OF THINGS (IoT)	A network of interconnected physical objects—(things) that are embedded with sensors, software, and other technologies so that they can connect and exchange data with other devices and systems over the internet.	IoT connected devices can provide learners better access to everything from learning materials to communication channels and provides teachers with the ability to measure student learning progress in real-time.
LEARNING ANALYTICS	Learning analytics involves the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.	Learning management systems record data on student interaction with course materials, their interaction with teachers and other peers, and how they perform on digital assessments. Schools can use analysis of this data to monitor student performance, predict overall performance and facilitate the provision of support through personalized feedback to each student.
MACHINE LEARNING	The ability of a computer system to learn, extract patterns and change in response to new data, without the help of a human being.	Machine learning is a form of personalised learning that is used to give each student an individualised educational experience. Learners are guided through their own learning, can follow the pace they want, and make their own decisions about what to learn based on system prompts.
MACHINE TRANSLATION	The translation of text or voice data by an algorithm in real-time and without any human involvement.	Machine translation tools are used in language teaching to help learners improve their understanding and pronunciation and can enable teachers to devote more time to the content and communicative aspects of a language.



.AI Term	What it means	How it can apply to education
METADATA	Metadata is information used to describe, reference, contextualise or characterise a data file such as a web page, image, video, document, or file. It is data that describes data, but it isn't the data itself.	Through the use of metadata teachers can source and evaluate teaching and learning resources more easily so they have more choice in the material they choose for their learners. This can help to direct each student to content at their ability or readiness level.
NATURAL LANGUAGE PROCESSING (NLP)	Natural language processing is a form of AI that helps computers read and respond by simulating the human ability to understand everyday language.	Virtual tutoring system can use speech recognition to identify problems in a student's reading ability and can provide real-time, automatic feedback on how to improve as well as helping to match the student with reading material that's best suited to them.
NEURAL NETWORK	A computer system that is designed as a collection of units and nodes, inspired by biological neural neurons in animals, connected in a way to transmit signals.	A neural network can be trained to learn a new skill or ability by using the repetition method of learning.
OPTICAL CHARACTER RECOGNITION (OCR)	OCR is the conversion of images of text (typed, handwritten, or printed) into machine-encoded text.	Optical character recognition can help students with literacy difficulties by allowing them to listen to text rather than read it. It can also create a searchable digital document which enables students to look up the definition of a word more easily, or to bookmark different parts of the text.
PERSONAL DATA	Information relating to an identified or identifiable natural person, directly or indirectly, in particular by reference to one or more elements specific to that person.	Schools accumulate substantial amounts of personal information about students, parents, staff, management, and suppliers. Schools, as data controllers, are required to store data which they process confidentially and securely and need to have appropriate policies and procedures in place for the protection and proper use of all personal data.
PREDICTIVE ANALYTICS	The use of statistical algorithms and machine learning techniques to make predictions about the future using current and historical data.	Predictive analytics can provide insight into which students require additional support, not only based on their current and historical performance, but their predicted future performance.
ROBOTICS	Robotics is the design, construction, and operation of robots that can help and assist humans with a variety of tasks.	Educational robotics and simulators allow students to learn in different ways in science, technology, engineering, and mathematics (STEM) subjects, with the objective to facilitate students' skills and attitudes for analysis and operation of robots. Such activities can include design, programming, application, or experimentation with robots.

.AI Term	What it means	How it can apply to education
SUPERVISED LEARNING	This is a type of machine learning where structured datasets, with inputs and labels, are used to train and develop an algorithm.	Supervised Learning systems are defined by their use of labelled datasets to train algorithms to classify data or predict outcomes accurately. They can help teachers identify at-risk students and target interventions. They can also improve the efficiency of teaching, assessments, and grading by helping to personalise learning.
TEXT TO SPEECH	Text-to-speech is the generation of synthesised speech from text. The technology is used to communicate with users when reading a screen is either not possible or inconvenient.	Text-to-speech technology allows learners to focus on the content rather than on the mechanics of reading, resulting in a better understanding of the material, better retention and increased confidence and motivation.
TRACE DATA	Trace data refers to records of activity such as mouse clicks, data on opened pages, the timing of interaction events, or key presses undertaken through an online information system.	Trace data, in conjunction with metadata and predefined datasets, provide a wealth of contextual information on learning efficacy and student performance, which can in turn shape strategies for personalised learning.
TRAINING DATA	The data used during the process of training a machine learning algorithm.	Machine learning algorithms learn from data. They find relationships, develop understanding and make decisions from the training data they are given. In an educational context this data can be used to make learning more efficient, adaptable, and personalised by providing detailed analytics of past and predicted future achievement.
UNSUPERVISED LEARNING	This is a form of training where an algorithm is programmed to make inferences from datasets that don't contain labels. These inferences are what help it to learn.	Unsupervised learning is conducted to discover hidden and interesting patterns in unlabelled data. These patterns are valuable for the prediction of students' performance analysing a range of contextual information like demographics and how these relate to overall attainment.
VIRTUAL PERSONAL ASSISTANT (VPA)	A virtual personal assistant is an application that understands natural language voice commands and completes tasks for the user like dictation, reading text or email messages aloud, scheduling, making calls and setting reminders.	Virtual personal assistants can enable interaction with technology using voice only thus saving time by providing instant access to information. Students can access class schedules, information and resources and communicate with teachers and peers. VPAs are also used by teachers to prepare lessons, set assignments, and provide feedback.
VIRTUAL REALITY (VR)	Virtual reality is a computer-generated scenario that simulates a real-world experience that can be interacted with using special electronic equipment, such as a VR headset or gloves fitted with sensors.	Learners explore and interact with computer-generated objects in a 3D space and see everything as if it was in front of them such as a walk-through of an art gallery or an ancient monument.


Ethical guidelines

Further Information

Keeping up to date with AI and data trends, technologies, applications, and regulations will be more important than ever. There is a growing range of resources available to help us keep up with new innovations and research that is relevant to educators. Here are a selected number of starting points:

EU Commission (2020). A European strategy for data
https://digital-strategy.ec.europa.eu/en/policies/data

EU Commission (2021). Digital Education Action Plan (2021-2027)
https://education.ec.europa.eu/focus-topics/digital-education/about/digital-education-action-plan

EU Commission (2018). Handbook on European data protection law
https://op.europa.eu/en/publication-detail/-/publication/5b0cfa83-63f3-11e8-ab9c-01aa75ed71a1

High-Level Expert Group on Artificial Intelligence (AI HLEG) (2020).
Assessment List For Trustworthy Artificial Intelligence (ALTAI)
https://digital-strategy.ec.europa.eu/en/library/assessment-list-trustworthy-artificial-intelligence-altai-self-assessment

Independent Expert Group on AI (2019). Ethics Guidelines for Trustworthy AI
https://op.europa.eu/en/publication-detail/-/publication/d3988569-0434-11ea-8c1f-01aa75ed71a1

JRC (2017). Digital Competence Framework for Educators (DigCompEdu)
https://publications.jrc.ec.europa.eu/repository/handle/JRC107466

JRC (2022). DigComp 2.2: The Digital Competence Framework for Citizens
https://publications.jrc.ec.europa.eu/repository/handle/JRC128415

JRC (2020). Emerging technologies and the teaching profession
https://publications.jrc.ec.europa.eu/repository/handle/JRC120183

OECD (2021). Recommendation of the Council on Artificial Intelligence
https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449

UNESCO (2021). Recommendation on the Ethics of Artificial Intelligence
https://unesdoc.unesco.org/ark:/48223/pf0000381137.locale=en

UNESCO (2019). Artificial Intelligence in Education:
Challenges and Opportunities for Sustainable Development
https://unesdoc.unesco.org/ark:/48223/pf0000366994

UNICEF (2021). Policy guidance on AI for children
https://www.unicef.org/globalinsight/reports/policy-guidance-ai-children

Publications Office
of the European Union

Generative Artificial Intelligence in K-12 Education

Guidance for Arizona Schools and School Systems

A Balanced Perspective

Publication Date:
May 2024

Please use and share this link to access the published version of this document.

azk12.ai

ARIZONA INSTITUTE FOR EDUCATION & THE ECONOMY

NAU NORTHERN ARIZONA UNIVERSITY

1. Direct questions about this document to LeeAnn Lindsey at the Arizona Institute for Education and the Economy.
2. This document is a first version that reflects the time period within which it was written (Spring 2024).

Version History

DATE	VERSION	CHANGES & UPDATES
5/13/24	24.01	Original Publication

Table of Contents

Our Message

Message from the Arizona Institute for Education and the Economy

When the Arizona Institute for Education and the Economy (AIEE) launched in the spring of 2023, I never imagined that artificial intelligence (AI) would become an initial focus area. However, as I traveled the state in the summer and fall of 2023 to meet with local leaders, both the energy and overwhelm around AI in education was palpable. It became apparent that the Institute, designed to create transformational solutions, would need to prioritize AI.

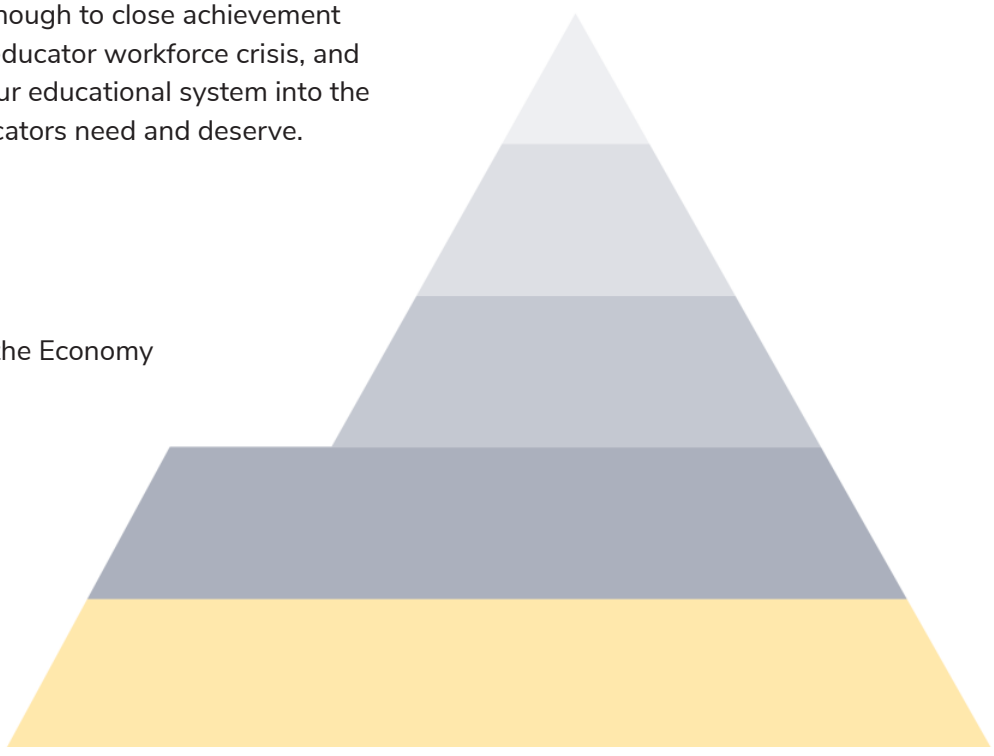
Early in the 2023-2024 school year, the Institute published an article titled, "AI In Education: Top 10 Questions for School Systems Leaders." The goal was to encourage schools and school systems to get off the sidelines, shift conversations about banning AI, and begin to learn more about AI policies, practices, tools, and trends. Later in the fall, the Institute hosted a statewide session that aimed to demystify AI and challenge education leaders to grapple with what this technology could mean for our profession. Recently, in partnership with the Arizona K-12 Center, we hosted a four-part podcast series on AI in Education. Now, we present to Arizona our state's first official AI guidance for K-12 school systems.

If you've been waiting for a signal to get started, consider this your permission slip. The light is green – it's time to step on the gas. We don't, however, encourage you to speed recklessly. Haphazard AI implementation is arguably worse than no AI implementation. That is why this document is subtitled, "A Balanced Perspective." AI is a powerful, disruptive tool. It has the potential to transform education models and approaches to learning for good, but there are also pitfalls to avoid. We believe that responsible AI implementation can be an incredible agent of change in Arizona schools and classrooms if led by a true north star for student learning yet guided by the ethics that impact a just society.

If we are wise with usage and implementation of AI, we will embark upon a new kind of intelligence – a collective intelligence. A profession – and quite possibly a society – where we harness the best of human intelligence and also leverage the efficiencies and generative power of artificial intelligence to create a collective intelligence. An intelligence smart enough to close achievement and opportunity gaps, address the educator workforce crisis, and ultimately reimagine and redesign our educational system into the one that both our students and educators need and deserve.

Dr. Chad Gestson

Dr. Chad Gestson
Executive Director
Arizona Institute for Education and the Economy
Northern Arizona University



Acknowledgements

Core Team members determined the values and goals of the guidance found in this document. They also analyzed data, drafted, and revised the document's content. The Reviewers provided critical feedback from multiple perspectives that shaped the content of this guidance.

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Introduction

The Arizona Institute for Education and the Economy (AIEE) exists to cultivate solutions that improve K-12 education outcomes and ensure long-term statewide economic prosperity (AIEE, 2024). Sitting at the intersection of PK-12, higher education, and workforce development, we first seek to understand what is needed for Arizona's future to thrive, then work with stakeholders to innovate bold solutions to transform outcomes for our students.

The Future of Jobs Report 2024 by the World Economic Forum forecasts significant changes in the job market over the next five years prompted by Artificial Intelligence (AI). According to the report, 75% of surveyed companies plan to implement generative AI by 2027, resulting in both job losses and new job creation. Other research has indicated that 19% of the workforce could have over 50% of their tasks automated by AI (Eloundou et al., 2023). Additionally, AI and machine learning are identified as skills most prioritized for reskilling and upskilling in the next five years (World Economic Forum, 2023). In light of this shift, educators and system leaders must consider how we prepare our students for economic agency in an evolving landscape.

> *"In light of this shift, educators and system leaders must consider how we prepare our students for economic agency in an evolving landscape."*

To help guide Arizona's education leaders in addressing AI technologies, the AIEE assembled a group of education experts to develop guidance that would assist Local Education Agencies (LEAs) to responsibly and confidently chart a path forward. As a team of education technology leaders, administrators, curriculum, and IT professionals, our collective experience is brought together in this document to offer a north star, proposed guardrails, and implementation recommendations.

This guidance is grounded in two core beliefs – 1. Artificial Intelligence has the potential to be the catalyst for positive transformation of education models, and 2. Responsible implementation requires a nuanced understanding of the ethical implications. With that in mind, our team has taken great care to present this guidance reflecting a **balanced perspective.**

About This Document

Artificial Intelligence, especially Generative Artificial Intelligence (GenAI), has rapidly emerged in the K-12 landscape, bringing with it both excitement and confusion. This document intends to provide direction for K-12 leaders as they grapple with the implications of GenAI in education and make plans to address it.

The first steps to moving forward with intention include establishing a common language and leading important conversations about purpose and vision. The information provided in this document can help strengthen individual and collective understanding of GenAI including the opportunities, imperatives, and risks inherent in its use.

Document Organization

Document Section(s)	Purpose
Understanding GenAI	**Explainer:** Build a basic understanding of Generative AI to better navigate this document and participate in AI-related conversations.
Powerful Teaching and Learning & School and Administrative Uses	**North Star:** Envision the possibilities to transform not only teaching, learning, and leadership, but also our profession, and unquestionably, our future workforce.
Responsible and Ethical Implementation	**Guardrails:** Strengthen understanding of what's at stake in order to move forward safely and responsibly.
Implementation Recommendations	**Recommendations:** Prepare to lead implementation. Those who have already begun can compare and confirm action plans.

Overarching Value: The Human Agency and Oversight Imperative

This guidance was built around a core value of human agency and oversight at every stage of AI-use and implementation. It's essential that humans serve as a critical navigator of AI use and ensure alignment with educational and societal goals. The U.S. Department of Education Office of Educational Technology's policy report, Artificial Intelligence and the Future of Teaching and Learning: Insights and Recommendations, emphasizes "humans in the loop" stating, "Teachers, learners, and others need to retain their agency to decide what patterns mean and to choose courses of action (2023, p. 6). Likewise, in their AI guidance document, the Washington Office of Superintendent of Public Instruction suggests a "Human -> AI-> Human" frame to establish a collaborative partnership with AI that reflects human agency and governance over its use (2024).

As an overarching core value, human oversight considerations are found throughout every section of this document.

About This Document

To further explain the human and AI relationship, Vera Cubero from the North Carolina Department of Public Instruction uses an analogy of three different bikes. She compares education without AI to a mountain bike – the human is in control with no assistance, too much reliance on AI to a motorcycle – fast but potentially dangerous, and partnership with AI to an e-bike – the bike assists and the human is in control (NCDPI, 2024).

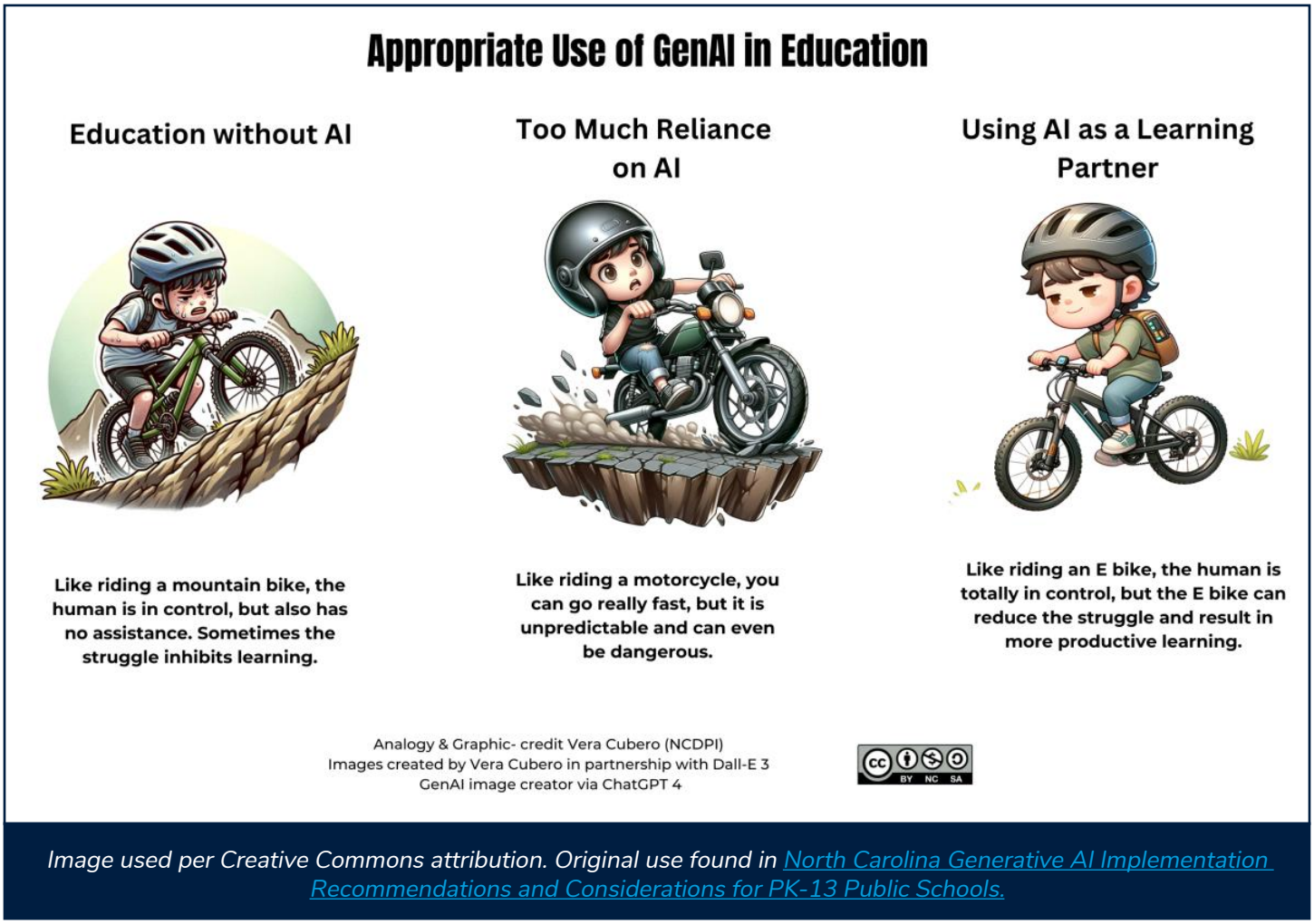


Image used per Creative Commons attribution. Original use found in North Carolina Generative AI Implementation Recommendations and Considerations for PK-13 Public Schools.

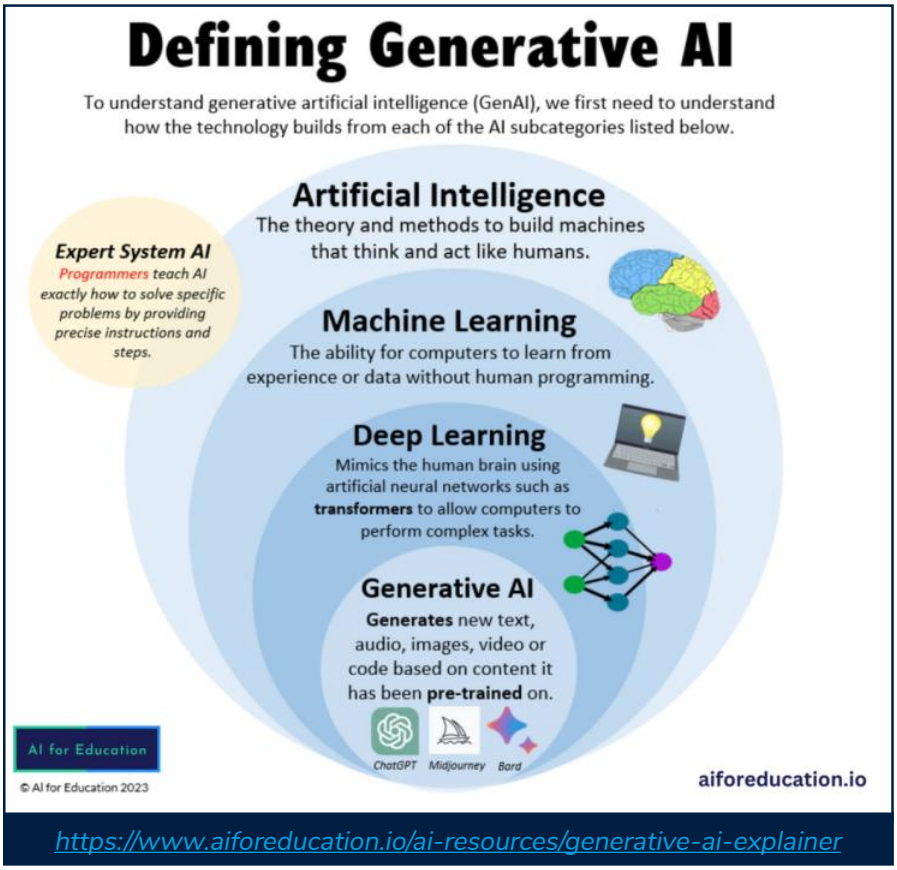
RESOURCE

The European Commission (2022, p. 19) provides questions to initiate reflection and dialogue about human agency and oversight in the implementation of AI in education.

Understanding GenAI

Artificial Intelligence (AI) refers to computer systems or algorithms that simulate human intelligence or problem-solving. It is not new technology – in fact, it has decades of use even in the field of education. In the 1990s, edtech companies used adaptive learning technologies to adjust the pace and style of digital content based on student needs, making learning faster or slower and adjusting the lessons for students. In the 2000s, schools and colleges began using machine learning on their "big data" to predict student performance and intervention needs. Still, the release of ChatGPT in November 2022 has caused a new flurry of interest in AI technologies.

Text-based interaction with AI ("chatbots") and AI-powered image & video creation tools are powered by a subset of AI called Generative AI which produces content that often appears as though it came from a "human hand." The graphic from AI for Education (2023) clarifies how GenAI is positioned in the broader field of AI.



https://www.aiforeducation.io/ai-resources/generative-ai-explainer

It is important to understand that AI tools, GenAI included, are not inherently knowledgeable; they learn from large amounts of data collected from all over the internet and world, which introduces an inherent bias to their output. Imagine two 18-year-olds, one who grew up in rural Arizona and one who grew up in bustling Tokyo. They are both human, but their differences in lived experiences cause their worldviews and perspectives to be drastically different. Just as humans are influenced by both nature and nurture, a GenAI tool will reflect the algorithms and the datasets that trained them, both of which are selected by companies whose interests are not always aligned with those of educators. Further, GenAI models that currently exist cannot precisely define how or why they produce an output. Therefore, when it comes to biased or inaccurate output that feels "human" it is important to understand that the tool gave the statistically best answer or product based on what we asked, shaped by the training data used in that model.

The ability of GenAI tools to *mimic* human patterns of communication and creation has potential to be valuable in the world of education. For example, the use of "tutor bots" that allow students to have individual coaching that *feels* like a human conversation is being explored by both technologists and educators. As these explorations unfold, we will learn more about the impacts and net effect.

With a high regard for innovation and to set the tone of possibility, we continue with an investigation of GenAI's role in **powerful teaching and learning.**

Powerful Teaching and Learning

Harnessed appropriately, GenAI can be a catalyst for pedagogical models that increase equitable learning conditions, foster learner agency, and equip students with highly valued future-forward skills. However, we must not treat AI as though it is a magic bullet that will miraculously improve student outcomes. Whether our instructional goals aim toward content achievement, digital literacy, or workforce skills, we should anchor instructional choices in a vision for powerful teaching and learning.

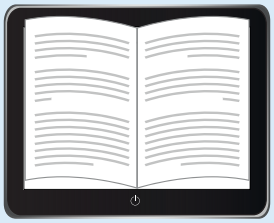
> *"Whether our instructional goals aim toward content achievement, digital literacy, or workforce skills, we should anchor instructional choices in a vision for powerful teaching and learning."*

Use the information in this section to spark conversations around the true value of GenAI-use in the classroom. Dialogue among teachers, administrators, instructional coaches, and curriculum leaders will help frame your organization's perspective on powerful practices for teaching and learning in an AI-powered world.

Educators can lean into the Arizona Academic Standards, including those for Computer Science, Educational Technology, and content areas to anchor instructional decisions.

Arizona Academic Standards

- Computer Science
- Educational Technology
- English Language Arts
- History and Social Science
- Mathematics
- Science



AI Literacy

AI literacy includes the knowledge and skills that enable humans to critically understand, use, and evaluate AI systems and tools to safely and ethically participate in an increasingly digital world (Digital Promise, 2024)

As educators, we shape students' understanding of the world and prepare them for active engagement in it. Because GenAI will continue to transform the way we work and live, we must make AI literacy a priority for all students and adults in our communities. Creating an AI-literate population is the only true approach to shaping an AI-driven world that is safe and just. AI-literate individuals are better equipped to be proactive and participatory in shaping the technology's use within our schools and our lives.

Our team's unwavering stance on the importance of AI Literacy as a core skill for the future has led to its inclusion at several points throughout this guidance document. We encourage all LEAs to create an AI Literacy plan that includes curriculum and professional development affixed to the Arizona Academic Standards.

Human Oversight: AI literacy equips teachers and leaders to provide informed human oversight for AI implementation.

The following table shows key alignment between AI literacy and AZ Academic Standards.

AI Literacy Goals	AZ Academic Standards
Safe, Responsible, and Ethical Technology Use *Critical source evaluation:* • Identify biases and misinformation in AI-generated content and understand their societal implications • Demonstrate source transparency, including GenAI tools and output • Critically evaluate information generated by AI across multiple sources *Data Management* • Manage and protect one's own and others' data when using AI *Cybersecurity* • Protect computers, networks, and data from unauthorized access or harm • Understand common cybersecurity threats	EdTech Standard 2: Digital Citizen EdTech Standard 3: Knowledge Constructor ELA Writing Anchor Standard 8 ELA Reading Anchor Standard 8 Social Studies Disciplinary Skills and Processes Anchor Standards 1, 2, 3, 4 Science and Engineering Practice 8 Computer Science Concept: Impacts of Computing Computer Science Concept: Networking and the Internet
Computational Thinking • Break down complex problems into smaller, more manageable parts • Detect patterns, trends, or regularities that can help inform decision-making and problem-solving processes • Develop step-by-step solutions that can be replicated • Assess and analyze the effectiveness of solutions to problems or tasks	EdTech Standard 5: Computational Thinker Computer Science Concept: Data and Analysis Computer Science Concept: Algorithms and Programming Standards for Mathematical Practice 1, 2, 4, 5, 6, 8 Science and Engineering Practices 1 - 8

AI Integration

Integrating GenAI into the classroom marks a transformative shift in educational practice as teachers and students use it to shift learning models so that teachers serve as facilitators who coach students to develop learning agency. While some educators at first feared that AI would reduce the human aspect of teaching, if used appropriately, it holds vast potential to foster a more humanistic approach.

We share the classroom use cases below to paint a picture of the possibilities of intentional use of GenAI. Applications like these can improve instruction and create more space for human interaction between teachers and students.

Human Oversight:
Teachers partner with AI to enhance instructional opportunities for students and increase human interaction.

Teacher Use Cases

GenAI offers teachers a wide range of applications that can simplify routine tasks, create learning materials, or serve as a thought partner. Initially, educators may be most excited to use tools to accomplish everyday tasks more quickly. However, the real value of saving time happens when teachers reinvest that time into creating more effective lessons and having more real-time academic conversations with students.

Consider how the following examples of teacher use may foster a culture of personalized and inclusive education with strong teacher/student connections.

THOUGHT PARTNER

- **Idea Generation:** Use GenAI to generate fresh ideas, making learning more engaging and relevant for students.
- **Reflective Practice:** Engage with GenAI as a thought partner to improve lesson plans and bolster elements like differentiation, student choice, and collaboration.
- **Accessibility Check:** Ask GenAI to look for potential accessibility oversights in lesson plans and to provide strategies to strengthen inclusivity.
- **Feedback Loop:** Use GenAI to test for alignment between instructional plans, materials, and assessments.

PERSONALIZATION

- **Content Customization:** Leverage AI to tailor content to the unique needs of each student including those in English learner, special education, and gifted programs.
- **Adaptive Materials:** Use AI to modify reading levels of texts, design activities that cater to students' interests, and create visual aids for complex vocabulary or concepts.
- **Feedback and Assessment:** Use AI as a starting point to provide more regular and personalized feedback on student assignments, enabling timely and individualized responses.

ASSISTANT

- **Task Automation:** Use AI to handle routine tasks efficiently, such as composing emails, creating rubrics, or writing detailed instructions.
- **Interactive Presentations:** Have AI design engaging slide decks that include student engagement features.
- **Visual Content Creation:** Generate custom images with AI to support educational content.

Powerful Teaching and Learning

Student Use Cases

When ChatGPT was first released, it conjured images of students furiously copying and pasting, which some thought would surely be the demise of education. While this is an understandable first reaction, it is only so in the context of assignments and assessments that can be easily generated, copied, and pasted. In other words, AI can be the catalyst to push beyond the status quo of multiple-choice tests and basic essays, rethinking what we ask students to do and why.

GenAI offers capabilities that can allow students to be more independent and self-directed in their learning journey. Students may find additional uses that bring out curiosity, creativity, and reflection. Consider the following examples of student use.

Human Oversight: Teachers ensure student use is developmentally appropriate and adheres to age requirements.

SELF-DIRECTED LEARNING

- **Goal-Setting:** Students use GenAI as a thought partner to establish realistic and attainable learning objectives.
- **Planning:** AI helps students to map out a personalized schedule for completing extensive projects.
- **Reflection:** Students partner with GenAI to think about their learning process.

PERSONALIZATION

- **Interactive Learning:** Students engage with GenAI to gain deeper insights or clarification on topics, including those of personal interest.
- **AI Coaching:** GenAI serves as a coach by recommending reading materials that align with a student's interests and reading proficiency.
- **Writing Enhancement:** Students use GenAI throughout the writing process as a critical friend. AI can help brainstorm, outline, draft, revise, and proofread.

ACCESSIBILITY

- **Inclusive Tools:** GenAI tools provide incredible support to students with differing abilities.
- **Language Support:** English Language Learners use AI to practice speaking or to translate textual and auditory content.
- **Content Acquisition:** Students use AI to create summaries and explanations that help them better understand assigned material.

Risks of Teacher and Student Use

Although there are many exciting possibilities for teacher and student use, educators also have a responsibility to consider possible downsides. In the spirit of the balanced approach this guidance seeks to encourage, consider these risks to integrating GenAI into teaching and learning practices.

Human Oversight: Human oversight is necessary to mitigate these risks.

- **Over-Reliance on Technology:** No technology can replace the deep understanding that educators have of their students' unique needs and preferences. Nor can it improve student learning if it is used as a crutch.
- **Dependence on Specific Tools:** GenAI tools are usually developed and maintained by private companies who may decide not to stop offering the tool or change pricing in ways that are prohibitive for LEAs to fund its use.
- **Accuracy and Quality Assurance:** Some educators may find it challenging to verify the accuracy and quality of AI-generated content.
- **Loss of Human Interaction:** Automating solutions creates a risk of decreased human interaction (adult-student, adult-adult, student-student) in exchange for efficiency. In turn, this presents the potential to exacerbate loneliness, isolation, and anxiety.
- **Implementation Dip:** As GenAI and its use in education continues to evolve, we will learn more about best practices. In the meantime, it could result in an "implementation dip" with a beginning-stage net negative impact.

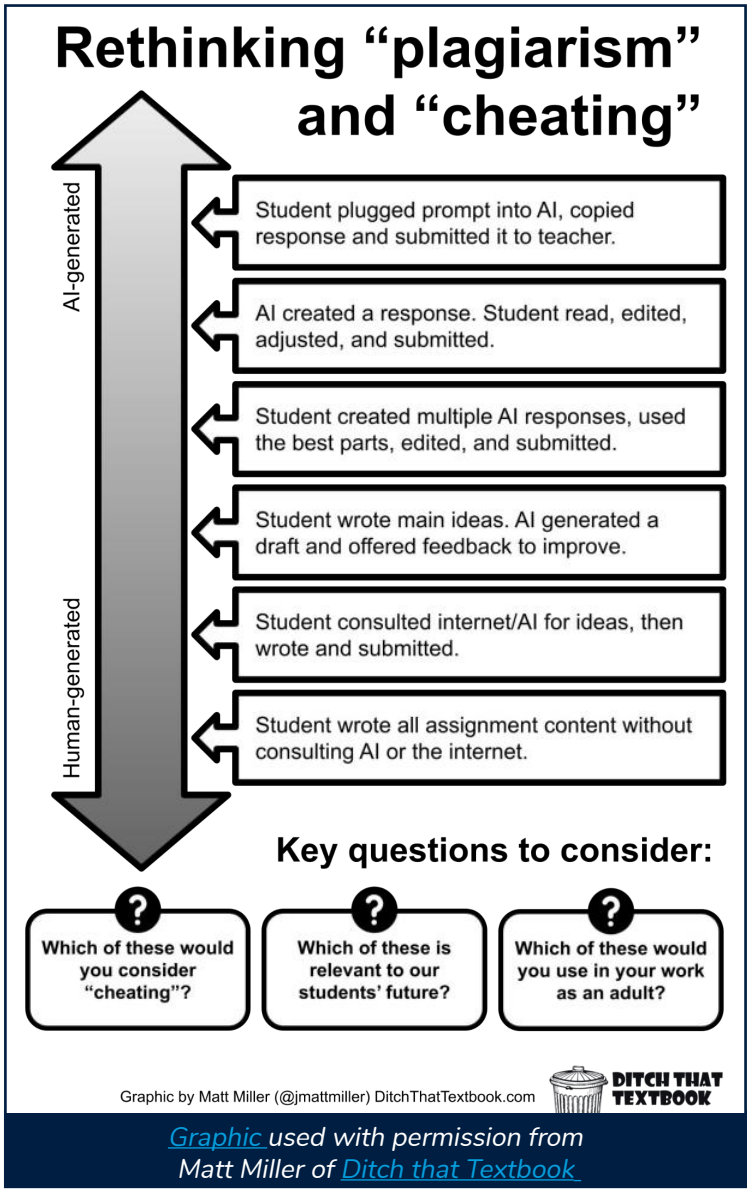
Redefining Academic Integrity

Within the educational implementation of GenAI lies a transformative opportunity to reconsider the methods we use to teach and assess student learning. We can challenge the traditional notion of cheating and plagiarism by redesigning curriculum and assignments that students are eager to learn and are willing to invest time and effort to complete. Assignments that encourage authentic student engagement and creation can rarely be completed via automated solutions.

Redefining "acceptable use" requires students, staff, and families to grapple with new questions about cheating, plagiarism, and future-forward skills.

Matt Miller (2022) offers updated definitions of plagiarism and cheating, as well as a graphic that illustrates a continuum of GenAI-reliance that education leaders can use to foster important dialogue with administrators, teachers, students, and families.

- **Cheating:** When a student does something dishonest in academic work that misrepresents what they understand or are able to do for an unfair advantage.
- **Plagiarism:** When a student represents some type of work as their own creation when, in reality, it is not their own work.



Graphic used with permission from Matt Miller of Ditch that Textbook

Refer to state and federal laws regarding age requirements and data privacy to further guide decisions about student-use.

Citation and Disclosure

It is true that the integration of GenAI into our creative processes introduces more complexity to practices that ensure transparency and ethical use of tools and content. For example, citing AI use becomes challenging when AI technology is embedded into other digital tools (Bauschard, 2024). Additionally, as educators and students adopt a collaborative approach with AI (Human -> AI-> Human) it becomes difficult to distinguish the contributions made independently from those generated by AI.

Despite these complexities, the overarching goal remains: to uphold transparency. Adults and students should strive to consistently be clear and forthright about the extent to which AI tools have been utilized in the creation of academic work. The following resources provide a sample of how to cite the use of AI:

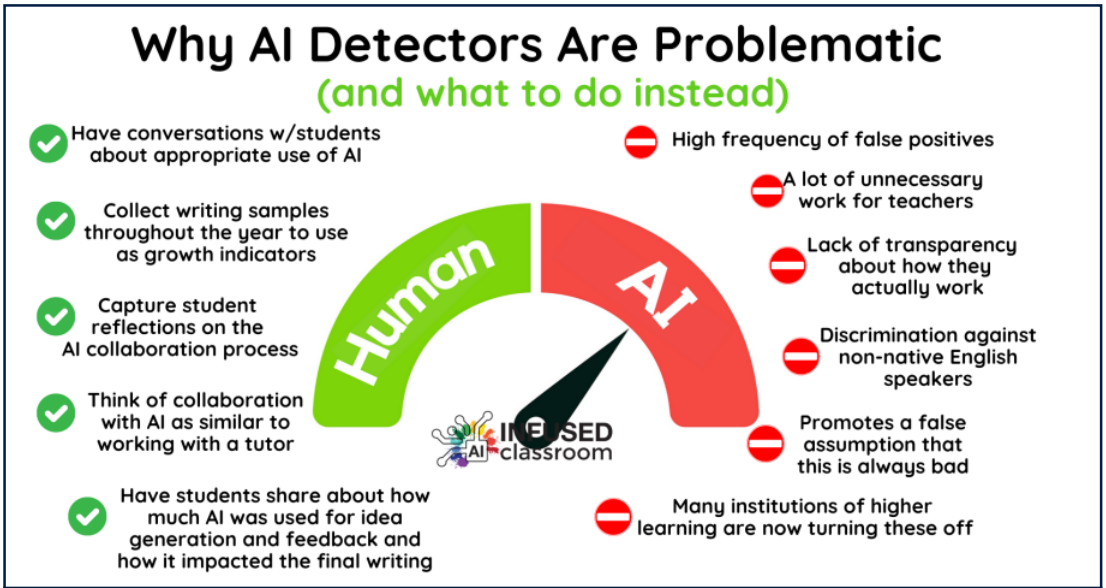
- MLA Style - Generative AI
- APA Style - ChatGPT
- Chicago Style - Generative AI

Human Oversight:
Teachers can foster academic integrity by establishing clear policies and expectations for AI use, encouraging communication, and nurturing students' intrinsic motivation.

AI Detectors

In the pursuit of upholding academic integrity, some teachers and administrators have looked to AI detectors to combat cheating and plagiarism. The primary problem with this approach is that AI detectors have proven to be unreliable. Their frequent false positives punish students whose first language isn't English at a higher rate (Sample, 2023). What's more, students with higher AI literacy are more likely to get past the detector.

For these reasons, AI detectors should not be used as a sole source of determining whether plagiarism has occurred. Rather than relying on flawed technology, a more effective approach is to establish clear policies and expectations through an AI Acceptable Use Scale, encourage open communication, and nurture students' intrinsic motivation by offering them choices and opportunities to explore their interests within assignments (Clark, n.d.).



Graphic used with permission from Holly Clark, author of The AI Infused Classroom

School and Administrative Use

Not only does GenAI present transformational opportunities for the classroom, it also provides capabilities that can enhance efficiency within school systems. The truth is, GenAI can perform some administrative and organizational tasks better than a human can. Consider its ability to analyze student data quickly and accurately. GenAI can also help streamline administrative tasks, freeing up time to focus on more impactful activities.

The following ideas can spark ideas about how using GenAI might transform school operations and systems outside of the classroom. This list is not exhaustive; in fact, conversations regarding AI for non-classroom use are presently at the beginning stages and gaining interest. As AI becomes even more integrated in education, opportunities and risks for school and administrative use will become more apparent.

How might GenAI be used to support operations in departments such as human resources, finance, transportation, or facilities?

Opportunities

- **Improve efficiency:** Use GenAI to automate repetitive tasks such as drafting communications and preparing presentations.
- **Enhance data analysis:** AI algorithms can analyze large volumes of data quickly and accurately, making its analysis easily consumable for all users and aiding in data-driven decision-making processes.
- **Streamline master scheduling:** Use AI to create a master schedule in minutes, not months. Balancing class sizes, teacher availability, and room assignments while taking into account factors such as teacher certifications, student course selections, and resource availability becomes far less cumbersome.
- **Optimize evaluation processes:** GenAI tools can aid evaluation processes by organizing notes by the appropriate criteria.
- **Gather and disseminate information:** GenAI tools can serve as a tool to answer both internal and external questions about complex systems such as special education, student discipline, bonds and overrides, and more. Consider how a chatbot could be used to enhance family communication.
- **Draft procedures and policies:** Use GenAI to develop internal processes and procedures that can be sent to a legal team for review rather than having an attorney develop it from scratch.
- **Create how-to resources:** Use AI to create both video and written steps for internal processes such as taking attendance, accessing a shared drive, submitting a time off request, etc.
- **Translate:** GenAI can translate documents, spoken word, or typed information to many different languages simultaneously. It can also answer questions, give directions, and provide information to stakeholders in many different languages.

Risks

- **Loss of human interaction:** Over-reliance on AI may diminish the personalized interactions and human connections that are essential for fostering a supportive and inclusive school environment.
- **Bias in algorithmic decision-making:** AI systems are susceptible to biases present in the data used to train them, potentially leading to discriminatory outcomes or reinforcing existing inequities within the school system.
- **Data privacy concerns:** The collection and analysis of sensitive student and staff data by AI systems can raise privacy concerns that must be carefully addressed through robust data protection measures and compliance with relevant regulations.
- **Technical challenges:** Implementing and maintaining AI systems requires specialized technical expertise and infrastructure, posing challenges for schools with limited resources or technological capabilities.

Responsible & Ethical Implementation

The power of GenAI to produce human-like outputs presents remarkable opportunities for Arizona's schools and classrooms; it also punctuates the need for staff and student training, as well as regulation that is informed by legal and ethical input. At this point in its societal adoption, it is impossible to know the full gamut of ethical considerations – but based on how GenAI is trained, what it produces, and how, some key ethical risks are evident.

To help Arizona's education leaders better understand the ethical terrain of GenAI, we present five key considerations to begin critical dialogue within their institutions. While these may not cover the entire spectrum of ethical challenges posed by GenAI, they reflect some big ideas that LEAs should consider. We end this section with recommendations to address ethical considerations.

Consideration #1: Bias

GenAI systems use Large Language Models (LLMs) that are trained on extensive datasets, primarily consisting of human-generated content. Consequently, these models inherently incorporate human and societal biases into the applications and outputs they produce. Punya Mishra from Arizona State University has highlighted a concern that most contemporary datasets are WEIRD, that is, they "disproportionately represent Western, Educated, Industrialized, Rich, and Democratic societies" (Mishra, 2023; Shulz et al., 2018). This imbalance can distort perspectives, perpetuate narrow worldviews, exacerbate biases that marginalize minority and underrepresented communities, and cause harm to individuals.

Risks

- Student tracking based on data containing inherent bias can lead to unfair treatment that perpetuates inequities.
- Use of biased GenAI output absent critical evaluation can affirm narrow worldviews and exacerbate societal biases.
- AI-generated teaching materials may reflect bias.

> "You should not face discrimination by algorithms and systems should be used and designed in an equitable way. Algorithmic discrimination occurs when automated systems contribute to unjustified different treatment or impacts disfavoring people based on their race, color, ethnicity, sex (including pregnancy, childbirth, and related medical conditions, gender identity, intersex status, and sexual orientation), religion, age, national origin, disability, veteran status, genetic information, or any other classification protected by law."
>
> Principle #2: Algorithmic Discrimination Protections, Blueprint on AI Bill of Rights Whitehouse.

Consideration #2: Misinformation and Falsehoods

Manipulated videos of political leaders, websites containing inaccurate medical advice, and tales of celebrity death hoaxes are examples of GenAI-created falsehoods. While misinformation has been persistent in digital platforms for some time, the introduction of generative technologies makes both intentional and unintentional creation of "believable" stories easier, amplifying its spread. Widely spread misinformation can manipulate public opinion, polarize society, and even influence election outcomes, over time eroding citizens' faith in institutions and undermining democracy.

Why does GenAI produce misinformation?

If the data used to train an AI model contains misinformation or biased content, its output will reflect the false information. Moreover, when confronted with incomplete or contradictory input, AI models resort to probabilities to fill in gaps that are often creative but lack any factual basis. This phenomenon is commonly known as "hallucination" - although many prefer the term "error" which uncouples it from the medical definition and humanization of the technology.

Risks

- As with bias, misinformation generated by AI can perpetuate biases and stereotypes or reinforce societal prejudices.
- AI-generated curricular materials can contain general inaccuracies which, if undetected by teachers, can mislead students and distort learning.
- Misinformation can plague student research efforts if they are not taught to use GenAI effectively, including evaluating and verifying output.

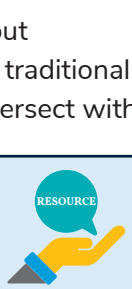
Consideration #3: Intellectual Property

Since GenAI relies on existing data, its output naturally raises questions about content ownership, copyright, and intellectual property (IP). Current policies and laws may be inadequate to address IP issues generated by a machine, although interpretations are beginning to surface amidst novel situations. For example, in 2023 a federal judge ruled that copyright may not be granted for images generated with AI citing a lack of human authorship; he also acknowledged that the rise of GenAI will prompt challenging questions about copyright protection and existing copyrighted works (Bloomberg Law, 2023).

The introduction of GenAI into educational contexts has left many educators feeling apprehensive about accepting student work that may have been machine-generated. Certainly, these new tools challenge traditional understandings of authorship with respect to human creativity. Concerns over intellectual property intersect with questions about academic integrity, professional responsibilities, and student learning.

Risks

- GenAI introduces another means for plagiarism - whether intentional or unintentional.
- Authorship is not always clear-cut, leading to confusion around plagiarism and academic integrity.
- GenAI can inadvertently produce content that violates copyright laws or lacks appropriate attribution.
- The authenticity of content and communication may be compromised or challenged.
- Personal values may be threatened by individuals, including teachers and other professionals who feel as though their use of machine-generated content or lessons is "cheating."



6 Tenets of Postplagiarism: Writing in the Age of Artificial Intelligence.

Consideration #4: Data Privacy

Because of the way GenAI uses data, it can store, process, and reveal personally identifiable information (PII). According to the 2023 report, Artificial Intelligence and the Future of Teaching and Learning, published by the U.S. Department of Education Office of Educational Technology, most AI models do not consider educational use or student privacy. Therefore, their products may put student data at risk, diminishing an LEA's efforts to comply with student privacy mandates. Data privacy may also justifiably be a concern for parents and caretakers. Being transparent with the community about data protection practices can go a long way in building trust and credibility with the community.

Risks

- An LEA's compliance with student privacy laws may be put at risk by using certain tools and applications in a school setting.
- Introducing AI in the school environment may raise questions from parents and families regarding the protection of their children's data.
- Problems can occur if data that was used as GenAI input for a specific purpose is later used in a different application. For example, data collected for research and then repurposed for commercial purposes is considered data misuse.
- GenAI tools and platforms may be susceptible to security breaches, hacking attempts, or unauthorized access which could compromise the confidentiality and integrity of student data.

Relevant Policies in the US and Arizona

- **Children's Internet Protection Act (CIPA):** Ensure that AI tools and platforms align with internet safety policies, web-filtering measures, monitoring requirements, and provisions established to protect students from accessing obscene or harmful content online.
- **Family Educational Rights and Privacy Act (FERPA):** Safeguard student educational records to protect student privacy and confidentiality. Train teachers to securely manage student records, such as grades and attendance, and avoid the disclosure of personally identifiable information without proper consent.
- **Children's Online Privacy Protection Rule (COPPA):** Only use tools that adhere to COPPA age and parental consent requirements, noting that some platforms' terms of service require users to be at least 13 years old or with parental consent while others may have age restrictions for students under 18.
- **Protection of Pupil Rights Amendment (PPRA):** Be mindful of AI use that requires students to provide information on protected areas.
- **Arizona Revised Statute 15-142:** Ensure that the use of generative AI tools safeguards student directory information and school property data.
- **Arizona Revised Statute 15-117:** Adhere to survey protocols, obtain parental consent, and maintain informed consent procedures when employing GenAI tools.
- **Arizona Revised Statute 15-1046:** Implement robust student data privacy measures to protect sensitive information, respect privacy boundaries, and secure student data confidentiality.

Consideration #5: Equitable Access

The 2024 National Educational Technology Plan (NETP) recognizes technology as a powerful tool to transform learning through student-centered and personalized models. It also acknowledges the present-day failure of technology to realize its full potential to benefit all students. The 2024 NETP calls upon all education agencies to close divides in digital use, digital design, and digital access that contribute to growing inequities.

Risks

- Digital Divides may be created or exacerbated by unequal AI implementation
  - > Digital Use Divide: Students who actively use digital tools including GenAI for higher level learning tasks such as analysis, creation, and evaluation are at a significant advantage over students who use it for low level activities and passive assignment completion.
  - > Digital Design Divide: Teachers who receive quality ed tech professional learning are better equipped to design effective digital learning experiences for all students. A digital design divide can take place between neighboring classrooms in the same school, schools in the same district, and districts throughout the state.
  - > Digital Access Divides: Teachers and students in some communities have far better access than others to the devices, internet connectivity, and resources that GenAI requires.
- Differences in exposure and use of GenAI tools can position some students to gain skills and competencies they will need to thrive in future workplaces while leaving others behind. A lack of AI skills could potentially limit students' career opportunities.

Addressing Ethical Considerations

While it is important to understand all that is at stake for GenAI use and implementation, education leaders should also consider the incredible opportunities that implementation affords. For example, renewed attention to data privacy practices can help LEAs shore up procedures and build trust with the community. Creating a plan to strengthen AI literacy may prompt a new community partnership. Best of all, engaging teachers, staff, and students in ethical conversations about AI strengthens everyone's understanding of humanity and citizenship in an AI-powered world.

Relevant US Regulations

- Individuals with Disabilities Education Act (IDEA): AI implementation must not deny students with disabilities equal access to education opportunities.
- Section 504 of the Rehabilitation Act: Schools must ensure that students with disabilities have equal access to digital content, technologies, and platforms, including AI.

Human Oversight: Humans serve as a safeguard to ensure that GenAI is used in pursuit of educational and societal goals providing oversight along the way.

"Engaging teachers, staff, and students in ethical convesations about AI strengthens everyone's understanding of humanity and citizenship in an AI-powered world."

Responsible & Ethical Implementation

To help education leaders envision and operationalize the opportunities of responsible implementation, we provide the following recommendations.

Recommendations

1. Educate and Train: Train teachers, staff, students, and community members to recognize, evaluate, and challenge bias and misinformation in generated content. Training should also help individuals recognize personal values that influence the interpretation of biased content.

2. Hold Ed Tech Companies to Ethical Standards: Evaluate educational technology companies' ethical commitment; include contractual clauses related to ethical compliance when procuring ed tech services.

Resource: Top 6 Questions for GenAI EdTech Providers (AI for Education, 2023)

3. Prioritize AI Literacy and other "new literacies": Adults and students alike need training to effectively and ethically navigate an AI-powered landscape. Build AI and other new literacies into the curriculum across grade levels and provide ongoing professional development for teachers and staff.

- **AI Literacy:** AI literacy includes the knowledge and skills that enable humans to critically understand, use, and evaluate AI systems and tools safely and ethically (Digital Promise, 2024).
- **Digital Literacy:** Digital literacy involves the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital technologies (UNESCO, n.d.)
- **Media and Information Literacy:** Media and information literacy teaches how information is created, packaged, and disseminated, and encourages critical thinking skills to evaluate sources and verify information. Include training on how cognitive biases influence our perception of media and information.
- **Technology Literacy:** Technology literacy encompasses a range of skills related to using and understanding technology devices, tools, and systems in various contexts.

4. Revisit Existing Privacy Practices: Use AI implementation as a good excuse to revisit existing data governance practices. Your current practices may be robust enough to account for GenAI. If not, consider it an opportunity to update and strengthen them. It is also a great time to train administrators and teachers how to safeguard student data and handle privacy challenges.

5. Strengthen Digital Citizenship Education: Move digital citizenship education from the back burner to the front. Instead of relegating it to an assembly or a few lessons per year, help students to make informed decisions about their digital use all the time and in meaningful ways.

6. Evaluate Digital Access: Assess the digital access of your entire school community to pinpoint existing gaps and barriers. Then investigate and promote appropriate solutions such as low-cost internet options from local providers like Cox's Connect2Compete plan, federal programs such as Lifeline, and state support such as Arizona's Broadband Initiative to bolster digital access efforts.

7. Align to Universal Design for Learning (UDL): Use UDL as a frame to focus AI use around greater inclusivity and accessibility for all learners.

8. Revisit Existing Security Measures: Review your security practices to evaluate their ability to protect against cyber threats and ensure the security of sensitive information.

Implementation Recommendations

While AI Literacy is an important skill for the workforce of the future, adoption should not be rushed or fully implemented without intentionality and preparation. In fact, AI implemented poorly may be worse than not implementing AI at all due to what is at stake if certain safety and ethical measures are not in place.

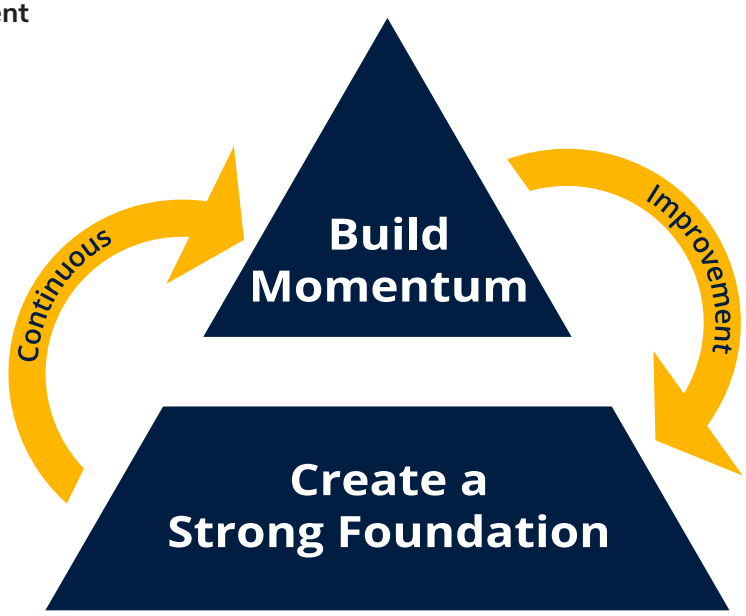
To assist education leaders thoughtfully implement GenAI we recommend a three-phase implementation structure which was informed by the TeachAI Toolkit's Framework for Incorporating AI in an Education System.

1. Create a Strong Foundation

2. Build Momentum

3. Continuous Improvement

Human Oversight:
Keep the human in AI! Refer to resources such as the Artificial Intelligence and the Future of Teaching and Learning: Insights and Recommendations policy document (US ED, 2023) to guide implementation, ensuring that human values and ethics remain central.



Implementation Recommendations

Stage 1 - Create a Strong Foundation

Build a stakeholder group and task force to review policy, develop guidelines, and prepare a timeline for AI implementation.

- **Convene a Task Force:**

Identify individuals to carry out tasks and develop a timeline associated with AI implementation and associated professional development. Consider curriculum directors, IT directors, education technology specialists, and other LEA and site leaders.

- **Create a Stakeholder Group:**

Identify and invite stakeholders to help conceptualize GenAI within the context of LEA priorities and initiatives. Together, think through the shared values of the community to develop organizational stances on AI integration. Include all stakeholder groups in the development of guiding principles including district leaders, school staff, parents, students, community partners, tribal leaders, etc.

Topics to be explored:

> Alignment of AI to LEA mission and vision

> Stance on plagiarism/cheating with AI

> Equity, inclusion, and access for all learners

> Safe, responsible, and ethical usage by staff and students

> Applicable federal laws that protect student data

- **Review and Update Policy:**

> Review existing policy. Many of the current technology related policies cover the concerns that district leaders have about the implementation of GenAI. ASBA members should start with policy IJNDB. Trust Model Policy members should start with policy 3-403.

> Update or create new policy to mitigate risks posed by new technology. Bring policy recommended changes to association attorneys and present to the school board for changes.

- **Review Existing Guidelines:**

Instead of creating separate rules specific to AI use, start by reviewing guidelines already in place. Depending on their currency and strength, it may take only minor revisions to account for GenAI use.

> Student Code of Conduct

> Acceptable Use Policy for Technology Use

> Academic Integrity Statement

> Discipline Procedures

Refer to this readiness checklist from CGCS and COSN.

Stage 2 - Build Momentum

Expand the small group of key stakeholders from stage one to a broader audience. As you build momentum, remain rooted in your LEA's overarching vision for GenAI adoption, legal and ethical practices, and long-term aspirations for the growth and development of staff, students, families, and the community.

- **Recruit and Support Early Adopters:**
  - > Early adopters who explore and experiment with new technologies pave the way for innovation in education.
  - > Encourage early adopters to share their experiences and insights with peers to foster a collaborative learning culture within the district and scale best practices.
  - > Leverage the experiences of early adopters to identify potential challenges associated with AI implementation so that issues can be addressed early on. For example, they can serve as "white hats" specifically tasked with attempting to break, abuse, and identify vulnerabilities and security issues in all AI models considered for broader adoption.
  - > Look for the success gems of early adopters, then celebrate and share widely! Early wins can create a buzz of success that can help reduce anxiety for those who are more resistant.

Supporting early adopters with time and compensation will signal appreciation and encourage innovation.

- **Unblock AI-powered Tools:**
  - > Determine which AI tools to allow access for teacher and staff use.
  - > Determine which AI tools to allow access for student use.
  - > As GenAI tools are unblocked and permitted for use, remind staff how to protect student data when using them.
- **Build Exposure and Provide PD:**
  - > Provide ongoing professional development opportunities that expose instructional and non-instructional staff to GenAI tools and applications, alongside responsible use and ethical considerations.
  - > Share how the district mission and vision align with the implementation of AI with staff, students, and families.
  - > Work with stakeholders to help them rethink plagiarism/cheating in light of GenAI integration.
  - > Introduce common language that teachers can use to establish GenAI use. The AI Stoplight from Agua Fria USD is one example.
  - > Continue to involve families - ask for ongoing input, provide learning opportunities, and communicate regular updates.
- **Develop an AI Literacy Plan:**
  - > Involve multiple stakeholders in the development of an AI literacy plan that includes curriculum and professional development.
  - > Make clear how AI literacy and integration support students to develop skills included Arizona's Academic Standards.
- **Initiate Cross-Sector Conversations:**
  - > Engage non-classroom staff (e.g., HR, finance, transportation, facilities) in conversations about how AI may support their department's operations.

Stage 3 - Continuous Improvement

Human Oversight: Dedicated continuous improvement efforts show human oversight in action.

Continuous Improvement is crucial for any design or implementation project. While all technology evolves quickly, GenAI seems to be growing daily. This means that it will be impossible for any plan to remain accurate for long. Focus on feedback and goal-setting, understanding that doing so will help bring clarity to the task force. As staff becomes more AI literate, you will be able to further leverage the power of AI to meet broader district goals.

- **Regular Monitoring:**
  - > Continuously monitor emerging technologies and adjust policies, practices, and procedures as necessary. Stay vigilant for transformative changes to teaching and learning methodologies and congruence with system values.
- **Continual Professional Development:**
  - > Provide ongoing professional development for GenAI implementation inside and outside of the classroom that integrates the technology with pedagogy, content, and ethical use.
  - > Create and monitor a plan to develop AI literacy in age-appropriate and safe ways.
- **Ethics and Bias Evaluation:**
  - > Continuously delve into ethics and bias conversations among leadership teams.
  - > Engage teachers and staff in continuous learning, enabling them to apply AI ethics to their implementation and teaching.
- **Context-Specific Evaluation:**
  - > Develop an evaluation process to determine whether AI implementation is meeting your LEA-specific goals.
  - > Develop measurements to gauge how well the plan addresses AI literacy goals.
- **Revision and Adaptation:**
  - > Continuously review outcomes of implemented strategies, solicit feedback from stakeholders, and analyze data to identify areas for improvement.

Conclusion and Next Steps

We have already glimpsed the potential of GenAI to change education, the workforce, and the way we "do life". Fellow educators, we are called to recognize these shifting sands and adapt to an ever-evolving digital world powered by Artificial Intelligence. This includes preparing students for a future increasingly powered by AI.

The Arizona Institute for Education and the Economy and the Core AI Guidance Team see the incredible opportunity we have to grab hold of emerging technologies and use them to improve education and make the world a better, more equitable place. We hope our guidance can be a useful tool for all LEAs who are ready to embark on this exciting journey.

Consider the following to guide your next steps:

Starting with zero AI momentum in your district and no idea where to start, but feel like you should do something?

Find a partner, someone to begin crafting a plan with. Share this Guidance document with them, and once you have your head around it, focus on the Implementation section. Call a needs meeting and set a vision that is aligned with your LEA's strategic plan.

Are you the only one around who thinks you need an AI Strategic plan? How do you win friends and influence people?

First, know that you AREN'T the only one around. Look for your early adopters. You DO have staff members or community members with thoughts. Call them together for a facilitated conversation about the direction of AI implementation and create your task force from that group, having already conducted your first needs assessment.

Already have an AI implementation plan?

Use this document to audit what you have done and what you are planning. Engage with other groups in the state to share resources and improve each other.

Additional Resources

General Resources and Research

- aiEDU
- ISTE: Artificial Intelligence in Education Resource Collection
- Learn 21: Generative AI Annotated Bibliography and AI Video Series
- Microsoft: Education AI Toolkit and AI in Education Research
- Teach AI
- European Commision: Ethical Guidelines on the Use of Artifical Intelligence (AI) and Data in Teaching and Learning for Educators
- US Department of Education Office of Educational Technology: Artificial Intelligence and the Future of Teaching and Learning

Technology Bias, Ethics, and Justice

- Kapor Foundation: Responsible AI and Tech Justice: A Guide for K-12 Education

Data Privacy

- Future of Privacy Forum: Student Privacy Compass
- Consortium for School Networking (CoSN): Student Data Privacy Toolkit
- Access for Learning (A4L): Arizona Student Privacy Alliance (AZSPA).

Academic Integrity

- Matt Miller, Ditch that Textbook: AI in the Classroom: What's Cheating and What's OK?
- Sarah Elaine Eaton, PhD: 6 Tenets of Postplagiarism: Writing in the Age of Artificial Intelligence
- Leon Furze: The AI Assessment Scale: Update and Pilot Study

AI Literacy Lessons

- aiEDU: Teach AI Classroom Curricula
- Code.org: AI Curricula
- Common Sense Media: AI Literacy Lesson for Grades 6-12
- MIT: Day of AI Curriclum
- MIT: An Ethics of Aritifical Intelligence Currriculum for Middle School Students
- Stanford Graduate School of Education: CRAFT AI Literacy Resources

AI Leadership and Implementation:

- ILO Group: Framework for Implementing Artificial Intelligence (AI) in K-12 Education
- Teach AI: Guidance for Schools Toolkit
- Common Sense: AI and Our Kids: Common Sense Consdierations and Guidance for Parents, Educators, and Policymakers

Professional Development:

- Google: Grow with Google Generative AI for Teachers
- Code.org: AI 101 for Teachers
- AI For Education: An Essential Guide to AI for Educators

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OREGON
DEPARTMENT OF
EDUCATION

GENERATIVE ARTIFICIAL INTELLIGENCE (AI) IN K–12 CLASSROOMS

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WHAT IS GENERATIVE ARTIFICIAL INTELLIGENCE (AI)?

Broadly speaking, artificial intelligence (AI) is defined as "the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable."[1] Many types of artificial intelligence have been defined, which have led to a large number of applications of AI including self-driving vehicles, automatic language translation, facial recognition, virtual assistants (like Siri or Alexa), recommendation systems used in streaming platforms like Netflix, and of course chatbots like ChatGPT and Bard.

While AI includes a wide variety of applications and tools used in education and other fields, this document focuses on AI applications that are generative in nature - referred to herein as "generative AI." This includes programs like ChatGPT, Bard, and other chatbots that use AI and natural language processing (NLP) to provide human-like responses to questions.

The field of AI encompasses far more than just generative AI. However, given the rapid emergence of chatbots like ChatGPT and Bard in the field of education, this resource focuses solely on this application of AI.[2] It is important to acknowledge that AI is growing at a rapid pace and additional platforms and resources will continue to be developed.

1 McCarthy, J. (2004). What is artificial intelligence? Retrieved from: https://www-formal.stanford.edu/jmc/whatisai.pdf

2 Additional types of artificial intelligence include: Reactive Machines, Limited Memory, Theory of Mind, Self-aware, Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Superintelligence (ASI). You can read more about these types in the Forbes article "7 Types Of Artificial Intelligence"

When considering these foundational AI technologies that make tools like ChatGPT and Bard possible, it is important to keep the following in mind:

- These tools are designed to act like or simulate what most would consider intelligent behavior, such as responding to questions in a human-like manner. They are not artificial brains or sentient life forms with human characteristics like free will, self-awareness, and emotions.
- These tools are trained on vast amounts of data, much of which comes from the Internet. As such they are subject to biases and inaccuracies that are inherent in the information found on the Internet. Caution must be exercised when considering a response from a generative AI system.

KEY TERMINOLOGY

Generative AI: Generative AI systems fall under the broad category of machine learning with GPT being one example.

GPT: Generative Pre-trained Transformers are an example of generative AI. GPT models are trained using large data sets to generate text. Examples of GPT AI include: Bard, ChatGPT, and Microsoft's Digital Assistant Co-Pilot.

Large Language Model AI: Large Language Model AI: This model is trained using an extensive amount of data in order to produce human-like responses.[3]

It is also important to note that various forms of AI have been integrated into classrooms and our everyday lives for decades. For example, instructional resources and assessments that use algorithmic or adaptive learning, automatic translation tools such as Google translate or Babelfish (which was an early translation tool), and programs such as Grammarly that support writing are all examples of AI. The Office of Educational Technology published a report titled "Artificial Intelligence and the Future of Teaching and Learning" that provides additional examples regarding the history of AI and the importance of proactively addressing the growth of AI in our schools and classrooms. Importantly, this report puts an emphasis on developing people rather than machine-centered policies by keeping humans in the loop when using AI. They use the following metaphor to describe its use noting that "teachers, learners, and others need to retain their agency to decide what patterns mean and to choose courses of action."

We envision a technology-enhanced future more like an electric bike and less like robot vacuums. On an electric bike, the human is fully aware and fully in control, but their burden is less, and their effort is multiplied by a complementary technological enhancement. Robot vacuums do their job, freeing the human from involvement or oversight.

This resource developed by ODE as well as any future resources align with this metaphor in that whenever using AI (or any educational technology in the classroom) it is essential that educators are the decision makers and their knowledge and expertise is central.

3 An Introduction to Large Language Models. Retrieved from: https://www.analyticsvidhya.com/blog/2023/03/an-introduction-to-large-language-models-llms/

WHY TALK ABOUT AI NOW?

The use of AI in education, while not a new phenomenon, has gained traction recently given the introduction of generative AI that uses large language models such as ChatGPT, Bard, and Co-Pilot. Such models have the potential to transform the way that technology is used by educators, students, and families alike. Given this influx, it is vital that schools and districts plan proactively in developing policies related to the use of AI in classrooms so as to ensure that policies are clear, attentive to the current moment, mindful of student data privacy and equity centered.

Whenever new technologies are introduced, there is a potential for both innovation and risks when considering the impact on instructional practices and student learning experiences and outcomes. Generative AI are just the newest examples of these emerging technologies, with previous generations experiencing advances in technology such as the internet, graphing calculators, smart phones, etc. While generative AI has the potential to support access to learning in classrooms for all students, these technologies can exacerbate inequities for students from marginalized student groups in the absence of thoughtful policy, practice, and educator support and training.

Given the influx of AI in education, several organizations have come together to provide guidance on the use of AI in education in addition to resources for teaching about AI. Examples include:

- The CRAFT (Classroom-Ready Resources About AI For Teaching Project), developed by Stanford University's Graduate School of Education has resources to support high school teachers in supporting students' AI literacy.
- Teach AI, a partnership between major education organizations, including Code.Org, ISTE, the World Economic Forum, National Association of State Boards of Education, National School Boards Association, Educational Testing Service, Khan Academy, and ISTE was developed in an effort to to provide guidance to policy-makers and educational leaders around AI in education.
- The Hands-On AI Projects for the Classroom from ISTE and GM has developed guides for elementary and secondary teachers to support student-driven learning related to AI and its impacts on society.

WHAT ARE THE EQUITY IMPLICATIONS OF GENERATIVE AI IN K–12 CLASSROOMS?

When developing policy around the use of generative AI in K-12 classrooms, it is important to take into consideration the fact that generative AI is a component of a larger digital learning ecosystem. While digital learning and education technology has the potential to address inequities when implemented with an equity focus and mindset, in the absence of this intention, digital learning and education technology can also exacerbate existing inequities and make schooling more difficult for those who are already marginalized within the system.

Equity implications to keep front and center when designing policy specific to generative AI in K-12 classrooms includes bias, innaccuracy, plagiarism, copyright/licensing unknowns, and equity of access. Table 1 provides examples of strategies to address these equity implications.

- **Bias:** As generative AI uses algorithms created by human designers, there is a strong potential for the introduction of bias into the system. Some examples include privileging certain language variations, showing racial and gender biases, having a United States-centric lens, and providing only a limited perspective. As generative AI uses large data sets, historical and systemic biases are introduced into the system. Further, as generative AI lacks cultural knowledge and experience, this can lead to misinterpretations of prompts given and answers that privilege a certain cultural perspective.
- **Inaccuracy:** As generative AI draws from large data sets, it is not guaranteed to be accurate as not all information on the internet is accurate. AI is only as good as the data that is fed into the machine learning algorithms. Additionally, generative AI is not necessarily coded to provide accurate information, rather it simply predicts the type of information needed to best fit a given Prompt. For example, when asking ChatGPT for sources to support information provided, there are times in which the sources are fabricated. This is known as "AI hallucinations."[4]
- **Plagiarism:** A common concern from educators is that generative AI and other AI technologies will be used by students to write essays and complete assignments. As generative AI does provide written responses to prompts, this concern has led a number of districts across the nation toward banning the platform due to a concern for cheating and plagiarism.
- **Copyright/ Licensing Unknowns:** Understanding copyright laws is an important element of using generative AI and other AI technology in the classroom, in that as this is new technology, there are not clear boundaries regarding who owns the content generated by AI. As companies continue to develop licenses on their products, it is important for educators to reflect on the implications of copyright/licensing unknowns.
- **Equity of Access:** Access to generative AI and lack thereof can have broad and deep equity impacts on students – both while in K-12 education and for college and career readiness.

Given the inherent equity impacts of introducing generative AI into the digital learning ecosystem, educating students, families, and educators (including paraeducators, secretaries, support staff, etc.) on these equity implications can help to move toward using generative AI in ways that are culturally responsive and sustaining for students, families, and communities. Additionally, when developing policy, it is important that creating and cultivating a digital learning ecosystem wherein equity is at the heart of the decision making process is key to ensuring that the learning experiences that students engage in honor their sociocultural identity and lived experience.

4 Shripad Shenwai, D. (2023). What is AI Hallucination? What Goes Wrong with AI Chatbots? How to Spot a Hallucinating Artificial Intelligence? Retrieved from: https://www.marktechpost.com/2023/04/02/what-is-ai-hallucination-what-goes-wrong-with-ai-chatbots-how-to-spot-a-hallucinating-artificial-intelligence/

TABLE 1. POTENTIAL STRATEGIES TO ADDRESS EQUITY IMPACTS OF THE USE OF GENERATIVE AI IN K–12 CLASSROOMS

Equity Impact	Strategies to Address Equity Impact
Bias	▪ Ensure that all educators are trained to understand the potential for bias in AI. This can include training modules, PLC focused topics, book studies, etc. ▪ Talk with students about the potential biases of AI in addition to teaching strong research and digital literacy skills to ensure that if generative AI is used, it is done so with an understanding that it is a first step rather than a final step with the most importance being placed on the human user in verifying the information presented. ▪ Provide resources for families so that they understand the potential bias within ChatGPT and other AI technologies. Common Sense Media has a Guide to ChatGPT for Parents and Caregivers that is a great place to start.
Inaccuracy	▪ Provide training to educators, students, and families (e.g. digital literacy) to support in deepening skills in lateral reading and fact checking for misinformation, disinformation, and malinformation within generative AI responses. ▪ If using generative AI in the classroom, ask students to find other sources that support the information provided by generative AI in order to check for accuracy. Consider using resources such as Stanford History Education's Civic Online Reasoning curriculum, National Council for Social Studies (NCSS) Evaluating Sources and Using Evidence resources, and books such as *Developing Digital Detectives: Essential Lessons for Discerning Fact from Fiction in the Fake News Era* by Jennifer LaGarde and Darren Hudgins.
Plagiarism[5]	▪ Rethink assignments and be clear on what standards/skills are being addressed. ▪ Create more opportunities for students to problem solve, analyze and synthesize and share their thinking in classroom settings. ▪ Embed formative assessment throughout in order to get a deeper sense of students' writing over time. ▪ Train educators to detect the presence of AI written communication such as repetitive sentences, overly complicated vocabulary, and predictable writing structure. ▪ Consider using AI detectors – with an understanding that these detectors often incorrectly detect the use of AI particularly when students use formal academic language. There are several resources that educators can use to determine whether or not students are using generative AI including Turnitin AI detector and GPT Zero. Both of these programs have mixed results with regards to detecting AI. However, as the AI technology continues to progress, so too will these evaluation resources. ▪ Develop strong policies that include when and how generative AI can be used in the classroom. Be sure to discuss the potential risks of using AI with students (e.g. inaccurate information, bias, etc.) and provide students with digital literacy and citizenship so that they understand these risks. ▪ Support students in sharing their writing process e.g. discussing how and where they got their information and their strategy for integrating it into their drafts. Creating discussion opportunities in addition to having students turn in drafts of their writing along the way in order to show that the process is equally as valuable as the product can be helpful in creating strong writers and researchers. ▪ Consider how to teach and support students in developing digital and information literacy skills. For example, the International Baccalaureate (IB) has determined that rather than banning software, they will support schools in using software to "...support their students on how to use these tools ethically in line with our principles of academic integrity.[6]"

5 Recently, AI art tools that plagiarize artists' original works and styles have become mainstream. Both of these examples create an opportunity to teach students digital literacy skills in association with the use of ChatGPT and other AI technologies in ensuring that they are correctly citing their sources and using lateral reading skills to ensure that information learned from AI is accurate.

6 You can read more about both IB and AP's approach in the article: Statement from the IB about ChatGPT and artificial intelligence in assessment and education

Equity Impact	Strategies to Address Equity Impact
Copyright/ Licensing Unknowns	▪ Review licensing types on Creative Commons and discuss copyright and licensing information with staff. ▪ Review the Copyright Office's New Artificial Intelligence Initiative - while not specific to education, as educators often use, curate, and share instructional materials through digital means, understanding copyright laws and how they impact the use of information developed through AI will be important.
Equity of Access	▪ Consider the equity impacts of certain students having access and others not having access in addition to not all educators having the training needed to support students in the use of this technology – for example, generative AI can be particularly impactful for students with disabilities and multilingual learners and not using them has the potential to limit students' access to learning opportunities (see below for information regarding the use of ChatGPT and UDL - Universal Design for Learning). ▪ Talk to students, educators, families, community members, and industry professionals to better understand the potential uses of generative AI and how generative AI might be used as a skill set for future employment. ▪ Be attentive to the cost of the platforms such as ChatGPT. While platforms such as ChatGPT are currently available at no cost, this might not be the case in the future as it is not uncommon for technology companies to create a paywall after initial success and website traffic. This has the potential to create equity implications for students and families who are unable to afford the associated cost of the platform.[7][8]

HOW DO STUDENT DATA PRIVACY POLICIES IMPACT THE USE OF AI IN K–12 CLASSROOMS?

There are several federal and state policies associated with student data privacy that are important to be aware of when setting policy for the use of AI technologies in schools including Family Educational Rights & Privacy Act (FERPA), the Children's Internet Privacy Act (CIPA), the Children's Online Privacy and Protection Act (COPPA) and the Oregon Student Information Protection Act (OSIPA). COPPA, in particular, impacts technology users under the age of 13 in that companies are not allowed to collect personal information from children under the age of 13 without parental consent, while OSIPA lays out certain requirements that must be met when using digital platforms of any kind including the following:

- Disclosing any covered information provided by the operator to subsequent third parties, except in furtherance of kindergarten through grade 12 school purposes of the site.
- Engaging in targeted advertising on the operator's site, service or application.
- Selling a student's information, including covered information.

PERSONAL INFORMATION AND GENERATIVE AI

Users should be cautious when entering personal information into any technology application. This is a particularly important consideration when using generative AI applications such as ChatGPT as the information entered by users (including prompts and questions posed) is stored on the application's server and integrated into the large language model used to respond to user prompts.

7 Byrd, C. (2023). WRITE Center Helps Teachers Grapple with ChatGPT and Future of Writing Instruction. Retrieved from: https://education.uci.edu/chatgpt.html

8 Note that the most powerful version of ChatGPT (v4) does require a paid monthly subscription.

When developing district policies, it is essential to ensure that they are not in violation of COPPA or OSIPA. All schools and districts engaging with AI technologies (or any technology broadly) should regularly review the company's usage and privacy policies to ensure that they are not in violation of COPPA or OSIPA.

RECOMMENDATIONS AND RESOURCES FOR STUDENT DATA PRIVACY IMPLICATIONS

Whenever new technology is introduced, reviewing the data use and privacy policies are of key importance. For example, for the purposes of ChatGPT, a starting place is to read the privacy policy of OpenAI, the developer of ChatGPT. The privacy policy includes specific information related to the use of ChatGPT for children:

> *"Our Service is not directed to children who are under the age of 13. OpenAI does not knowingly collect Personal Information from children under the age of 13. If you have reason to believe that a child under the age of 13 has provided Personal Information to OpenAI through the Service please email us at legal@openai.com. We will investigate any notification and if appropriate, delete the Personal Information from our systems."*

Schools and districts are also encouraged to look over OpenAI's Educator Considerations for ChatGPT for additional information.

WHAT IS THE POTENTIAL OF GENERATIVE AI IN K–12 CLASSROOMS?[9]

Generative AI can be leveraged for use in education in a variety of ways including providing support with designing learning experiences for students, as a teaching tool, as a support for differentiation, as a "partner" in instructional support, as a virtual assistant, and as a starting point for providing student support and guidance. See Table 2 below for additional context and ideas. As this technology is expanding at rapid speed, it is likely that its uses in education will continue to expand, thus providing additional ways in which to create equitable learning opportunities for students if done so in tandem with strong and intentional policy development.

AI is part of the larger educational technology ecosystem and thus should be implemented alongside strong policy and educator training. Generative AI alone will not transform educational opportunities for students. Instead, using AI within an educational technology ecosystem that centers relationships and mental health, pedagogy and practice, and high-quality instructional materials creates opportunities for more equitable and culturally responsive learning opportunities for students – opportunities that lead to student learning and belonging.

RESOURCES TO SUPPORT THE USE OF GENERATIVE AI IN K-12 CLASSROOMS

Resources for the Educational Use of Generative AI in K-12 Classrooms: This document developed by ODE highlights potential resources for school and district leaders and educators to use to support deeper understandings of AI in schools. The document is broken down by categories so that educators can find resources that match their needs. Given that the field of AI is changing so rapidly, this document will be updated to reflect new resources that center the equitable use of AI in schools. If you have particular resources that you would like to see included on this document, please email ODE.DigitalLearning@ode.oregon.gov.

9 This list has been modified from McClennen, N. and Dené Poth , R. (2023). Education is about to radically change: AI for the masses. Retrieved from: https://www.gettingsmart.com/2022/12/16/education-is-about-to-radically-change-ai-for-the-masses/

Although generative AI is still in its infancy, educators across the world have found the use of this tool to create increased learning opportunities for their students. Some learning opportunities include:

- **Learning Design:** Generative AI can support teachers in developing lesson plans to support student learning in addition to lessening the burden of creating individualized instructional materials for students. While it is important that generative AI is seen as a starting point for this work, with the teacher being the most important part of lesson and materials development, generative AI can support teachers in the beginning stages of the development. Generative AI can support students with disabilities as it can streamline content and therefore scaffold learning materials.[10]
- **Teaching Tool:** Generative AI can be used as a teaching tool in the classroom. When teachers have explicit policies about when it is appropriate to use generative AI, and students have been taught digital literacy skills to understand how to couple the information provided by generative AI with lateral reading skills, it can serve as a teaching tool.
- **Instructional Support:** Generative AI can be used by teachers to efficiently find instructional resources on the basis of specific topic areas as well as pedagogical approaches to provide individualized instruction. This includes using a program like ChatGPT to differentiate instructional resources by student grade level.
- **Virtual Assistant:** Generative AI can serve as a virtual research assistant for educators to support everyday tasks. This use of generative AI can create additional time for teachers to spend on building relationships with their students, engaging in direct and small group instruction, and providing feedback on assignments.
- **Student Support and Guidance:** Generative AI has the potential to support students with developing research skills, learning to ask strong questions, and providing advice regarding college and career planning.
- **Future Career Options:** Generative AI and the use of AI is likely to be central to future careers - both in terms of understanding the ways in which AI functions (computer science) and using AI to communicate and engage in work functions (digital literacy). Therefore, supporting students in learning about AI and using it responsibly, ethically, and productively will support them far beyond their K-12 education.

While generative AI provides valuable educational opportunities, it is merely a starting point. Teachers are the most essential part of the teaching and learning process. Generative AI and any other AI or technology does not, and cannot, replace a teacher or a counselor. Generative AI is an emerging tool with no critical thinking abilities - it cannot discern whether the information it provides is generated in a way that is responsive to the needs and context of the students. However, it can be used as a teaching and learning tool. Therefore, when developing training to support policy related to the use of AI technologies, ensuring that teachers are trained in its uses (and limitations) as well as lifted up as the experts will be of utmost importance.

USING AI TO REACH ALL LEARNERS

With intentional use and teacher guidance, AI can also be a great aid to students receiving special education and language services. For example, AI can provide visual descriptions of objects and scenes for students with visual impairments and can help them in visualizing content. Text to speech features and speech to text features can also make accessing and contributing to classroom content more fluid and immediate. Multilingual learners can benefit through language conversations with AI in order to practice speaking and writing skills. Asking questions and receiving immediate feedback allows for language development and can introduce new words, idiomatic expressions, and varied vocabulary. Given student data privacy laws, however, it is important that districts confirm that their policy around student use of AI conforms to student data privacy rules – student privacy and safety should be emphasized first and foremost in any policy decisions.

10 AI technologies more broadly provide support for students with disabilities including: image and facial recognition for students with visual impairments, lip-reading recognition for students with a hearing impairment, text summarization and real-time captioning, and AI-powered automatic speech recognition and transcription.

TABLE 2. POTENTIAL INSTRUCTIONAL STRATEGIES FOR THE USE OF GENERATIVE AI IN K–12 CLASSROOMS

Opportunity	Example(s)
Learning Design	▪ Teachers can lean on Generative AI to develop assessment questions based on content – based on the prompt, teachers can ask for specific question types e.g. written response, multiple choice, higher order thinking, etc. ▪ Teachers can use Generative AI to support and expand their own learning about the content they are teaching. ▪ Generative AI can generate lessons, activities, and assessments that follow UDL (Universal Design for Learning) guidelines. ▪ Generative AI can provide steps in how to integrate culturally specific content into lesson planning.
Instructional Support	▪ Teachers can modify a response provided by generative AI to provide more specificity e.g. rewrite using a project-based learning activity, rewrite the lesson with a focus on vocabulary development. ▪ Teachers can provide a rubric and include student writing samples and ask generative AI to evaluate student work. ▪ Generative AI responses can be generated in a variety of languages allowing multilingual learners access to translated materials that may not be embedded within the school's instructional materials. ▪ When asking generative AI a question, the user can request the response to be provided at a particular grade level or reading level. Furthermore, the user can request that responses contain specific vocabulary and sentence complexity. ▪ Teachers can use generative AI tools to support writing instruction. For example, ChatGPT and other AI platforms can be used to develop outlines for student writing to provide scaffolds for students.
Virtual Assistant	▪ Generative AI can help with developing drafts of emails and other communications, finding supplementary content aligned with their curriculum, and searching the web for continuing education courses aligned with their interests and needs.
Student Support and Guidance	▪ Students can practice writing research questions and use generative AI responses as a determination of the strength of their questions. ▪ Students who have difficulty with writing can use generative AI to write an initial draft of an essay and use it as a "rough draft" with the next step being to revise to make it unique. ▪ Students can ask generative AI which colleges or universities offer particular programs of interest or what education or experience is required for certain career pathways. ▪ Students can use generative AI to better understand the revision process by asking ChatGPT to revise a particular section and then analyzing the methods used to accomplish the requested revision.
Future Career Options	▪ Show students examples of the ways that AI is being used in spaces outside of education e.g. the medical industry, the automobile industry, and the manufacturing industry. ▪ Consider integrating instruction about AI into the curriculum. For example, AI4All has an openly licensed curriculum "Bytes of AI" available on Oregon Open Learning that can be integrated into high school courses. ▪ Ensure that students understand how to use AI responsibly, ethically, and productively by integrating digital citizenship lessons into the curriculum. For example, Common Sense Media has openly licensed digital citizenship lessons that can provide a starting point for integration across K-12.

WHAT MIGHT DISTRICTS CONSIDER WHEN DEVELOPING POLICY RELATED TO GENERATIVE AI?

With the influx of generative AI platforms entering the education sphere, it is important that schools and districts are taking into consideration the equity impacts of such technologies alongside the potential for student learning that generative AI can have when implemented with equity at its core. What is equally important is for schools and districts to reflect on the larger digital learning ecosystem in order to ensure that generative AI platforms, if used, are done so in culturally responsive and sustaining ways and supported by strong professional development for teachers, transparent communication with families and the larger school community, and education for students. This resource is designed to support schools and districts in developing policy and protocols related to introducing generative AI into the larger digital learning ecosystem. For some schools and districts, this might require creating new policy, for others this might require shifting current policy, and for others it might look like developing protocols for use as aligned with current technology policy and cyber plans.

STARTING POINTS FOR REFLECTION AND DEVELOPMENT OF POLICIES AND PROTOCOLS

As schools and districts begin or continue discussions related to policy development around the use of AI technologies in classrooms, it is important to acknowledge the prevalence of AI being used outside of the education system. For example, computer programmers are already using it to write code, Human Resources departments are using it to write job descriptions, companies like Microsoft and Salesforce are using it to write emails and perform administrative tasks, and the use of AI is continuing to change the medical field. Additionally, there are examples of AI technologies being used for language revitalization within Indigenous communities.[11] Therefore, while there are concerns to be aware of with regard to the use of AI within school it will be a tool that many will use throughout their lives.

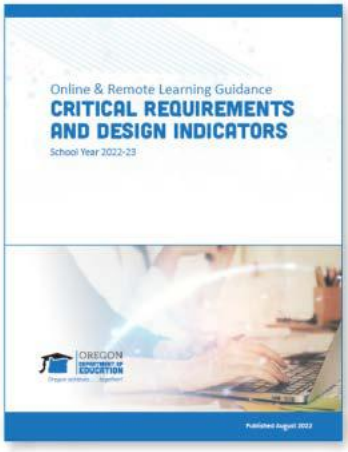
RESOURCES TO SUPPORT THE DEVELOPMENT OF POLICIES AND PROTOCOLS FOR THE USE OF GENERATIVE AI IN K-12 CLASSROOMS

Developing Policy and Protocols for the use of Generative AI in K-12 Classrooms: This document serves as a resource for school and district leaders when considering the use of AI in schools. The document highlights policies from across Oregon, the nation, and internationally and provides an AI Policy and Protocol Development Planning and Reflection Tool.

11 How AI is helping revitalise indigenous languages. Retrieved from: https://www.itu.int/hub/2022/08/ai-indigenous-languages-maori-te-reo/

Additional guidance developed by ODE speaks specifically about equity within educational technology and can be referenced as districts and schools navigate AI and its role in education including The Key Components of Digital Learning and Online and Remote Learning Guidance.

The Key Components of Digital Learning provides a starting point for design, dialogue, and implementation of equity-centered technology integration by offering five Key Components including: relationships and mental health, pedagogy and practice, high-quality instructional materials, digital learning capacity and readiness, and funding for digital learning.



The Online and Remote Learning Guidance: Critical Requirements and Design Indicators provides three pillars for online and remote schools and programs to consider within their design process: lead and design for equity, creating relational conditions for learning, and plan and implement inclusive instruction. While this guidance is designed for online and remote schools and programs, the pillars can provide a starting point for all schools in developing policy related to educational technology.

For more information, please contact ODE's Digital Learning Team at ode.onlineremotelearning@ode.oregon.gov.

Educators' Perspectives on Generative AI in K-12:
Informing AI in Education Guidance

May 2024

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Overview

The rapid development of generative AI is transforming the educational landscape (Mintz et al., 2023; Ottenbreit-Leftwich et al., 2023; Zafari et al., 2022). Educators from the classroom to the district office are confronted with new challenges and uncertainties regarding safe, equitable, and effective implementation (Fullan et al., 2023). This study explored education leaders' perceptions and experiences with AI integration in K-12 education through interview and focus group data collection during the Friday Institute's AI in K-12 Education Convening. At the culmination of the 2023-24 school year, the study's findings are compared against guidance for AI in K-12 education published by 12 state education agencies.

Background

As educators navigate a constantly evolving and often confusing landscape regarding the impact of generative AI on K-12 education, limited studies on educators' perceptions of generative AI reveal concerns about equity, impact on curricula, teacher workloads, student privacy, and funding (Fullan et al., 2023; Miao et al., 2021). Kaplan-Rakowski et al. (2023) found that educators generally view AI positively for its potential to reduce workloads, deepen student learning, and foster meaningful human connection in the classroom. However, education leaders face challenges in effectively leading and ensuring ethical and meaningful integration of AI into K-12 classrooms (Fullan et al. 2023).

In Fall 2023, the William and Ida Friday Institute for Educational Innovation, a part of the College of Education at North Carolina State University hosted an event tailored for district and state leaders in partnership with SparkNC, the EngageAI Institute, and the Consortium for School Networking (COSN). During the event, participants discussed the landscape of AI in K-12 education, integrating AI in schools and classrooms, and further recommendations for safe and responsible AI in K-12 learning environments. Activities and interviews were developed to explore the research questions identified in this research study.

Research Questions

The following research questions guided the study:

1. What perceptions do education leaders hold about how AI impacts teachers and classroom instruction?
2. What perceptions do education leaders hold about how AI impacts students and learning?
3. Where do education leaders identify AI as potentially integrating within existing systems of practice?;
4. What do education leaders identify as potential needs for new systems of practice leading to AI integration?; and
5. What systems have education leaders implemented to evaluate the impact of AI on K-12 instruction and learning?

Methods

The study used qualitative data collection and analysis methods, including deductive content analysis. Education leaders' perceptions and expectations of AI in K-12 education surfaced through the data analysis process. A convenient sample of participants consisted of approximately 40 education leaders (from state and district levels) and education researchers (from higher education and national non-profits) who participated in semi-structured interviews and focus groups during an AI in K-12 Education Convening. This event was held at the Friday Institute for Educational Innovation at North Carolina State University in Raleigh, NC. Participants were invited to attend; however, only those who consented to participate in this study were included in data collection. The interview and focus group data were transcribed and coded using an a priori coding scheme, with additional codes emerging during the content analysis process (Cho & Lee, 2014; Kyngäs, 2020).

Study Findings

Deductive content analysis using the a priori coding scheme mentioned revealed five themes related to education leaders' perceptions of AI integration into K-12 environments.

AI has the potential to transform teacher work

Participants were optimistic about the potential positive impact of generative AI for teachers. Education leaders shared that AI could help lighten teacher loads by helping them save time. For example, they shared that generative AI tools could be used as a resource in preparing lesson plans or other materials, allowing teachers to focus on

connecting with students and supporting them in the process of learning. One education leader shared:

> There are very few things that I've come across in my career that actually give time back to teachers and staff, and this is one of those things. This can cut out those mundane, repetitive tasks and allow teachers the ability to really sit with students one-on-one to really invest in the human relationships that can never be replaced with technology. (director of digital learning)

AI has the potential to transform learning

Education leaders were similarly optimistic about the potential for AI to transform learning, allowing students and teachers to focus more on the learning process as opposed to the product. Participants felt that generative AI integration could facilitate deeper learning, the use of higher-order thinking, and support teachers in scaffolding student learning. One veteran educator shared, "It pushes my students beyond sort of simple recall to applying knowledge in a way that really matters." Another participant expanded:

> I think [generative AI] has the potential to advance the kinds of questions that we are giving our students. [For example], if I know that AI can produce an essay around this, I might move away from asking my kids to write essays and they start creating products. (high school teacher)

AI needs to address issues of ethics, equity, bias, and keeping the educator-in-the-loop

Participants shared their concerns about ethics, equitable access, potential bias, and the necessity for human oversight. However, they also shared their optimism about generative AI's potential to enhance equity through thoughtful and purposeful development of policies around AI integration in K-12.

A veteran educator shared, "AI has the potential to advance equity in ways that we haven't been able to up to now." She expressed her concern that decision makers, including legislators, should establish policies and legislation that would foster equity in rural and low-income schools by ensuring access to the internet, which would also allow for AI integration.

Other participants spoke about their worries that bias has been and continues to be introduced into generative AI models because of how they are trained:

> Bias is the other thing that we have to be really careful about…whose voice is represented and whose voice is not represented. (director of curriculum and instruction)

Education leaders also identified the need for humans-in-the-loop when integrating AI into schools:

> We want to make sure that what AI does is help students learn safely…we also want to make sure that when decisions are being made, they are primarily [made by] a human. (director of an education non-profit)

AI POLICIES AND PRACTICES NEED FURTHER ARTICULATION

Education leaders held divergent views about how education policies should be enacted to promote ethical and effective AI integration. They also held differing views on whether existing systems of practice were sufficient to meet the needs of K-12 schools or whether new systems of practice should be developed and by whom. For example, one educator shared that policies should be decided at the district level, "I think the districts have to... translate what all of these support systems have - the state and outside organizations - and then translate that to their local context." Meanwhile, another participant expressed a different perspective, "What if at the beginning of the school year, each class sits down and comes up with the constitution, guardrails, collective commitments?"

AI NEEDS SYSTEMS FOR EVALUATING IMPLEMENTATION AND IMPACT

Education leaders emphasized the need for policies that promote equitable and safe integration of AI into K-12. However, participants did not appear to have specific ideas of what effective AI implementation means or how it would be implemented. In addition, they did not appear to have systems in place to evaluate effective classroom integration of generative AI. Only one participant mentioned evaluating effective AI integration.

> Is [AI] really helping you? And if it's not helping you…do we need to change the model of instruction at that point? (educator focus group)

Implications for AI in Education Guidance

The study's findings inform how education leaders perceived the potential benefits and challenges of AI integration into schools. Although the emergent themes are not generalizable to a larger population, they highlight some of the perceptions held by education leaders. Compared against state-issued guidance published by education agencies across the country during the 2023-24 school year, much of the same themes are evident. As states look to update their guidance, additional states publish new guidance, or districts and schools develop their guidance, the findings and following examples may be helpful to inform their work.

This section spotlights guidance from the following sources:

Arizona	North Carolina	Oregon
California	Mississippi	Virginia
Indiana	Ohio	Washington
Kentucky	Oklahoma	West Virginia

AI has the potential to transform teacher work

All state guidance documents published in 2023-24 identify avenues for how AI in education settings can change how educators work--both administratively and instructionally.

The Oklahoma State Department of Education's Guidance and Considerations for Using Artificial Intelligence in Oklahoma K-12 Schools explains:

> Providing teachers with comprehensive training on AI tools can equip them with the knowledge and skills necessary to integrate these technologies seamlessly into their classrooms and administrative tasks. This strategic approach fosters a more efficient and innovative learning environment for all. Educators who are proficient in using AI tools can deliver personalized instruction, tailoring their approach to meet each student's unique learning needs. As a result, educational outcomes could improve significantly. Moreover, leveraging AI for administrative tasks reduces the time spent on routine activities, allowing teachers to focus more on direct student interaction and curriculum development.

The North Carolina Department of Public Instruction's Generative AI Implementation Recommendations and Considerations for PK-13 Public Schools identifies that AI "can help reduce the burden of teaching as well as improve educators' ability to personalize learning for their students, thus improving teaching and learning" and provides various examples of "Teacher Use Cases of Generative AI" and "AI Resistant, AI Assisted, & AI Partnered Assignments."

AI has the potential to transform learning

Similarly, all state guidance published has recognized the impact that AI in education can have on student learning, especially when AI literacy is effectively integrated into the curriculum.

The Arizona Institute for Education and the Economy's AI Guidance for Arizona Schools "encourage[s] all LEAs to create an AI Literacy plan that includes curriculum and professional development" and offers a table showing key alignments between AI literacy and the Arizona academic standards. North Carolina Department of Public Instruction's guidance provides AI Literacy Recommendations by Grade Span for elementary, middle, and high school.

The Kentucky Department of Education's Artificial Intelligence Guidance Brief outlines three paradigms for student engagement with AI in education:

> The three current paradigms of AI in K-12 education18 are: AI-directed (where the learner is a recipient); AI-supported (where the learner is a collaborator); AI-empowered (where the learner is a leader).

While most state guidance discusses teaching students with AI, the West Virginia Department of Education's Guidance, Considerations, and Intentions for the Use of Artificial Intelligence in West Virginia Schools explores teaching students about AI through computer science, AI literacy, computational thinking, and equipping future ready students.

AI needs to address issues of ethics, equity, bias, and keeping the educator-in-the-loop

As the Oklahoma State Department of Education states: "All use of AI should begin and end with a human-centered approach." Each guidance document discusses the necessity for augmenting the teaching and learning experience with AI while keeping the human (student and teacher) in the loop.

The California Department of Education's guidance Artificial Intelligence in California: Learning with AI, Learning About AI emphasizes the need for addressing bias, diversity and representation in AI integration:

> Developing artificial intelligence (AI) in K-12 schools, which may occur through computer science pathways, may act as a powerful means to address systemic bias and expand access for traditionally marginalized groups in computer science, technology, and STEM (science, technology, engineering, mathematics) fields. By integrating AI education with a focus on diversity and inclusion, we can pave the way for a more equitable future in these disciplines. A lack of diversity and representation in computer science, technology, and STEM fields has long been a concern.

Oregon Department of Education's Generative Artificial (AI) in K-12 Classrooms centers its exploration around equity in the learning environment, including a table with strategies to address the identified equity impact of bias, inaccuracy, plagiarism, copyright/licensing unknowns, and access.

> …When developing policy, it is important that creating and cultivating a digital learning ecosystem wherein equity is at the heart of the decision making process is key to ensuring that the learning experiences that students engage in honor their sociocultural identity and lived experience.

AI policies and practices need further articulation

Most of the published guidance from state education agencies indicate the need for districts to develop their own guidance, policies and practices for AI in education. Like many states, the Washington Office of Superintendent of Public Instruction's Human-Centered AI: Guidance for K-12 Public Schools recommends that districts build human-centered AI policies and update their existing policies.

The Mississippi Department of Education's Artificial Intelligence: Guidance for K-12 Classrooms explains that "unregulated access makes the banning of AI tools impractical and does not provide a solution to security and appropriate use concerns. In fact, districts can create a more significant risk by doing nothing to address AI use or train stakeholders in its proper application." Policies for integration of AI in K-12 classrooms should include evaluation of AI tools, adherence to security guidelines, promotion of benefits and mitigation of risks, monitor of AI use, detection of plagiarism, expansion of digital citizenship instruction, and gathering feedback.

InnovateOhio's AI Toolkit: Guidance and Resources to Advance AI Readiness in Ohio's Schools provides the most comprehensive support for policy development around AI in education. Their step-by-step approach encourages educators to take stock of the landscape, Identify high-level values and goals, derive principles from values, derive policies from principles, and put policies into practice. It offers two types of guidance:

> (1) Guidance on a sound, transparent, and practical method for translating high-level aspirational goals into actionable AI-focused policies and (2) Guidance on the resources available to stakeholders (superintendents, principals, teachers, parents, and the citizens of Ohio generally) as they seek to implement that method on the way to concrete policies and practices that ensure the safe, effective, and responsible integration of AI in Ohio's schools.

AI needs systems for evaluating implementation and impact

While most states provide guidance around integration and implementation of AI, few states have developed recommendations for evaluation systems to determine the effectiveness of AI in K-12 education. As part of their implementation recommendations, Arizona Institute for Education and the Economy's AI Guidance for Arizona Schools identifies components for continuous improvement: regular monitoring, continual professional development, ethics and bias evaluation, context-specific evaluation, revision and adaptation.

Based on the lack of state-level guidance around evaluation and impact, further study and framework development is necessary to help states and districts understand and measure the impact of AI in K-12 education.

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Integrating generative artificial intelligence in K–12 education: Examining teachers' preparedness, practices, and barriers

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Integrating generative artificial intelligence in K-12 education: Examining teachers' preparedness, practices, and barriers

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ABSTRACT

Despite the growing body of research on developing K-12 teachers' generative AI (GenAI) knowledge and skills, its integration into daily teaching practices remains underexplored. Using a snowball sampling method, this study examined the preparedness, practices, and barriers encountered by 89 U.S. teachers in the state of Idaho. Participants were predominantly White, female teachers serving in rural schools. A mixed-methods analysis of survey responses revealed that teachers were generally underprepared for integrating GenAI, with fewer than half incorporating it into their educational practices. Unlike the widespread classroom integration patterns observed with general educational technologies, teachers in this study tended to use GenAI for out-of-classroom duties (i.e., lesson preparation, assessment, and administrative tasks) rather than for real-time teaching and learning. These preferences could be attributed to key barriers teachers faced, including doubts about GenAI's ability to manage risks (i.e., technology value beliefs), reduced human interaction in instruction (i.e., pedagogical beliefs), ethical considerations, and the absence of policies and guidance. This study highlights the need to develop support systems and targeted policies to facilitate teachers' GenAI integration, offering implications for Idaho's education system and the broader U.S. context.

1. Introduction

In recent decades, the growing prevalence of mobile devices, the Internet, and emerging technologies such as augmented reality and digital makerspaces have been adopted to improve the quality of education, making it more effective, meaningful, and scalable. However, researchers have observed a recurrent pattern in the expectations and outcomes: when a new digital innovation enters the educational realm, initially, it draws overwhelming interest and enthusiasm about its potential to transform instructional practices (Cuban, 1986; Reiser, 2001). Yet, the positive effects of digital innovations on student outcomes are often less than anticipated. A meta-analysis examining the effectiveness of educational technologies for enhancing mathematics achievement in K-12 classrooms revealed that the use of technology generally produced positive but modest effects on learning outcomes (effect size = +0.15) compared to traditional teaching methods (Cheung & Slavin, 2013). A more recent review of 126 rigorous studies on technology-based education interventions showed mixed results (J-PAL Evidence Review, 2019). Specifically, initiatives that merely expand access to computers and the Internet have generally not improved students' grades and test scores, but those utilizing educational software for personalized learning significantly enhance outcomes. These findings imply that *how* technology is used could be more influential than *what* technology is used, underscoring the crucial role teachers play for integrating technology into education (Crawford et al., 2023; OECD, 2015).

Our study situates the above argument within the context of generative artificial intelligence (GenAI), a subset of AI that utilizes deep learning techniques to identify patterns in massive data; this enables it to generate new or novel outputs in the form of text, images, audios, or videos based on the prompts it receives (Chan & Colloton, 2024; IBM, 2024). For instance, large language models, a type of generative AI, produce human-like text based on patterns learned from their training data. GenAI has captivated society's attention since the launch of ChatGPT in 2022. Unlike earlier AI models operated using computational language, GenAI applications (e.g., ChatGPT, Gemini, DALL-E) enable seamless communication in human languages (i.e., *social* nature) and can handle cognitive tasks that have traditionally depended on human intelligence (i.e., *generative* attribute), such as content generation, writing assistance, multimedia creation, and problem-solving (Mishra et al., 2023). Leveraging its powerful capabilities, GenAI is

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poised to significantly transform the landscape of teaching and learning. For instance, GenAI can improve educational effectiveness and efficiency by tailoring educational experiences to individual needs (Ji et al., 2022), assisting teachers in content creation (Dijkstra et al., 2022), promoting higher-order and critical thinking (Abdelghani et al., 2024), and utilizing large datasets for system improvements (Tsai et al., 2020). However, challenges such as monitoring biases in GenAI systems, ensuring its ethical use, and avoiding overreliance on it are also ever present (Celik et al., 2022; Lambert & Stevens, 2023; Pham & Sampson, 2022).

Considering both the powerful capabilities and potential risks of GenAI, the U.S. Department of Education (2023) has advocated the concept of "keeping humans in the loop." This emphasizes the importance of teachers' proactive involvement in utilizing and managing the use of GenAI in education, including providing feedback on its design and exercising agency in selecting and evaluating the use of these technologies. Aligned with this advocacy, an emerging research trend has focused on developing teachers' knowledge and skills for integrating GenAI into education, with most studies conducted in intervention settings. For instance, by implementing the "Five S″ prompting framework, Tassoti (2024) provided GenAI training to 23 preservice chemistry teachers and subsequently examined the evolution of their prompts and their satisfaction with GenAI-generated responses. Another study reported the results of a 60-hour GenAI development program for in-service teachers (Kong & Yang, 2024). In this study, teachers were presented with cases illustrating the application of a human-centered teaching and learning framework aimed at facilitating their understanding of GenAI concepts and encouraging integration into their teaching practices. Although teachers participating in these interventions generally developed their understanding and implementation of GenAI, the training often adopts top-down approaches detached from the actual school context and everyday teaching practices, which results in a gap between research and practice.

To better prepare teachers for navigating the evolving GenAI landscape, this study adopts a bottom-up approach by examining their preparedness, practices, and barriers encountered for GenAI integration in their daily contexts. Our findings seek to inform a systematic approach in supporting teachers' GenAI integration, considering their existing experience as well as personal and contextual factors. The research questions are as follows:

1) What are K-12 teachers' levels of preparedness and their initiatives in learning and exploring GenAI for educational purposes?
2) How, if at all, do K-12 teachers integrate GenAI into their daily practices?
3) What barriers do K-12 teachers perceive for integrating GenAI into education?

2. Literature review

2.1. K-12 teachers' preparedness of AI integration

In recent years, the growing release of AI policies for K-12 education has highlighted the critical need for teachers to be prepared for AI integration. At the global level, UNESCO proposed an AI Competency Framework for Teachers, outlining the essential knowledge, skills, and values teachers need to develop for integrating AI effectively and ethically into their practices (Miao & Cukurova, 2024). The framework identified five key dimensions of AI competencies: a human-centered mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning. In the U.S., federal initiatives emphasize promoting AI education and workforce development (Owoeye, 2024). As of September 2024, 24 state departments of education have published AI guidance for K-12 schools, demonstrating a growing commitment to preparing educators for the opportunities and challenges of AI in education (TeachAI, n.d.).

In K-12 education, teachers' ability to effectively integrate AI is crucial for aligning broader policies with local educational needs (Chiu, 2021; Dai et al., 2022). This requires a high level of preparedness as teachers act as agents of change in designing inclusive AI curricula that address unique local challenges while mediating external influences (Dai et al., 2022). A human-centered mindset in applying AI tools is emphasized for supporting differentiated instruction and meeting diverse pedagogical needs (Ayyildiz & Yilmaz, 2023; Kong & Yang, 2024; Nazaretsky et al., 2022). In essence, K-12 teachers' preparedness for AI integration is vital as it equips them with the competencies needed to oversee and contextualize AI applications across various school levels, curriculum settings, and problem-solving tasks.

Despite these pressing needs, educators across various educational settings often remain unprepared for effective AI integration. A survey by Barrett and Pack (2023) revealed that 95.6% of university educators reported having received no training on the use of AI in education. Similarly, Sanusi et al.'s (2023) review highlighted that while successful integration of AI-related topics in K-12 teaching depends on proper teacher preparation, research on professional training is lacking. Additionally, most of the limited studies available have employed a top-down, researcher-led approach to professional development (Nazaretsky et al., 2022; Park et al., 2023). For example, Park et al. (2023) piloted an AI-integrated science lesson package designed by researchers with three secondary teachers to enhance the fidelity of the materials and their implementation. In contrast, several studies have provided teachers with opportunities to co-design lessons tailored to their local teaching contexts (Dai et al., 2022; Lin et al., 2022). For instance, Dai et al. (2022) collaborated with 23 elementary computer science teachers to co-construct an AI curriculum and explore how teachers adapt external influences to meet the needs of their schools and classrooms.

Teachers' limited preparedness has also led researchers to advocate for a range of AI educational initiatives tailored to support teachers' AI integration in key areas, such as curriculum development, technical applications, and pedagogical integration (An et al., 2023; Asunda et al., 2023; Chiu, 2021; Li et al., 2024; Nazaretsky et al., 2022). For instance, Chiu (2021) proposed a holistic approach to guiding teachers how to design AI curriculum for K-12 education, encompassing four key aspects: content, product, process, and praxis. Noting considerable gaps in teacher preparation and curriculum alignment, Asunda et al. (2023) underscored the importance of preparing K-12 STEM educators with foundational AI concepts, computational thinking, and machine learning pedagogy. Additionally, An et al. (2023) found that professional development programs focusing on the usability of AI applications in teaching can enhance K-12 English as a Foreign Language (EFL) teachers' behavioral intention to integrate AI into their instruction.

2.2. K-12 teachers' AI practices

In response to the growing demand in preparing K-12 teachers for AI integration, empirical studies have explored teachers' experiences applying AI in intervention or non-intervention settings to gain insights into their current conditions and enhance the preparation efforts. Using the techno-activities framework (Hughes et al., 2020), K-12 teachers' AI integration practices can be broadly categorized into teacher and student use.

From the teacher-use perspective, AI tools are often utilized to support lesson preparation and assessment (Duan & Zhao, 2024; Kong & Yang, 2024; Lin et al., 2022; Nazaretsky et al., 2022). For example, Nazaretsky et al. (2022) introduced an AI grading tool to six high school biology teachers in Israel, providing them with hands-on experience in using AI-generated feedback to improve the instruction. Duan and Zhao (2024) found that high school teachers who participated in AI workshops were able to integrate AI tools to create tailored learning experiences with differentiated resources and grade multiple-choice assessments. However, existing studies have underexplored AI

integration into classroom teaching or its use for communication with students and parents. While efforts are being made to involve K-12 teachers in collaborating with researchers on curriculum design and interventions (Dai et al., 2022; Tang et al., 2024), these studies remain limited. For instance, Tang et al. (2024) established a partnership between the research team and a group of Australian teachers to explore and address localized issues related to the use of GenAI in their educational environments.

From the student-use perspective, numerous intervention studies have focused on enhancing student engagement and motivation by creating personalized and interactive AI learning environments. However, in these studies, teachers' roles are often negligible or largely supportive (Adeyele & Ramnarain, 2024; Dieker et al., 2024; Hidayat, 2024). For example, Dieker et al. (2024) developed an AI agent to support elementary students in learning coding, communication, and self-regulation skills. During the initial phases, the research team led and delivered the project, while teachers were recruited later and provided with professional development to ensure effective implementation. In addition to STEM education, Hidayat (2024) designed an AI-based personalized reading platform to enhance reading comprehension among senior high school students in Indonesia. The intervention demonstrated that the research team provided training to ensure students could fully engage with the platform and offered ongoing support throughout the study, without involving teachers.

In contrast to the intervention studies discussed above, AI integration into teachers' daily practices presents a different picture. A survey by Collie and Martin (2024) investigating 339 K-12 teachers in Australia found that less than half of respondents used GenAI for teaching-related tasks, with only 19% integrated it into student learning activities. Similarly, only 18% of U.S. K-12 teachers reported using AI through virtual learning platforms, adaptive learning systems, and chatbots on a weekly basis, while another 15% had tried AI at least once (Diliberti et al., 2024). Moorhouse (2024) also reported comparable findings in a study of first-year in-service English teachers in Hong Kong, showing that GenAI tools were primarily utilized outside the classroom for lesson planning and material preparation, rather than being incorporated into direct classroom activities with students.

Additionally, research on K-12 teachers' AI integration remains limited compared to studies in higher education, which often explore a wide range of instructional applications, such as personalized tutoring, text simplification, assessment support, and fostering critical thinking (Mohebi, 2024; van den Berg, 2024). In the K-12 context, however, AI use tends to be predominantly machine-centered, as exemplified by intelligent tutoring systems (ITS). This approach highlights teachers' reliance on these platforms, where students are positioned as passive learners, responding to the self-paced, adaptable ITS environments (Díaz & Nussbaum, 2024; Velander et al., 2023). The machine-centered pedagogical approach may be influenced by the developmental levels of K-12 students, who often require more guided and structured learning with technology. Established patterns of technology use in K-12 classrooms, where technology is often used to support teacher-directed instruction or deliver content in a controlled manner (Cuban, 1986, 2018), could reinforce this approach.

2.3. K-12 teachers' barriers for AI integration

Understanding the challenges K-12 teachers encounter when integrating technology into the classroom is crucial for developing effective solutions. According to Ertmer's typology (1999), two types of barriers impact teachers' technology integration: first- and second-order barriers. First-order barriers are external limitations characterized by incremental and institutional factors, such as equipment, resources, training, policies, time, and support. For example, a study conducted in Ghana indicates that teachers have fewer opportunities to participate in technology professional development programs, which discourages them from integrating technology into instruction (Abedi & Ackah-Jnr, 2023). Conversely, second-order barriers are internal factors and include teacher beliefs, concerns, attitudes, competencies, and confidence. For instance, Wozney et al. (2006) revealed that teachers' expectancy of success and their perceived value of technology use significantly contributed to differentiating levels of computer use among teachers.

Prior to the advent of GenAI, the impact of first-order barriers on teachers' technology use had been significantly diminishing in many countries (including the U.S.) owing to the widespread access to technology and improved support systems in schools (Hamutoglu, 2021; Ottenbreit-Leftwich et al., 2018). Consequently, research efforts have shifted to focus on investigating second-order barriers, with teacher beliefs emerging as the key factor influencing technology integration (Ertmer et al., 2012; Wang & Cheng, 2021). In particular, teachers' *pedagogical beliefs* play a critical role in technology-supported instructional practices (Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010). Pedagogical beliefs refer to the convictions teachers hold about the teaching and learning process, which influence how they analyze, plan, and implement instruction (Liu, 2011; Pajares, 1992). These beliefs are commonly associated with teacher-centered (behaviorist) belief and learner-centered (constructivist) orientations. Teachers with strong constructivist pedagogical belief are more likely to use technology in the classroom than teachers with a traditional pedagogical belief (Cope & Ward, 2002; Ertmer et al., 2012).

More recently, teachers' *technology value beliefs* have been identified as another influential second-order barrier to technology integration (Backfisch et al., 2021; Vongkulluksn et al., 2020). Technology value beliefs refer to the principles and values that teachers hold regarding the use, impact, and potential of technology in education (Watson, 2006). In other words, the more valuable teachers perceive a technological approach or digital tool to be in achieving their goals, the more likely they are to integrate it. Teachers will not invest time and effort in learning and integrating a specific technology into their instructional practices if they do not perceive its value (Hughes, 2005; Zhao & Cziko, 2001). Conversely, if teachers perceive value in using technology to achieve specific instructional purposes, they are more likely to adopt it even when barriers exist. For instance, despite their dissatisfaction with the available infrastructure, Alberola-Mulet et al. (2021) found that 91% of participating primary education teachers positively valued the integration of digital educational resources (DER) into the classroom, believing that DER could motivate student learning by improving the quality of teaching. Similarly, Collie and Martin (2024) reported that teachers who value GenAI are more likely to implement this technology in both their teaching and learning.

The relationships between first- and second-order barriers and teachers' technology integration are nuanced and complex (Ertmer, 1999; Schmitz et al., 2022). For example, despite strong internal enabling factors, Ottenbreit-Leftwich et al.'s (2018) longitudinal investigation of four beginning teachers indicated that school resources and environment had a strong impact on their technology practices. While teachers' pedagogical beliefs are influential factors in technology use (Lim & Chai, 2008; Sang et al., 2010), teachers with learner-centered belief often integrate technology in fairly traditional ways, such as lecturing with PowerPoint (Liu, 2011). The misalignment between teachers' pedagogical beliefs and practices is often mediated by first-order barriers such as high-stake exam requirements, time constraints, and institutional expectations (Ertmer et al., 2001; Liu, 2011). These inconsistencies imply that first- and second-order barriers may coexist and interconnect (Tosuntaş et al., 2019; Wang & Cheng, 2021). An investigation into the barriers to integrating AI in education in Hong Kong K-12 schools showed that both first- and second-order barriers existed and appeared to be interconnected, although the types of barriers and connections varied between the cases (Wang & Cheng, 2021).

Overall, integrating GenAI in K-12 education may present barriers that are both similar to and distinct from those encountered in earlier technological innovations. As proposed by Mishra et al. (2023), GenAI's

ability to enable seamless communication in human languages and handle cognitive tasks that traditionally depended on human intelligence has differentiated it from other digital technologies. These attributes can enhance information processing and cognitive functions but also introduce risks such as plagiarism, equity and access issues, unethical use, and overreliance on the GenAI tools (Alavi et al., 2024; Farrelly & Baker, 2023). This highlights the potential for new dimensions of first- or second-order barriers. Beyond identifying new dimensions, our study explores the interrelationships between first- and second-order barriers, examining how they affect one another and identifying which barriers are most substantial and require immediate intervention to promote teachers' effective and meaningful GenAI integration.

In sum, as the demand for K-12 teachers to integrate AI grows alongside the challenges posed by GenAI innovations, the bottom-up exploration of teachers' existing conditions for GenAI integration is a pressing need. Numerous reviews and studies have highlighted that most research on K-12 AI integration and efforts to build teachers' AI readiness have been concentrated in Asia (An et al., 2023; Chiu, 2021; Lee & Kwon, 2024). This study aims to fill this gap by examining the preparedness, practices, and challenges faced by K-12 teachers in the U. S., with the goal of informing targeted professional development and other initiatives to support effective GenAI integration in education.

3. Methods

This study employed a cross-sectional survey research method (Check & Schutt, 2012) to explore K-12 teachers' status of GenAI integration in Idaho, U.S., where the predominantly rural setting presents unique challenges and opportunities for integrating technology in education. The state's vast geographical expanse, including many small towns and remote areas, often limits access to technological resources and infrastructure. These rural conditions impact how teachers prepare for and implement new technologies (Wargo & Hoke, 2022). Currently, Idaho schools are still in the early stages of developing comprehensive technology policies and guidelines, particularly concerning GenAI. Without state-level directives, individual schools and districts must navigate these challenges independently. This underscores the need to understand the current state of GenAI preparation and implementation and the specific barriers faced by Idaho's teachers.

3.1. Survey development and data collection

To address our research questions, we conducted an online search to identify survey instruments to design a questionnaire investigating teachers' preparedness, practices, and barriers to integrating GenAI into education. The design of the survey questions was informed by and adapted from the relevant instruments developed by Sebesta and Davis (2023) and Hallowell (2023), which focus on educators' AI-related perceptions and practices. Closed-ended questions were created to access participants' preparation levels, learning initiatives, and perceived barriers to GenAI integration. Preparation levels were measured using a single-answer Likert scale (1 = *Not at all prepared* to 5 = *Well prepared*). For learning initiatives and perceived barriers, participants could select multiple options and provide additional typed responses if the predefined choices did not fully represent their situations. Open-ended questions were employed to capture participants' descriptions of their current practices and future plans for integrating GenAI in education. A copy of the survey questions was included in Appendix A.

In survey research, validity and reliability are essential concepts typically associated with instruments designed to measure specific theoretical constructs. However, since this an exploratory study and our closed-ended survey questions were not derived from or tied to any preexisting instruments based on theoretical constructs, discussing the reliability of our survey instrument is not applicable (Kimberlin & Winterstein, 2008). To ensure that our survey was well-crafted and adequately addressed our research questions (validity), we conducted expert reviews following guidelines from Aithal and Aithal (2020) and Dillman et al. (2014). The first author, a researcher and teacher educator with expertise in K-12 technology integration, developed and evaluated the survey questions for content alignment. Additionally, we consulted two external reviewers—the Director of Teacher Education and the Director of Field Placement in the College of Education, Health and Human Sciences at the University of Idaho—who are familiar with the target population. We provided external reviewers with a copy of the survey and asked them to review the questions. We then interviewed them to gather feedback on the clarity and relevance of the questions, potential comprehension issues for K-12 teachers in the target population, recommended changes, and estimated time required for thoughtful survey completion. The feedback analysis revealed no major issues, with the survey questions considered clear, comprehensive, and aligned with the study objectives. Based on their input, minor adjustments were made, including restructuring and rephrasing certain questions, to enhance readability and comprehension. Additionally, a pilot study involving three K-12 teachers yielded satisfactory results.

The study was approved by the University of Idaho Human Research Protection Board (IRB#026288). Using a snowball sampling method (Goodman, 1961; Heckathorn, 2011), we initially distributed the survey invitation at a statewide educational technology conference in February 2024, inviting K-12 teacher attendees to participate and refer to other potential respondents. In March 2024, we leveraged our colleagues' professional networks to email survey invitations to all principals in K-12 public schools across Idaho, asking them to participate and forward the invitation to their fellow teachers. To boost response rates, a reminder email was sent to principals before the spring semester ended in May 2024. Additionally, we shared the survey invitation with K-12 teachers enrolled in our graduate classes. Data collection concluded in September 2024, and responses from 89 teachers who completed at least 70% of the survey were included in the analysis.

While snowball sampling can introduce bias owing to its reliance on personal connections or professional networks for recruiting participants, it was deemed appropriate for this study given the challenges in accessing teachers across Idaho's geographically and professionally diverse population. To mitigate this bias, we actively sought connections to reach teachers from diverse backgrounds and school settings. Specifically, we highlighted the importance of gathering insights from teachers with varying levels of technology integration experience in the survey invitation email sent to teachers through their principals. Additionally, we incentivized participation by offering a 50% chance to win a $25 gift card in a lucky draw.

3.2. Participants

Overall, 89 survey responses were collected, with participants' backgrounds presented in Table 1. Most participants are White, female teachers serving in rural elementary or high schools. This distribution closely mirrors the demographics of K-12 teachers in Idaho, where 93.4% are White (NCES, 2021), and it aligns with national trends where female teachers contribute to most of the K-12 teaching workforce (NCES, 2018). Furthermore, approximately 54% (393 out of 728) of the schools in Idaho are in rural areas (Our Kids, Idaho's Future Final Report, 2019). The sample also sufficiently includes a wide range of K-12 teaching experiences, from novice to experienced teachers. In terms of subject matter, 60 teachers taught STEM-related subjects (i.e., science, mathematics, computer science, career and technical education, and STEM), followed by 32 language teachers and 22 teachers with elementary specialization.

3.3. Data analysis

For RQ1, the mean, standard deviation, frequencies, and percentages were computed to determine teachers' GenAI preparation levels.

Table 1
Participants' background ($N = 89$).

Demographic Variables		Frequency	Percentage
Gender	Male	20	22.5
	Female	55	61.8
	Prefer not to say	2	2.2
	Missing	12	13.5
	Total	89	100.0
Ethnicity	White/Caucasian	72	80.9
	Hispanic/Latino/Latina/ Latinx	2	2.2
	Black or African American	1	1.1
	Others	2	2.2
	Missing	12	13.5
	Total	89	100.0
Location	Rural	61	68.5
	Suburban	15	16.9
	Urban	2	2.2
	Missing	11	12.4
	Total	89	100.0
K-12 Teaching Experience	0–3 years	12	13.5
	4–10 years	21	23.6
	11–20 years	21	23.6
	21–30 years	20	22.5
	More than 30 years	4	4.5
	Missing	11	12.4
	Total	89	100.0
School Level	Elementary school	27	30.3
	Middle school	15	16.9
	High school	30	33.7
	Others (across grade levels)	6	6.7
	Missing	11	12.4
	Total	89	100.0
Subject (may include multiple responses)	Language	32 (31 in English)	–
	Science	19	–
	Mathematics	23	–
	Visual and performing arts	4	–
	Physical and health education	6	–
	Social studies	15	–
	Computer science	8	–
	Career and technical education	9	–
	Elementary specialization	22	–
	Others (i.e., STEM, Socioemotional Learning, Study Skills/Strategies)	3	–

Additionally, frequencies and percentages were computed to understand teachers' initiatives across three stages of learning and exploring GenAI for educational purposes. The three stages are "not interested at all," "would like to learn but don't know how to start," and "have adopted one or more strategies for learning GenAI." Since participants could select multiple options in the questionnaire to indicate their GenAI learning strategies, we included an additional layer of analysis to count the options selected for each stage, in addition to calculating the number of participants at each stage.

For RQ2, we applied a combination of deductive and inductive approaches (Bingham, 2023) to code teachers' open-ended responses regarding their current GenAI practices and future plans. The coding process begun deductively using the techno-activities framework (Hughes et al., 2020). The first and second authors independently coded the data to assess whether the targeted users were teachers or students, along with their respective categories. Then, the authors met to review the coded responses, discussing areas of similarity and difference. This discussion also included an inductive process to identify and develop themes for responses that did not fit within the predefined framework. Following this, we independently reviewed and refined the coding of all responses, including clarifying definitions for the emerging themes. Through multiple rounds of discussion and refinement, we resolved inter-rater discrepancies and fine-tuned the themes until 100% consensus was achieved.

Table 2 summarizes the categories and their definitions that inform our coding process, along with an example coded for each category. Specifically, the coding category "communicating with students and parents" under "Teacher Uses" in the predefined framework was revised to "administrative tasks" to include other GenAI-supported administrative routines performed by teachers. Additionally, "grant writing" was introduced as a new category under "Teacher Uses." For "Student Uses," a new category was created to capture GenAI-related *content* (i.e., AI literacy) that students are expected to learn, in addition to using it as a *tool* to support their learning.

Table 2
Categories, definitions, and coding examples for target users of GenAI integration.

Category	Definition	Coding Example
Teacher Uses		
• Designing and preparing lessons	Teachers use GenAI to help them prepare in advance of a class lesson.	I use it to come up with ideas for lessons and activities for my classes. (Teacher 35)
• Teaching lessons	Teachers use GenAI to support teaching in the moment.	I use it to translate and simplify information for special education kids in class. (Teacher 24)
• Grading and assessment	Teachers use GenAI to support grading and developing assessments.	We use several programs including ChatGPT for general student feedback on writing assignments. (Teacher 1)
• Administrative tasks	Teachers use GenAI to carry out school's administrative requirements.	Spreadsheets … paperwork … (Teacher 4)
• Grant writing	Teachers use GenAI for grant writing.	Grant writing - AI sounds a lot more articulate than myself. It also gives me thoughts on how to speak regarding situations. (Teacher 13)
Student Uses		
• Passive hands-off	Learner hands-off use of GenAI that aims to support instructional moves and learner engagement with content, such as provided students with GenAI created information.	NA
• Passive hands-on	Learner hands-on use of GenAI to maximize exposure to content and/or to recall/ practice facts and procedures, such as completing assignments via intelligent tutoring system.	NA
• Active hands-on: participation	Authentic, learner hands-on, learner-driven instructional activities and environments, such as having students exploring learning topics via GenAI tools.	I have had students use it for light research. (Teacher 78)
• Active hands-on: creation	Learner hands-on activities that maximize active, deep learning, such as cognitively complex tasks which necessitate creativity, critical thinking, problem solving, or collaboration with GenAI; but maintaining learner agency.	I plan to help students use it as a tool to enhance their writing process. (Teacher 10)
• Learning of AI literacy	Lessons created to develop students' GenAI knowledge, including promoting responsible and ethical use of GenAI.	I teach a news literacy unit, and I would like to incorporate lessons on the ethical use of AI into this unit. (Teacher 59)

For RQ3, teachers were provided with predefined choices to identify barriers they encountered for integrating GenAI and had the option to describe additional challenges. First, we calculated the frequencies of the predefined choices and coded teachers' open-ended responses as either aligning with existing categories (predefined choices) or representing new types of barriers. We then synthesized these initial categories into broader groups based on Ertmer's (1999) framework of first- and second-order barriers, as described in Section 2.3. Specifically, first-order barriers refer to external factors, such as access to technology or institutional support, while second-order barriers are internal factors, including teachers' beliefs or attitudes. As "technology value beliefs" and "pedagogical beliefs" under second-order barriers involve abstract constructs, we developed themes to illustrate how these beliefs manifest concretely in our study. Finally, we calculated the frequencies and corresponding percentages for each category based on the finalized themes.

4. Results

4.1. K-12 teachers' preparedness of GenAI integration

Regarding the preparation levels, teachers generally perceived themselves as underprepared for integrating GenAI into education ($\bar{x} = 2.06$; $s = 1.22$). As shown in Fig. 1, most teachers (54, 61%) responded to the single-answer Likert scale question by reporting that they felt either "not at all prepared" or "slightly prepared," with only 10 teachers (11%) indicating they felt "prepared" or "well prepared" for GenAI integration. Additionally, seven teachers (8%) did not indicate their level of preparedness for using GenAI in education.

Regarding their initiatives in learning and exploring GenAI (Table 3), 79 teachers provided responses to the multiple-answer question. Specifically, 19 teachers (21.3%) indicated that they were not interested in learning about GenAI at all, while 10 (11.2%) did not respond to this question. For the 32 teachers (36.0%) who stated that they wanted to learn about GenAI but did not know how to start, nine of them indicated their learning efforts mainly through attending AI presentations/webinars. For the remaining 28 teachers (31.5%) who adopted one or more strategies for learning about GenAI, more than half of their responses (35 out of 60) showed that these they were still in the early stages of GenAI learning, engaging in activities such as discussing GenAI topics with colleagues, reading articles, attending webinars/presentations on GenAI, and/or reviewing GenAI guidance and resources for education.

Table 3
Teachers' initiatives in learning and exploring GenAI.

Stage and Strategies	Number of Teachers	Percentage (%)
Teachers who are not interested in learning GenAI	19	21.3
Teachers who would like to but don't know how to start • Discuss with colleagues about GenAI in education (3 responses) • Read articles and/or attend webinars/ presentations on the topic of GenAI (5 responses) • Review GenAI guidance and resources for education (1 response)	32	36.0
Teachers who adopted one or more strategies for learning and/or integrating GenAI • Discuss with colleagues about GenAI in education (18 responses) • Read articles and/or attend webinars/ presentations on the topic of GenAI (12 responses) • Review GenAI guidance and resources for education (5 responses) • Join GenAI educational group(s) on social media (5 responses) • Participate in GenAI professional development (8 responses) • Explore GenAI tools to support my practice (12 responses)	28	31.5
Teachers who did not responded	10	11.2
	89	100.0

4.2. K-12 teachers' GenAI-supported educational practices

Based on teachers' responses to open-ened questions about their current practices and future plans, our findings reveal the diverse yet predominantly teacher-centered applications of GenAI in education (Table 4). Additionally, coding examples provided in Table 2 offer insight into how teachers integrated GenAI into their daily usage.

Among the 89 participating teachers, only 39 reported that they currently use GenAI in their daily practices. Some teachers mentioned more than one approach to GenAI usage, which resulted in a total frequency of 60 responses (Table 4). For "Teacher uses," the most common application was in designing and preparing lessons (26, 44%). Teachers indicated that GenAI supported them in generating lesson ideas, creating instructional activities, differentiating lessons for diverse groups of students, and sourcing relevant teaching materials. The second most

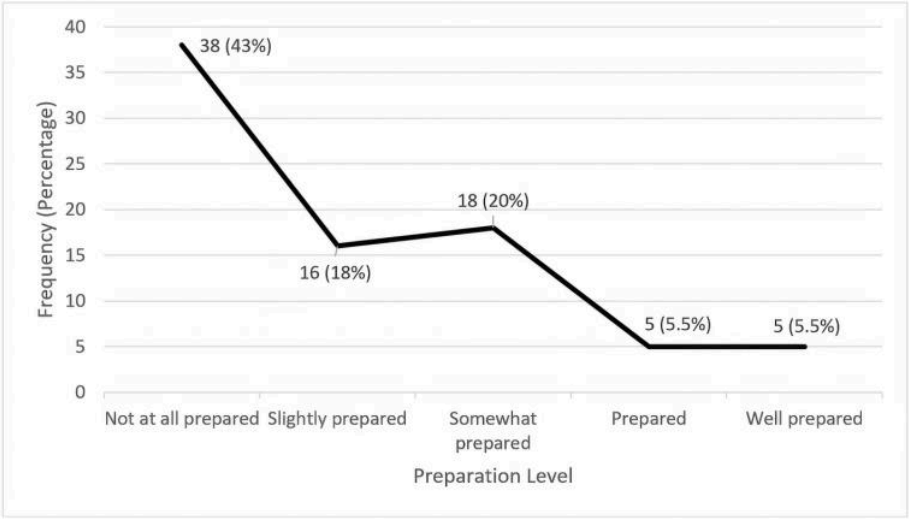

Fig. 1. Teachers' preparation levels for GenAI integration.

Table 4
Teachers' current practices and future plans of integrating GenAI.

Type of Usage	Number of Responses (%)	
	Current Practice	Future Plan
Teacher Uses		
Designing and preparing lessons	26 (44%)	10 (37%)
Teaching lessons	5 (8%)	3 (11%)
Grading and assessment	13 (22%)	4 (15%)
Administrative tasks	11 (18%)	2 (7%)
Grant writing	0 (0%)	1 (4%)
	55 (92%)	20 (74%)
Student Uses		
Active hands-on: participation (e.g., conduct research)	2 (3%)	1 (4%)
Active hands-on: creation (e.g., enhance writing process)	3 (5%)	2 (7%)
Learning of AI literacy	0 (0%)	4 (15%)
	5 (8%)	7 (26%)
Total	**60 (100%)**	**27 (100%)**

frequent use was for grading and assessment (13, 22%), where teachers primarily relied on GenAI to create test questions. Administrative tasks accounted for 11 responses (18%), with teachers using GenAI to proofread texts, enhance communications with parents, and assist with tasks in productivity software such as Excel. The least common use of GenAI was for teaching lessons directly (5, 8%). In these cases, teachers leveraged GenAI to provide translations for students or instantly access information during classroom instruction. For future plans, the percentage of "Teacher Uses" decreased from 92% to 74% compared to current practices. However, a similar trend persisted, with teachers continuing with an inclination to integrate GenAI for lesson design and preparation (10, 37%).

Overall, teacher-reported "Student Uses" of GenAI were limited. When comparing current practices to future plans, we observed a light increase in percentage, from 8% to 26%. This increase was primarily driven by four responses (15%) indicating plans for teaching AI literacy to enhance students' responsible and ethical use of GenAI. No responses were coded under the "Student Uses" categories of passive hands-off or passive hands-on learning.

4.3. K-12 teachers' barriers for GenAI integration

As shown in Table 5, teachers' responses to both closed- and open-ended questions revealed the significance of both first- and second-order barriers to GenAI integration, with second-order barriers being perceived as more influential (i.e., 58% versus 42%). The major barriers reported include technology value beliefs (63, 17%), followed by pedagogical beliefs (51, 14%), concerns about unethical use of GenAI (50, 14%), and lack of policies, goals, and strategies (46, 13%). This finding slightly differs from most previous research, which has often identified teachers' pedagogical beliefs as the predominant barrier to general technology integration.

Under the barrier of technology value beliefs, teachers expressed doubts about the ability of GenAI systems to identify, assess, and mitigate potential negative outcomes, such algorithmic bias, data privacy, and security risks. Teacher 49 noted, "There can be many data breaches and security concerns within GenAI platforms." Additionally, some teachers were not confident that the benefits of integrating GenAI into education would outweigh its risks or genuinely enhance learning. Concerns also arose about students potentially becoming over-reliant on GenAI. As Teacher 10 pondered, "If they always use ChatGPT to write in class, how will they know what to do when they are taking the ISAT (Idaho Standards Achievement Test)?"

Table 5
Teachers' perceived barriers to GenAI integration.

Barrier	Sub-count	Count	Percentage
First-order Barrier			
Lack of policies, goals, and strategies		46	13%
Lack of technology access (technology infrastructure, programs, or AI-empowered educational resources)		34	10%
Lack of technical support		23	6%
Lack of funding		19	5%
Lack of leadership commitment and support		18	5%
Lack of professional development or training		7	2%
Time constraint to learn and apply GenAI		4	1%
		151	42%
Second-order barrier			
Technology value beliefs		63	17%
• GenAI's inability to manage risks (e.g., algorithmic bias, data privacy and security)	53		
• Unable to enhance learning, or benefits do not outweigh the risks	7		
• Cause students to be overreliance	3		
Pedagogical beliefs		51	14%
• Human interaction is the core in education	36		
• Young students need to develop basic, hands-on skills	6		
• GenAI should be taught in technology-related subjects (e.g., programming)	5		
• GenAI use misaligns with pedagogical aims	4		
Concern about unethical use of GenAI		50	14%
Teacher awareness and/or attitudes		29	8%
Lack of knowledge and skills		18	5%
		211	58%
Total		**363**	**100%**

Regarding the barrier of pedagogical beliefs, most teachers expressed concerns that adopting GenAI could reduce or eliminate human interactions in teaching and learning. Some believed that integrating GenAI was inappropriate for teaching certain subjects or supporting younger children's learning. For instance, Teacher 25 articulated, "I teach first grade where a lot of basics of human interaction and basics of learning are taught that cannot be taught with technology (GenAI)." Teacher 17 stated that he would only use GenAI for teaching specific subjects such as programming. Meanwhile, others stated that the GenAI integration does not align with their teaching aims. For instance, Teacher 76 said, "I don't need AI. I teach students skills that will never be taken over by AI."

Another second-order barrier identified was teachers' concern regarding the unethical use of GenAI, including issues such as plagiarism and cheating by students or even teacher themselves. For example, Teacher 15 shared, "Not using because I don't know how to use it responsibly." Similarly, Teacher 3 elaborated, "If I catch my students using AI to do their work for them, then I give them a zero and have them do the assignment on their own. There is no school policy officially, but most teachers do that." This response also highlights the major first-order barrier reported by teachers: the lack of policies, goals, and strategies to guide the use of GenAI in education. As Teacher 48 articulated, "I have not encouraged student use or integrated it as a resource because my district has not given permission or guidance on doing so."

Regarding first-order barriers, teachers also reflected that they lacked necessary technology infrastructure, programs, or educational resources to support GenAI integration (31, 8%). Despite GenAI being recognized as a new wave of technology innovation, teachers were less likely to express a need for training or professional development (8, 2%). This phenomenon may stem from the unique attributes of GenAI, which

could lead teachers to believe that the same communication skills they use with humans are sufficient for interacting and collaborating with GenAI.

5. Discussion and implications

5.1. K-12 teachers' under-preparedness highlights an urgent need for GenAI training

Overall, our results indicate that the participating teachers were generally underprepared for integrating GenAI into education, consistent with prior research (Barrett & Pack, 2023; Sanusi et al., 2023). Nearly 40% of teachers expressed an intention to learn about GenAI but were uncertain about where to begin. The primary self-directed learning strategies they employed (i.e., discussing GenAI with colleagues, reading articles, attending webinars, and reviewing educational resources and guidance) suggest that most are still in the early stages of GenAI readiness. This underscores the urgent need for systematic, targeted initiatives to develop teachers' competencies, enabling them to harness GenAI's transformative potential to fundamentally reshape teaching and learning. These initiatives should focus on developing teachers with the skills to promote students' higher-order thinking with GenAI while supporting them to optimize human–machine interactions to enhance student engagement and provide personalized support.

Considering the distinctive and unique nature of GenAI compared to earlier AI models and other digital technologies, the current predominantly top-down research approaches and initiatives, with a focus on developing teachers' AI-related technological knowledge and skills, are valuable but insufficient (Kong & Yang, 2024). Simply equipping teachers with AI knowledge and skills and training them to implement researcher-developed curriculum with fidelity may fall short of addressing local needs and the emerging challenges posed by the rapid advancements in GenAI. Emerging studies have suggested that collaborating with teachers to co-design lessons can provide opportunities for them to explore various GenAI tools, while fostering discussions on effective and responsible integration strategies for instruction (An et al., 2023; Asunda et al., 2023; Dai et al., 2022). This approach can enhance teachers' pedagogical competency with GenAI and boost their confidence in addressing novel challenges posed by GenAI.

As most participating teachers in our study are located in rural areas shaped by Idaho's rugged geography and extensive mountain ranges, unique challenges arise for in-person professional development programs. Offering flexible, self-paced online courses could serve as an effective initial approach to introducing these teachers to GenAI (Petković et al., 2017; RETCP, 2015). With that in mind, training opportunities must ensure that teachers have reliable access to necessary technology, including computing devices, Internet connectivity, and relevant GenAI tools. This consideration aligns with the second major first-order barrier reported by teachers, highlighting a lack of technology infrastructure, programs, or AI-empowered educational resources to support their GenAI integration. As a notable number of teachers have shown reluctance to learn GenAI, offering professional development credits or certifications for completing GenAI training can incentivize their participation and help them develop essential understanding about GenAI (Cadero-Smith, 2020; Hill, 2015).

5.2. K-12 teachers as the primary users for GenAI integration

Our findings indicate that teachers' under-preparedness and their introductory level of GenAI learning might be associated with fewer than half of them integrating GenAI into their practices. Unlike the widespread classroom integration patterns observed with general educational technologies (Cuban, 1986, 2018), teachers in our study were more likely to use GenAI for out-of-classroom duties (i.e., lesson preparation, assessment, and administrative tasks) over real-time classroom implementation (Diliberti et al., 2024; Moorhouse, 2024). Teachers' limited adoption of GenAI for daily classroom instruction, particularly in supporting student-centered activities, could be attributed to two key second-order barriers: technology value beliefs and pedagogical beliefs, as explained in section 5.3. Additionally, the cautious approach teachers articulated taking during the initial stages of GenAI integration may reflect their careful examination of its capabilities and limitations before incorporating it into instructional activities. This cautiousness is particularly evident in the absence of GenAI policies, goals, and implementation strategies, which our respondents reported as the most influential first-order barrier.

While the prevailing literature on earlier AI models, such as ITS, has suggested that teachers' pedagogical approaches often position students as passive learners (Díaz & Nussbaum, 2024; Velander et al., 2023), our findings on teacher-reported student uses of GenAI—albeit limited—did not indicate passive usage. We attribute this difference largely to the unique *generative* and *social* nature of GenAI (Mishra et al., 2023), which holds great potential for fostering students' participation, creation, deep learning, and learner agency. These attributes enable students to collaborate and co-construct knowledge with GenAI, much like they would with their peers. Nevertheless, this potential also raises ethical concerns for teachers, particularly regarding the risk of students using GenAI for cheating or plagiarism, which they reflected as one of the major barriers in integrating GenAI. Teachers worried that, if not properly integrated, GenAI could inadvertently lead students to using it to provide direct answers, thereby bypassing independent and critical thinking.

As research and implementation of GenAI in K-12 education remain in their early stages, guidance documents from global organizations such as UNESCO (Miao & Cukurova, 2024; Miao & Shiohira, 2024) and state agencies such as the Oregon Department of Education (ODE, n.d.) and the Washington Office of Superintendent of Public Instruction (OSPI, n.d.) offer valuable insights for fostering active, constructive student learning with GenAI. These resources highlight how teachers can leverage GenAI's potential to create engaging learning experiences, support the development of research and analysis skills, encourage thoughtful questioning, and scaffold critical thinking. By providing clear direction and practical examples, these frameworks serve to guide the design and implementation of K-12 GenAI instructional practices that go beyond traditional methods and teacher-centered use, enabling meaningful student engagement with and learning about GenAI.

5.3. Concerted efforts to overcome interconnected GenAI integration barriers

Teachers' limited GenAI integration may be attributed to various first- and second-order barriers. At this early stage of GenAI integration, our results show that both orders of barriers play a substantial role in influencing teachers' adoption of GenAI. Specifically, teachers' technology value beliefs, pedagogical beliefs, ethical considerations, and a lack of clear AI policies and guidance emerged as the major barriers.

In the context of GenAI integration, teachers' technology value beliefs have emerged as the most influential (second-order) barrier, even when first-order barriers remain prominent. This result is consistent with recent research that identified a positive and direct relationship between teachers' technology value beliefs and their instructional practices (Alberola-Mulet et al., 2021; Collie & Martin, 2024; Vongkulluksn et al., 2020). In other words, the more teachers perceive a technology or digital tool as valuable for educational purposes, the more likely they are to integrate it into their practice and vice versa. Specifically, teachers' reluctance to fully embrace GenAI integration often stems from concerns about how big data are collected and how outputs are generated, which may lead to issues such as algorithmic bias, data breaches, and data privacy issues. This underscores the importance of technology value beliefs as a crucial factor in our study (Chounta et al., 2022). Consequently, teachers questioned the appropriateness and necessity of integrating GenAI into their instructional practices, especially

to support students' use (Hughes, 2005; Zhao & Cziko, 2001).

Ertmer et al. (2012) have indicated that second-order barriers, particularly pedagogical beliefs, significantly influence teachers' general technology integration once first-order barriers are largely eliminated; this assertion is well supported by ample research (Lim & Chai, 2008; Sang et al., 2010). Additionally, the relationship between teachers' pedagogical beliefs and their instructional use of technology is not always straightforward. For example, Liu (2011) revealed that Taiwanese teachers tended to hold learner-centered belief but did not use technology to promote constructive learning because they were more likely to comply with external expectations and focus on student achievements. A literature review also underscores that teachers' pedagogical beliefs may not always align with their day-to-day technology practices, particularly when contextual factors such as high-stake exam requirements and time constraints take precedence (Buabeng-Andoh, 2012). Therefore, the prevalence of first-order barriers reported in our study might have undermined the influence of teachers' pedagogical beliefs on GenAI integration.

Many teachers have also expressed concerns about the unethical use of GenAI, as revealed in earlier studies (Crompton et al., 2022; Hill & Narine, 2023). This concern represents a specific second-order barrier to GenAI integration. According to Mishra et al. (2023), GenAI's *generative* attribute allows it to produce spontaneous outputs or responses, despite the preset conditions. Its *social* nature enables human–machine interactions, surpassing the functions of previous technologies such as social media and digital learning tools, which mainly support human-to-human communication. Unlike other digital technologies that mainly serve as tools to enhance teaching and learning, GenAI's unique attributes—its generative capability and social nature—introduce both revolutionary potential and associated risks. Therefore, meaningful integration of GenAI necessitates a comprehensive understanding of its multifaceted aspects. This includes mastering its applications, grasping its underlying concepts, navigating its rapid advancements, and using it *ethically* and *responsibly* without compromising educational quality.

Traditionally, first-order barriers to general technology integration have focused on challenges such as lack of technology access and insufficient professional development (Abedi & Ackah-Jnr, 2023; Pittman & Gaines, 2015). However, in this study, teachers identified the lack of AI-related policies, strategies, and guidance as the most substantial first-order barrier to GenAI integration, highlighting an urgent need for clear and informed policy frameworks. With the gradual release of AI guidance for K-12 education at the federal level and Idaho's state guidelines still under development (Merod, 2024; TeachAI, n.d.), the fact that teachers prioritize advocating clear and informed policies and guidance over addressing other first-order barriers is understandable. Additionally, Dwyer and Laird (2024) reported that schools generally provided little guidance to teachers on responsible GenAI use, response to students' unethical use of GenAI, and detection of GenAI-generated work. Therefore, we infer that in the early stages of GenAI integration, clear direction and guidance beyond simply providing technology access and training are crucial.

In conclusion, our study provides valuable insights for creating support systems and policymaking to facilitate GenAI integration, particularly within the context of Idaho's education system and the broader U.S. landscape. First, the findings imply that, in addition to developing teachers' GenAI knowledge and skills, professional development programs targeting their technology value beliefs and pedagogical beliefs are critical. This may involve understanding teachers' contextual needs, establishing research-practice partnerships to co-create contextually relevant AI-supported instruction and resources, and modelling best practices for GenAI integration for different grade levels and subject areas, especially in promoting student-centered learning. By doing so, we foster teachers' positive perceptions and experiences regarding GenAI's role and use in achieving their instructional goals. Second, teachers' concerns about the unethical use of GenAI underscore the importance of developing AI literacy for both teachers and students. Specifically, AI literacy should go beyond technical knowledge and skills, being grounded in well-defined rationales tailored to K-12 education, such as the six key AI literacy constructs—recognizing, knowing and understanding, using and applying, evaluating, creating, and navigating ethically—synthesized by Almatrafi et al. (2024). Third, teachers' calls for policies and guidance highlight the need for actionable frameworks that support the responsible and effective GenAI integration in teaching and learning. Researchers can contribute by engaging with policymakers to share insights and findings, ensuring that policies are informed by the latest research and advancements in AI. In response to the lack of technology access, schools can partner with technology companies and local communities to launch educational GenAI initiatives, such as acquiring technology infrastructure, programs, and AI-empowered educational resources with enhanced security and privacy features, at reduced costs.

6. Limitations and future research

First, limited funding and resources have restricted the researchers' data collection through snowball sampling, where only interested teachers self-selected to participate. This non-randomized approach may limit the diversity of responses, potentially affecting the generalizability of the results to broader K-12 teacher population in Idaho. Nevertheless, our findings offer valuable insights for developing learning opportunities and implementation strategies for integrating GenAI, especially for rural teachers. Future research could assess the impact of these training designs and refine them accordingly.

Second, relying on teachers' self-reported data in this study may introduce social desirability bias, potentially affecting the accuracy of participants' responses. Future research could benefit from observational studies on teachers' GenAI implementation, complemented by interviews to gain a better understanding of their preparedness and barriers influencing their real-time pedagogical decisions. Triangulating multiple data sources would help mitigate the limitations of self-reported data and provide deeper insights into teachers' understanding and practices of GenAI integration in K-12 education. Specifically, survey respondents may provide brief and convenient answers to open-ended questions, which could obscure an accurate depiction of their GenAI practices (Tourangeau et al., 2000).

Third, this study is one of the few to examine K-12 teachers' preparedness, daily practices, and barriers to GenAI integration. Future studies with larger, more representative samples are essential to replicate this research design for broader generalization, while also capturing the similarities and differences among rural, urban, and suburban settings. In addition to understanding teachers' barriers (factors that inhibit teachers' GenAI integration), future research should include survey questions exploring factors that motivate teachers to use GenAI, to better encourage its adoption.

CRediT authorship contribution statement

Yin Hong Cheah: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jingru Lu:** Writing – review & editing, Writing – original draft, Formal analysis. **Juhee Kim:** Writing – review & editing, Writing – original draft, Investigation.

Statements on open data and ethics

The study was approved by an ethical committee (the University of Idaho Human Research Protection Board) with ID: 026288. Informed consent was obtained from all participants, and their privacy rights were strictly observed. The data can be obtained by sending request e-mails to the corresponding author.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT in order to improve the readability and language of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.caeai.2025.100363.

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GALLUP | WALTON FAMILY FOUNDATION

TEACHING FOR TOMORROW

Unlocking Six Weeks a Year With AI

Table of Contents

Executive Summary

As Americans determine how AI tools can benefit their work and lives, teachers are also establishing how the new technology will fit into K-12 education and whether it has the potential to address some of the challenges they face. Prior research from the Walton Family Foundation and Gallup[1] underscores what is at stake for today's teachers:

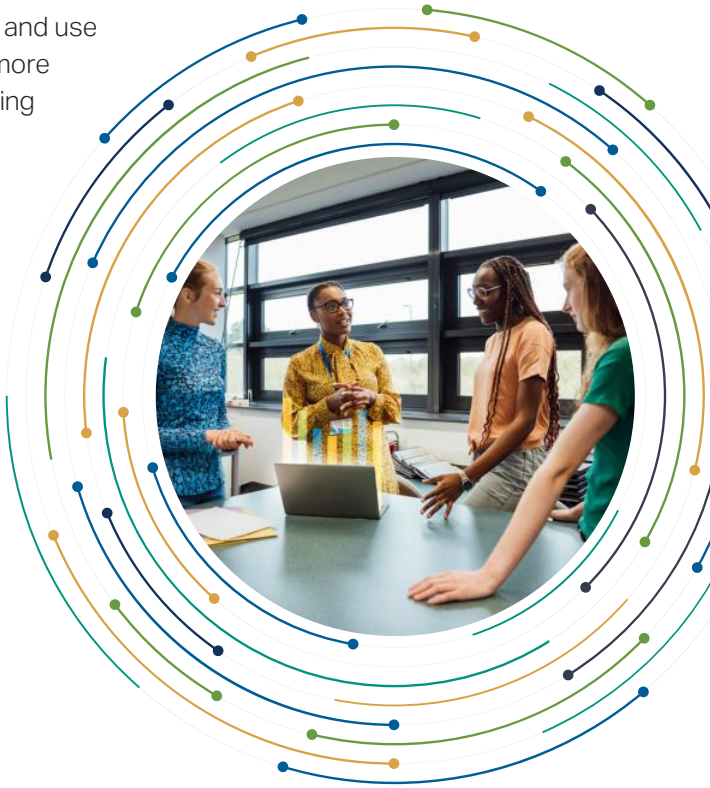
> **High workload:** On average, teachers say they are working 50 hours per week, and just 45% are satisfied with the amount they are paid.

> **Lagging student achievement**: Nearly four in 10 teachers don't agree that their students are on track to succeed in school. One in three say their students are not excited about what they're learning in classes.

> **Plans to return**: One in five teachers are either unsure about returning to the classroom or do not plan to in the next school year.

The Walton Family Foundation partnered with Gallup to find out how teachers are using AI tools in the classroom and whether AI might have the potential to save them time, alleviate burnout, or address key issues related to student achievement and engagement.

Over 2,000 teachers responded to a web-based survey in April 2025, sharing how AI is already impacting their students and teaching and how they believe AI will change both their profession and student success in the future. Findings also reveal a meaningful "AI dividend": When teachers invest time to learn about and use AI tools, they save valuable time that can then be used to provide more meaningful student feedback, create more individualized and engaging lesson plans, communicate with parents or even gain back time with their family.



1 Walton Family Foundation and Gallup. (n.d.). Walton Family Foundation Educator Research. https://www.gallup.com/analytics/659819/k-12-teacher-research.aspx

Key Findings

Highlights from the *Teaching for Tomorrow: Unlocking Six Weeks a Year With AI* study include:

01.

Six in 10 teachers have used an AI tool for their work this school year, with heavier use among high school (66%) and early-career teachers (69%).

02.

Teachers who use AI weekly save 5.9 hours per week — the equivalent of six weeks per school year. Currently, about three in 10 teachers are using AI at least weekly, with more frequent users experiencing greater time savings.

03.

Most teachers who use AI tools say the tools improve the quality of their work: 64% see higher quality in the modifications they make to student materials, 61% say they generate higher-quality insights about student learning or achievement data, and 57% say AI improves the quality of their grading and student feedback.

04.

Teachers who use AI are more likely to be optimistic about the impacts of AI on student outcomes: 48% of weekly AI users think AI will increase student engagement, compared with 25% of non-users.

05.

Teachers at schools with an AI policy are more likely to say they've used AI tools, and their schools received a 26% greater "AI dividend," or more hours saved per teacher.

Detailed Findings

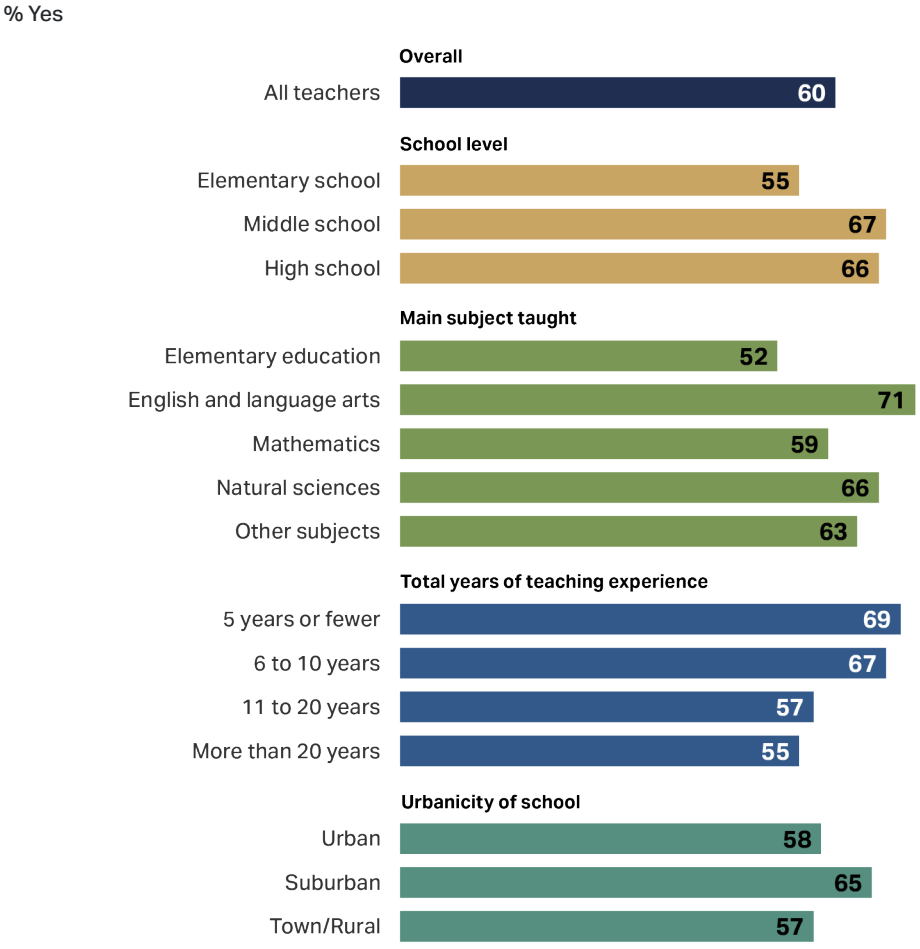
Six in 10 teachers have used an AI tool for their work this school year.

AI use is already widespread among K-12 teachers: 60% have used an AI tool for their work during the 2024-25 school year, and high school and early-career teachers are even more likely to be using the tools (66% and 69%, respectively). AI tool use is also higher among teachers in suburban schools (65%) compared with urban (58%) and town/rural schools (57%).

CHART 1

AI use by teacher and school characteristics

During the 2024-25 school year, have you used any AI tools, like chatbots, adaptive learning systems, or other interactive AI platforms for your work or teaching? (e.g., preparing to teach, making student learning materials or assessments, grading or providing feedback)



Teachers apply AI tools to their workload in a variety of ways, mostly around lesson planning and preparation.

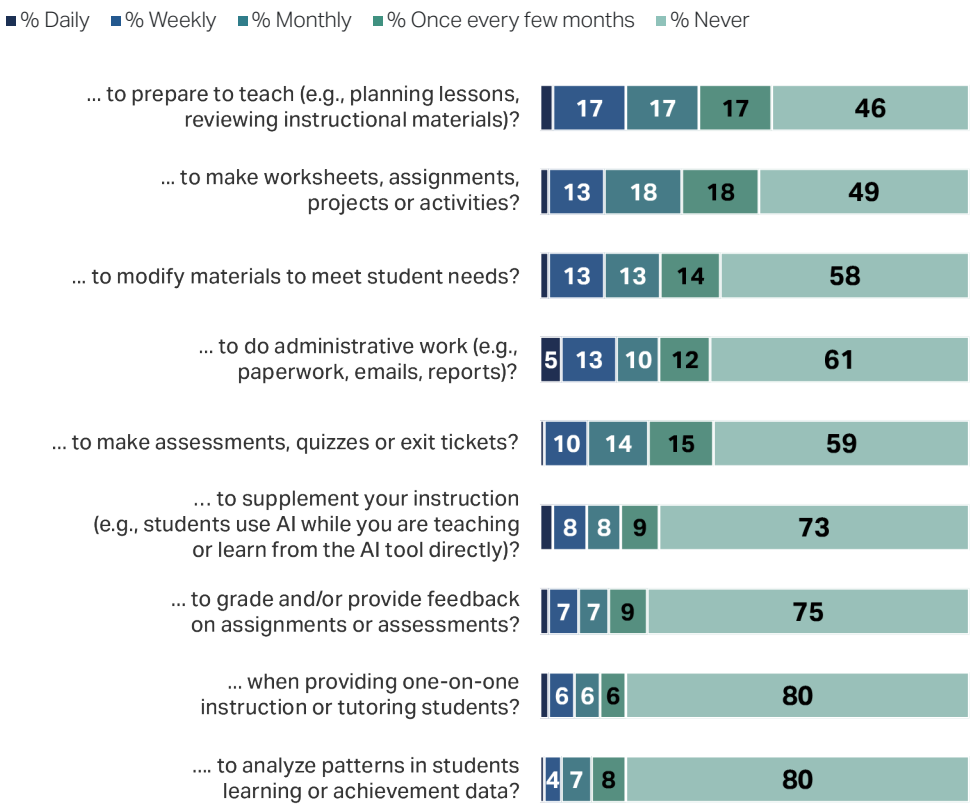
Thirty-seven percent of teachers say they use AI tools when preparing to teach at least once a month, making it the most common application of AI.

Other common applications of AI tools include making worksheets (33%), modifying student materials to meet students' needs (28%), doing administrative work (28%) and making assessments (25%). The least frequent applications are using AI tools to grade (16%), to provide one-on-one instruction (14%) and to analyze student data (12%).

CHART 2

Frequency of using AI tools for various teaching tasks

How often do you use AI tools ... ?



Note: Data labels less than 4% are not displayed.

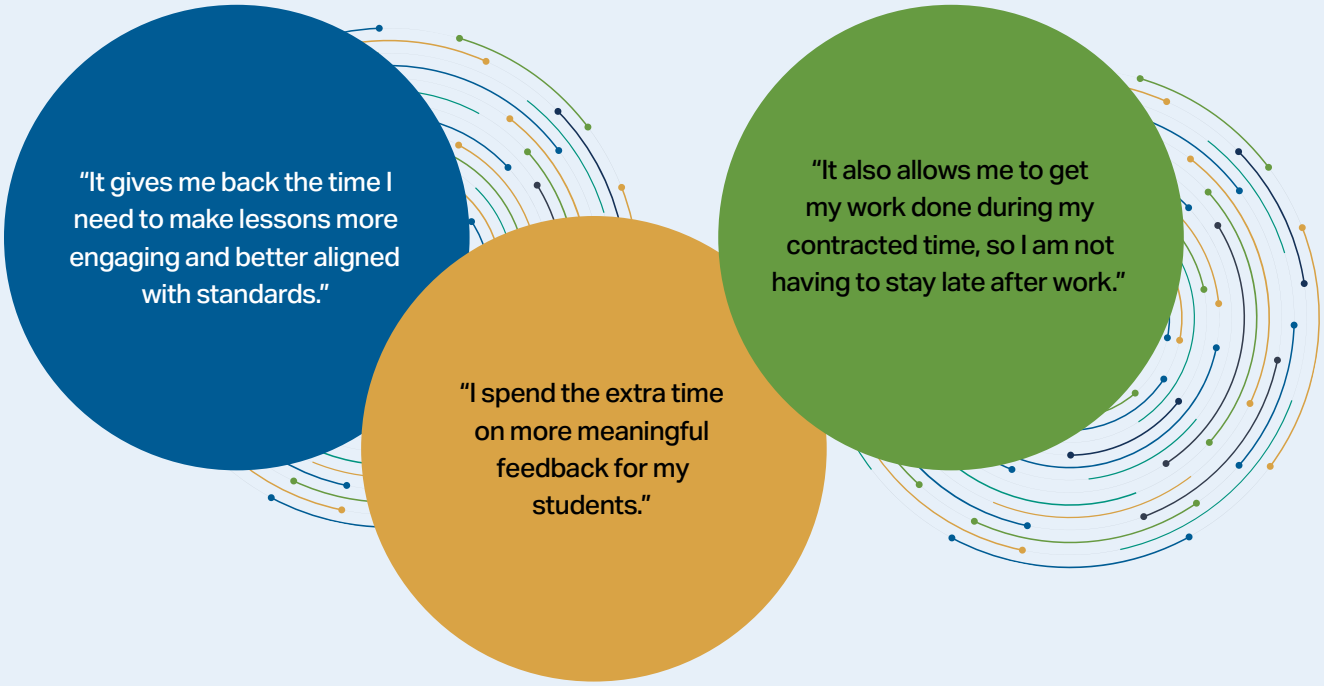
Teachers at schools that have an AI policy are more likely to have used AI in their teaching in the past year than those at schools that do not (70% vs. 60%). Yet only about one in five teachers (19%) are employed at schools with an AI policy.

The AI dividend: Teachers who use AI tools gain six weeks per school year to reinvest in their classroom.

In the 2024-25 school year, AI tools are already having a meaningful impact on time savings and giving an "AI dividend" back to teachers who invest the time into learning to use them. Teachers who use AI tools at least weekly estimate saving 5.9 hours per week on average.[2]

Over the course of a school year, these time savings add up to an additional six weeks, which teachers can then reinvest in other areas.

Qualitative data from the survey show that teachers use the time they save with AI on things like providing more nuanced student feedback, creating individualized lessons, writing emails to parents and getting home to their families at a more reasonable time.



The AI dividend pays — but only for those who invest. Just as an individual must make an investment to earn a dividend, educators must invest in learning about AI tools to earn the AI dividend. Despite the benefits of the AI dividend for teachers who use AI, 40% of teachers still aren't using it at all. Another 28% are using it, but infrequently, and 32% are using it at least weekly, leaving a big gap between the AI adopters and those who are still observing. Teachers who invest more time in learning and using AI also derive greater benefits from this technology: Weekly AI users save an average of 5.9 hours each week, whereas monthly users estimate saving the equivalent of 2.9 hours per week.

2 This number was generated by asking each teacher who uses AI at least weekly to estimate how many hours AI saves or adds to their workload each week. More information about calculating the AI dividend is available in the methodology.

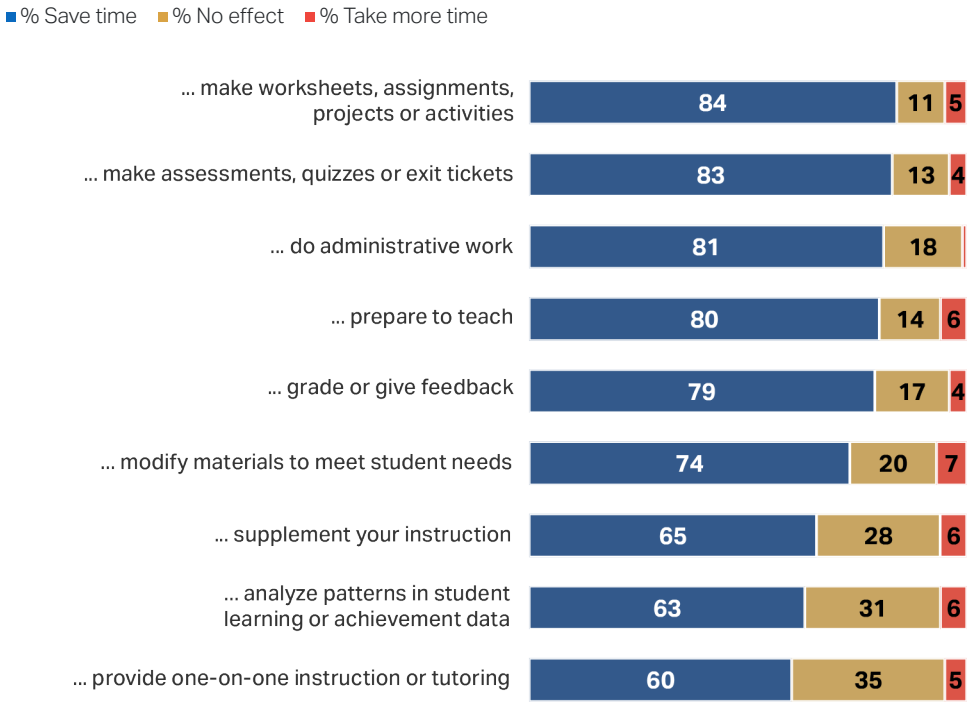
Teachers who use AI tools overwhelmingly say those tools save them time across a range of tasks.

Out of a list of nine tasks, teachers are most likely to report that AI saves them time when making worksheets or assessments, doing administrative work or preparing to teach.

CHART 3

The percentage of teachers who say AI saves them time on various work tasks

When you use AI tools to … does it save time, take more time or have no effect on the amount of time?



Note: Results for each task are reported among teachers who report using AI for that task at least monthly. Data labels less than 4% are not displayed.

Most teachers who use AI tools say the tools improve the quality of their classroom work.

Applying AI tools to their classroom work not only saves teachers time but in many cases also improves quality. A majority of teachers who use AI say it improves the quality of their everyday work tasks — and very few (16% or less) say the quality is lessened.

Among teachers who use AI tools for the following tasks:

64% see better quality in the materials they modify to meet student needs.

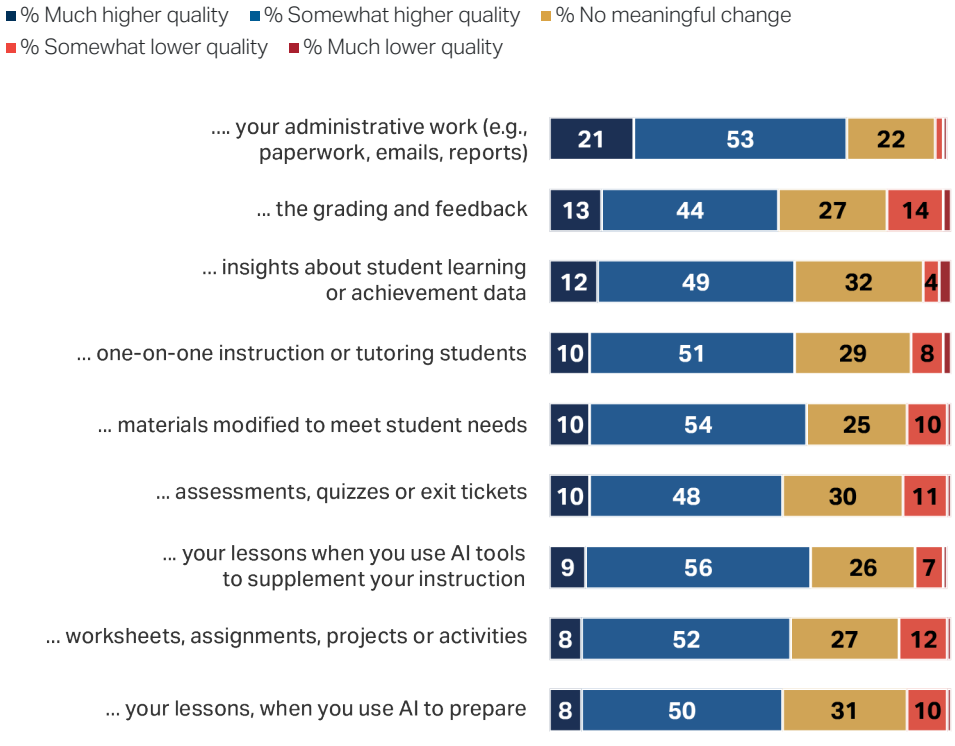
61% generate higher-quality insights about student learning or achievement data.

57% improve the quality of their student feedback and grading.

CHART 4

Impact of AI tools on quality of teachers' everyday work tasks

How would you describe the quality of … when you use AI tools?



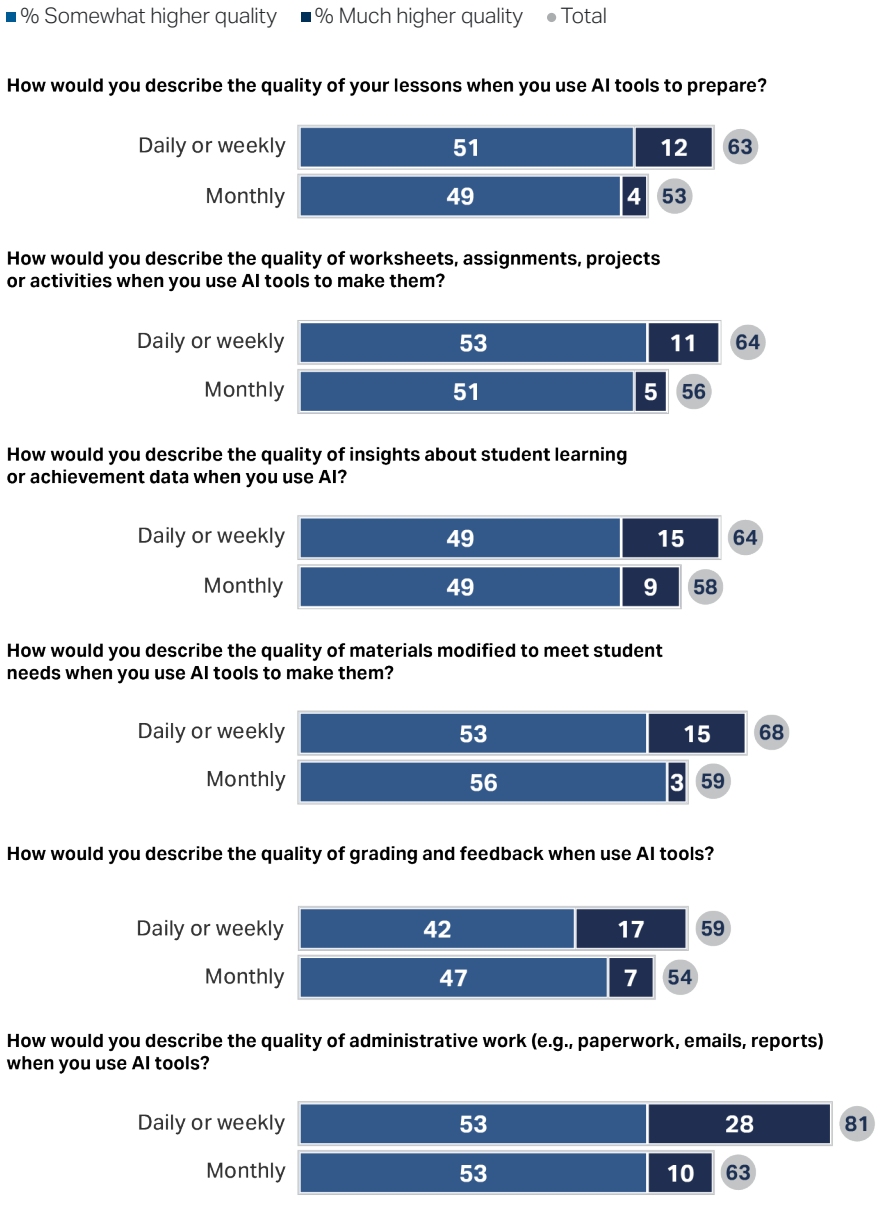
Note: Data labels less than 4% are not displayed.

Teachers who use AI more frequently are even more likely to see higher quality in their work tasks when using AI. In many cases, teachers who use AI at least weekly are twice as likely as less-frequent users to say that AI results in "much higher-quality" work.

CHART 5

Impact of AI tools on quality of teachers' work tasks, by frequency of teacher's AI use

How would you describe the quality of … when you use AI tools?



More frequent AI users see more potential for AI tools in education.

Teachers are slightly more likely to support than oppose the use of AI tools in K-12 schools.

Teachers are still gaining experience with AI tools in the K-12 setting, and no clear consensus exists on whether AI tools should be used in K-12 schools.

Overall, 40% of teachers strongly or somewhat favor the use of AI tools in K-12 schools, and 28% strongly or somewhat oppose.

Teachers in the natural sciences (42%) and subjects other than elementary, English language arts or math (47%) are the most likely to favor AI use. Male (44%) and Hispanic (44%) teachers are also more likely to favor the use of AI.

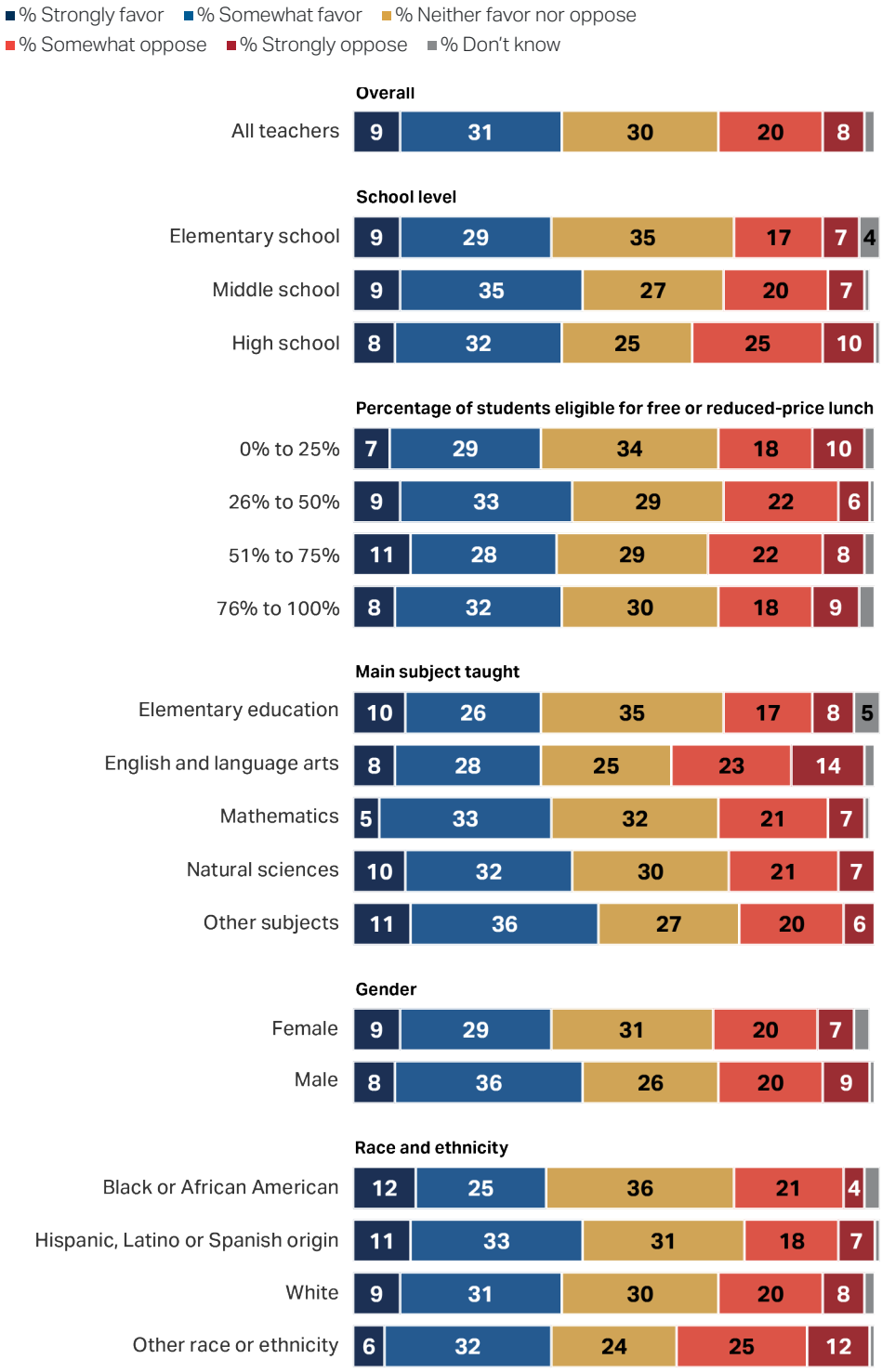
While high school teachers are among the heaviest users of AI, they are also among those most likely to oppose the use of AI. These teachers work with students who are the most likely to use AI (53% use it weekly compared with 41% of middle school students) — and to use it when they should not. Findings from the *Voices of Gen Z: How American Youth View and Use Artificial Intelligence*[3] study show that 35% of high school students say most or all of their classmates use AI when they are not supposed to, compared with 24% of middle school students.

3 Walton Family Foundation and Gallup. (2025). Voices of Gen Z: How American Youth View and Use Artificial Intelligence. https://www.gallup.com/file/analytics/658901/Gallup-Walton-Family-Foundation_Voices-of-Gen-Z_How-American-Youth-View-AI-Report.pdf

CHART 6

Support or opposition to the use of AI tools in K-12 schools, by teacher's grade level and subject taught

In general, to what extent do you favor or oppose the use of AI tools in K-12 schools?



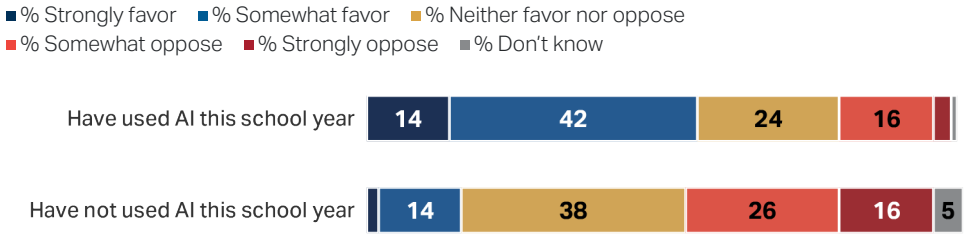
Note: Data labels less than 4% are not displayed.

Teachers who have used AI at least once in the past school year are more than twice as likely to favor use of AI tools in K-12 schools compared with those who have not used AI (56% vs. 16%).

CHART 7

Support or opposition to AI tools in K-12 schools among AI users vs. non-users

In general, to what extent do you favor or oppose the use of AI tools in K-12 schools?



Note: Data labels less than 4% are not displayed.

Findings from the *Voices of Gen Z: How American Youth View and Use Artificial Intelligence*[4] study also show that a plurality of students think their teachers should be able to use AI. Fifty-one percent of Gen Z K-12 students think teachers should be allowed to use AI tools for things like planning lessons (20% disagree). Thirty-nine percent of Gen Z K-12 students think teachers should be allowed to use AI tools for things like grading (31% disagree).

When it comes to their own use of AI tools, K-12 students also show some hesitancy, similar to their teachers: 47% of students agree they should be allowed to use AI tools for classwork and homework, while 31% neither agree nor disagree.

4 Walton Family Foundation and Gallup. (2025). Voices of Gen Z: How American Youth View and Use Artificial Intelligence. https://www.gallup.com/file/analytics/658901/Gallup-Walton-Family-Foundation_Voices-of-Gen-Z_How-American-Youth-View-AI-Report.pdf

Teachers see the most potential for AI tools to improve the accessibility of student materials, teacher workload and student engagement.

To better understand the possibilities that teachers envision when they think of AI in schools, Gallup asked respondents to consider a list of AI tools' potential benefits.

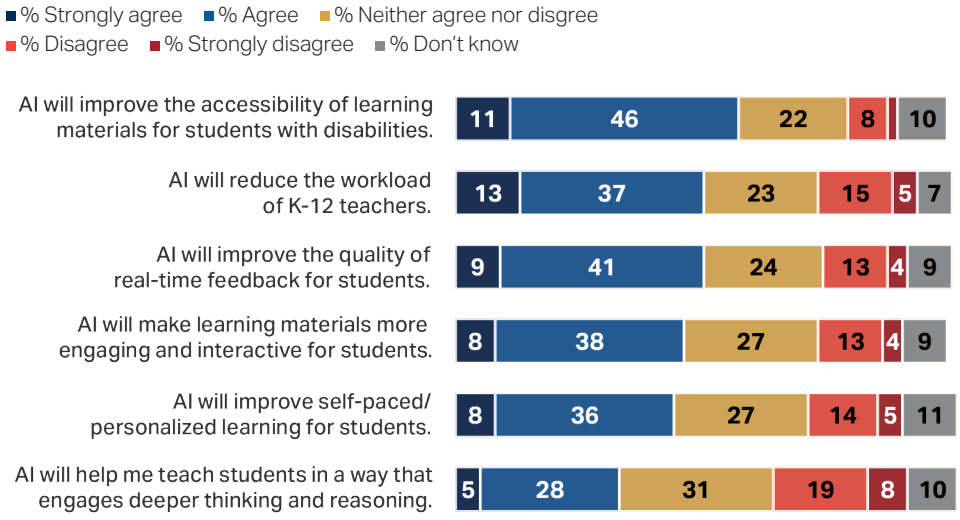
Accessibility emerged at the top of that list, as 57% of teachers agree (46%) or strongly agree (11%) that AI will improve the accessibility of learning materials for students with disabilities. Special education teachers are even more likely to agree AI will yield this benefit (65%).

Roughly half of teachers agree that AI will reduce the workload of teachers (50%), improve the quality of real-time feedback for students (50%) and make learning materials more engaging (46%).

CHART 8

Teachers' evaluation of the potential benefits of using AI tools

Please indicate your level of agreement or disagreement with the following statements.



Note: Data labels less than 4% are not displayed.

Teachers who use AI tools are more likely to see the benefit of those tools for their work tasks, with more than six in 10 agreeing they could help improve accessibility, reduce teacher workloads and improve the quality of real-time feedback.

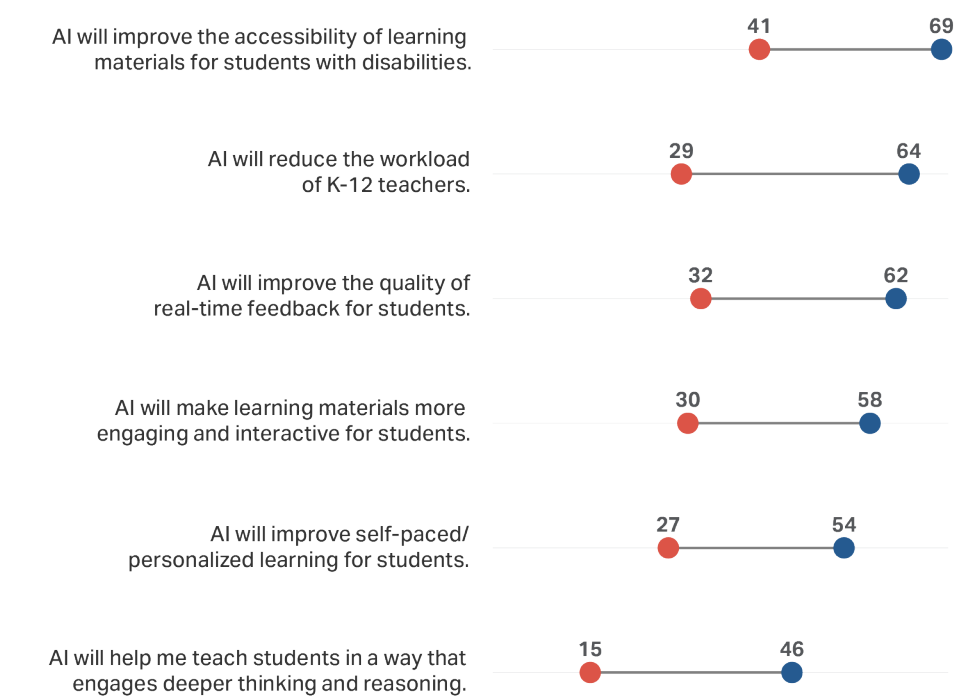
The cause of more positive expectations among AI users is likely multifaceted. As more educators adopt AI tools for teaching, the benefits and drawbacks of using AI tools will become more defined.

CHART 9

Potential benefits of AI tools, by teachers who have and have not used AI tools

Please indicate your level of agreement or disagreement with the following statements.

% Strongly agree + agree



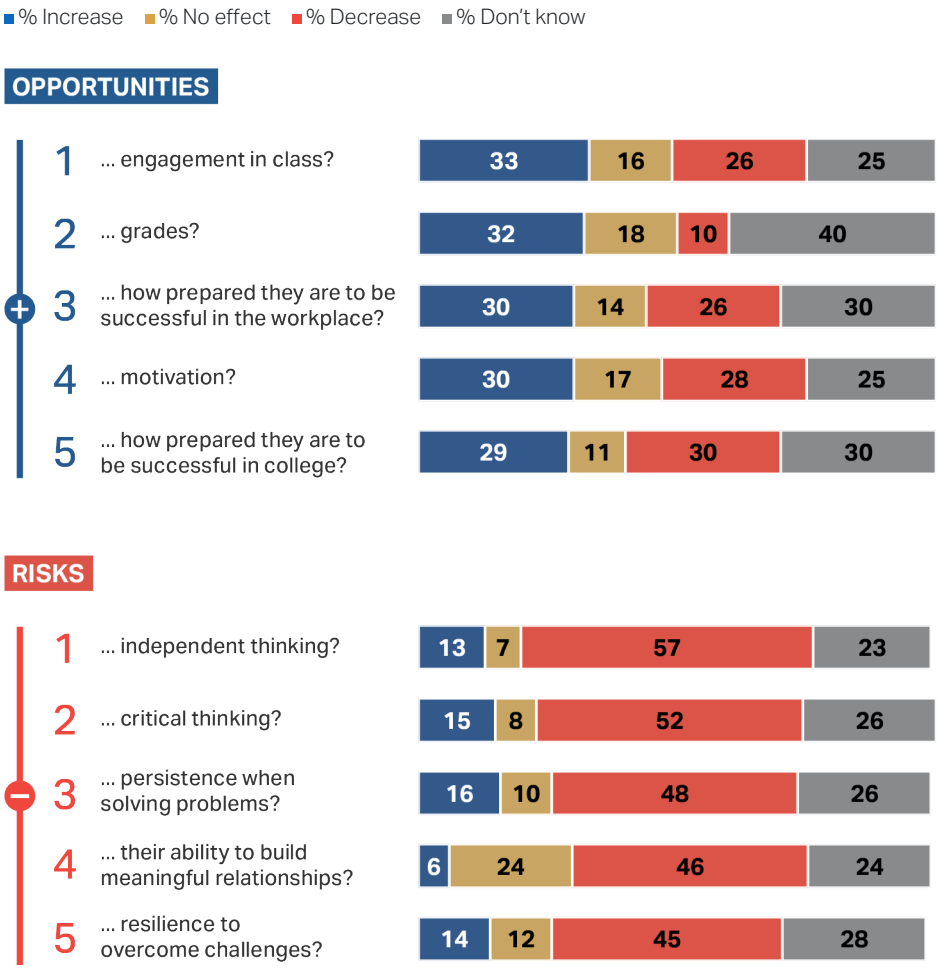
Teachers who use AI have a more confident outlook on AI tools' ability to improve student outcomes.

When it comes to the impact of AI tools on student outcomes, teachers still lack consensus. At least four in 10 are neutral or don't know what effect AI will have on student engagement, motivation, grades, and college and workforce preparation. Roughly three in 10 teachers expect AI will increase positive outcomes in these areas, with similar proportions expecting AI to decrease positive outcomes, except for grades. With respect to grades, 32% predict AI will increase student grades and 10% think it will decrease them.

CHART 10

Top five greatest opportunities and risks perceived by teachers

If your students used AI tools at least weekly, do you think it would increase, decrease or have no effect on ...



Teachers and Gen Z students are mostly aligned on the concerns they have for students' independence and critical thinking, as well as persistence when solving problems. Prior research from the Walton Family Foundation and Gallup in the *Voices of Gen Z: How American Youth View and Use Artificial Intelligence*[5] study shows that 49% of Gen Zers think AI will hurt their ability to think about information carefully. Similarly, independent and critical thinking are the top two areas that teachers predict will see negative effects from AI tool usage when it comes to student outcomes.

However, more frequent users of AI are more likely to be optimistic about its impact on students.

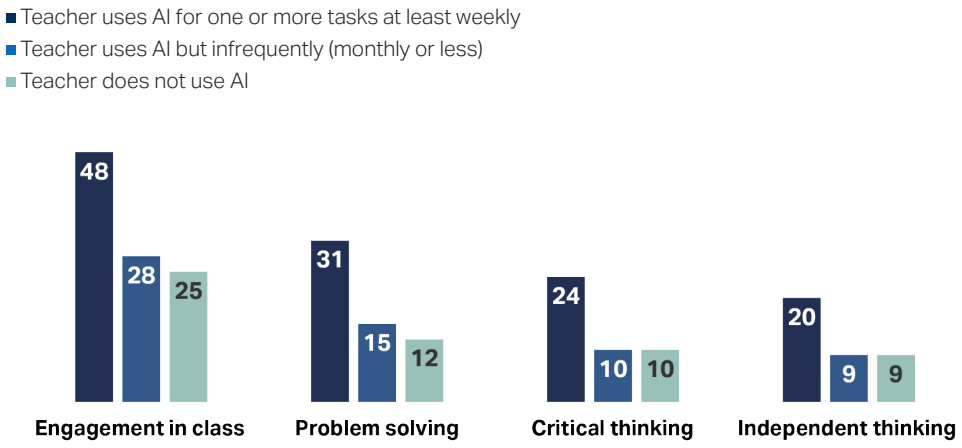
For example, 48% of teachers who use AI weekly think AI will increase student engagement, compared with 28% of teachers who use AI infrequently and 25% of teachers who have never used it this school year.

CHART 11

Perceived impact on student outcomes by frequency of AI use

If your students used AI tools at least weekly, do you think it would increase, decrease or have no effect on … ?

% Increase



5 Walton Family Foundation and Gallup. (2025). Voices of Gen Z: How American Youth View and Use Artificial Intelligence. https://www.gallup.com/file/analytics/658901/Gallup-Walton-Family-Foundation_Voices-of-Gen-Z_How-American-Youth-View-AI-Report.pdf

Some schools and teachers are poised to benefit more than others from the use of AI tools.

Schools with an AI policy see more returns from the AI dividend.

Teachers at schools with AI policies are more likely to have used AI in the past year (70% vs. 60%), and this translates to a better AI dividend for those schools. With more teachers using AI tools, schools with an AI policy are earning an AI dividend that is 26% greater than schools without an AI policy (2.3 vs. 1.7 hours saved per week per teacher).

CHART 12

School AI policies' impact on AI use and time savings

Teacher's school DOES have an AI policy

70%	6.0	2.3
Have used AI this year	Mean hours saved per week *Averaged across weekly users*	Mean hours saved per week *Averaged across all teachers*

Teacher's school DOES NOT have an AI policy

60%	5.6	1.7
Have used AI this year	Mean hours saved per week *Averaged across weekly users*	Mean hours saved per week *Averaged across all teachers*

Findings from the *Voices of Gen Z: How American Youth View and Use Artificial Intelligence*[6] study highlight the impact that school AI policies have on students' confidence to use AI in their postgraduation life. Results show that in schools that allow AI use in at least some circumstances, 57% of students agree they will know how to use artificial intelligence in their daily life after they graduate. For students at schools that do not allow AI use, just 32% feel they will know how to use AI after graduation.

6 Walton Family Foundation and Gallup. (2025). Voices of Gen Z: How American Youth View and Use Artificial Intelligence. https://www.gallup.com/file/analytics/658901/Gallup-Walton-Family-Foundation_Voices-of-Gen-Z_How-American-Youth-View-AI-Report.pdf

Schools that are unable to support their teachers with training and schoolwide policies on AI may risk widening the gaps that already exist between teachers with and without AI skills. In the 2024-25 school year, most teachers (68%) have not engaged in any training provided by their school or district on how to use AI or AI tools. In fact, teachers are more likely to teach themselves how to use AI than to receive training from their school or district (52% vs. 31%). And with just 19% of teachers saying their school has a policy on how to use AI, most schools stand to benefit from adopting policies on AI.

With so much of the "AI dividend" still on the table, there are myriad possibilities for how teachers might leverage AI tools to overcome challenges in teaching and improve student outcomes.

Methodology

Results are based on a web survey conducted March 18 to April 11, 2025, with a sample of 2,232 U.S. teachers working in public K-12 schools. Teachers were recruited from the RAND American Teacher Panel,[7] a nationally representative, probability-based panel of U.S. public school teachers. More information about the RAND American Teacher Panel is available here.

The final sample was weighted to match the school- and teacher-level demographics of K-12 public school teachers in the United States, including school level, student poverty, student race and Hispanic ethnicity, school size, school urbanicity, teacher gender, teacher race and Hispanic ethnicity, and teacher years of experience. Targets for these characteristics were retrieved from the National Center for Education Statistics. Teacher-level characteristics were based on the 2020-2021 National Teacher and Principal Survey, while school-level characteristics were based on the 2022-2023 Common Core of Data.

For the total sample of 2,232 U.S. teachers, the margin of sampling error is ±2.5 percentage points at the 95% confidence level. Margins of error for subgroups are higher. All reported margins of sampling error include computed design effects for weighting. In addition to sampling error, question wording and practical difficulties in conducting surveys can introduce error or bias into the findings of public opinion polls.

7 RAND. (n.d.). RAND American Educator Panels. https://www.rand.org/education-and-labor/survey-panels/aep.html

Calculating the AI Dividend

The AI dividend is the average of the total net time that each teacher estimates saving per week by using AI tools (among teachers who use AI at least monthly). The total net time is based on teachers' estimate of hours saved or spent when using AI for a list of six tasks: making worksheets, making assessments, modifying student materials, grading and/or providing feedback, analyzing patterns in student learning and doing administrative work.

Any teacher who said they have used AI for work or teaching during the 2024-25 school year was also asked how frequently, if ever, they use AI tools on a list of nine tasks. If the teacher indicated they use AI for that task at least monthly, the teacher was then asked whether using AI for that task saves them time, has no effect on time or takes them more time. Teachers who indicated that AI impacts the amount of time spent on a task were then asked to estimate the number of hours, to the nearest half hour, that AI saves them per week (or the number of additional hours they spend, if they indicated that using AI takes them more time).

After the data were collected, a net time estimate for each task was created: Hours saved were added to the total, and if a teacher said that using AI for a task takes them more time, those hours were subtracted from the total. If a teacher indicated that using AI has no impact on the amount of time it takes them to complete a task, a "0" was entered. The net time estimate for each task was then trimmed at the 2.5th and 97.5th percentiles to remove outliers and/or respondents who entered unrealistic amounts of time (e.g., more than 100% of their working hours).

The total net time a teacher saves using AI per week (or must take more time to do when using AI) was summed across six tasks. The six tasks were: making worksheets, making assessments, modifying student materials, grading and/or providing feedback, analyzing patterns in student learning and doing administrative work. Only six tasks were used to create the sum, to avoid overlapping tasks. Across all teachers in the sample who use AI at least weekly, the average time saved per week per teacher was 5.9 hours. When 5.9 is multiplied by the number of contracted weeks per year (37.4, on average), that sums to 220.66 hours per year. At 37.5 contracted hours per week, the total "AI dividend" of 5.9 hours per week is equivalent to 5.9, or about six, weeks per year.

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