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THE POTENTIAL IMPACT OF ARTIFICIAL INTELLIGENCE ON EQUITY AND INCLUSION IN EDUCATION

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Abstract

This working paper reviews the impact of artificial intelligence (AI) on equity and inclusion in education, focusing on learner-centred, teacher-led and other institutional AI tools. It highlights the potential of AI in, e.g. adapting learning while also addressing challenges such as access issues, inherent biases and the need for comprehensive teacher training. The paper emphasises the importance of balancing the potential benefits of AI with ethical considerations and the risk of exacerbating existing disparities. It highlights the need to address privacy and ethical concerns, enhance cultural responsiveness, manage techno-ableism and provide continuing professional learning in AI. Additionally, the paper stresses the importance of maintaining educational integrity amidst growing commercial influence. It encourages research on AI tools' implications for equity and inclusion to ensure that AI adoption in education supports a more equitable and inclusive learning environment.

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1 Introduction

Artificial intelligence (AI) has sparked transformative possibilities in many facets of human life in the current era of rapid technological advancement. AI tools continue to make headlines, while critiques also emerge, citing algorithmic biases, privacy concerns, accountability issues, implications for equity and inclusion, and others. As a general-purpose technology, AI is expected to transform and is already changing a wide range of areas, from advertising, agriculture, and criminal justice, through education, finance, health, marketing, science and security to transport (OECD, 2019[1]). Benefits of AI use in these areas include improving the efficiency of decision making, saving costs and enabling better resource allocation (ibid.).

AI might also have profound impacts on education systems, including on equity and inclusion. Therefore, this working paper delves into some debates around the connection between AI, equity and inclusion in education. By exploring the opportunities and challenges that arise as AI tools reshape the educational landscape, it aims to set the ground for a meaningful discourse on ensuring equitable and inclusive education in times of AI.

To this end, the working paper has three objectives. First, it aims to provide policy makers with a categorisation of AI tools that can support equity and inclusion in education. Following Holmes and Tuomi (2022[2]), the AI tools have been categorised into learner-centred, teacher-led, and other institutional tools. This taxonomy is particularly useful when addressing the question of who the primary user or the primary beneficiary is.

Second, in categorising the AI tools and providing examples, the working paper aims to highlight that AI solutions in various areas already exist, there is demand for them and they are likely already being used by educational institutions across OECD countries. New AI tools are being introduced in classrooms without much supervision or oversight in many countries. This kind of “unchecked adoption” of AI tools can result in some schools, often those that can afford the technology, reaping some of the benefits (but also potential risks) sooner than others. This leads to the final objective of this working paper, namely underscoring that the use of AI tools in education occurs mainly without systematic oversight and regulation. To this end, the paper outlines some of AI tools' significant opportunities and challenges. While opportunities and challenges are categorised based on the learner-centred, teacher-led and other institutional tools taxonomy, there is great overlap among them, and, ultimately, almost all the tools discussed were created to help students learn and address students’ needs (whether directly or indirectly by, e.g. assisting teachers). In particular, challenges mentioned in one section often extend and apply to AI tools described in other sections.

While the working paper does not provide an exhaustive list of AI tools, many are already present in schools, along with the opportunities and challenges they bring. As such, the question emerges to what extent policy makers should aim to support or discourage the use of the tools from a centralised perspective. While this working paper does not seek to provide a comprehensive answer at this early stage, it is the right time to ponder this question.

The paper was conducted using desk-based research, mainly in English. As such, the tools presented may not be relevant in non-English-speaking countries. Nevertheless, the opportunities and challenges are likely applicable regardless of location. Furthermore, little information is available on country-level approaches to AI in education. This probably partially stems from the fact that few education systems have

implemented system-level guidance or policies. Future research should place a greater focus on this aspect. Finally, the opportunities presented in this paper should be viewed more as hypotheses rather than evidence-based evaluations. Indeed, for many of the (types of) AI tools, there are only a handful of robust evaluations for the potential benefits or improvements in student learning and well-being (Holmes, 2023[3]). Where these are available, they are referenced. The working paper focuses mostly on school education.

This field is evolving rapidly and new AI tools are emerging daily. Challenges outlined in this paper are also being constantly addressed. In a year, some of the content will likely be out of date. As such, caution is required when reading this analysis after a prolonged time after publication. That said, the information in this paper can be used to take stock of where the field is at the present and how the field has evolved in a few years.

The working paper is structured as follows. The next section provides a framework for analysis in regard to definitions and guidelines published on AI in education, as well as a taxonomy to analyse the impact on equity and inclusion. Section 3 describes opportunities of learner-centred tools, such as adapting learning, content enrichment, support for learners with special education needs, and information and advice. However, these tools also face challenges such as ensuring access, combating techno-ableism[1], addressing bias, maintaining socio-emotional learning, and balancing AI integration with privacy and accountability concerns.

In section 4, the paper elaborates on teacher-led tools. It discusses the potential of supporting teaching with AI-powered robots, curating learning materials, assisting in assessment and classroom management, identifying some special education needs, and providing continuing professional learning opportunities. Yet, these benefits are weighed against challenges like the high costs of AI tools, the need to balance commercial interests with educational objectives, and the imperative of equipping educators with the necessary AI knowledge and skills.

In section 5, the paper explores institutional tools that can foster equity and inclusion, with opportunities such as increasing the efficiency of admissions, better identifying students at risk of early leaving from education and training, and data-based decisions. However, these tools present challenges, including addressing the complexities and ethical considerations involved in their implementation. The final section concludes and provides some overarching conclusions and policy implications.

[1] Techno-ableism refers to a tendency to argue that technology is a “solution” for disability and, as such, that people with disabilities need to be “fixed” (Shew, 2020[74]).

2 Definitions, guidelines and conceptualisations

Definitions of artificial intelligence, equity and inclusion

Before discussing the impact of AI on equity and inclusion in education, it is necessary to define AI and explore how AI can be applied in educational contexts in general. Defining AI is a crucial yet challenging starting point in the ever-changing realm of technology. This working paper adopts the definition of the OECD as recommended by the Council on Artificial Intelligence (OECD, 2023, p. 7[4]):

> "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. Different AI systems vary in their levels of autonomy and adaptiveness after deployment".

Other definitions stress AI's potential meaning for society even further, e.g. referring to AI as "a set of sciences, theories and techniques whose purpose is to reproduce by a machine the cognitive abilities of a human being" (Council of Europe, 2024[5]).

Given the focus of this working paper on equity and inclusion in education, it is also essential to define these (Figure 2.1). The concepts vary across the literature and in the interpretations of different education systems (Cerna et al., 2021[6]; Varsik, 2022[7]). The OECD Education for Inclusive Societies project offers a comprehensive insight into the critical elements encompassed within countries' definitions of equity and inclusion (OECD, 2023[8]). In regard to equity, the project's definition includes two complementary approaches. First, horizontal equity reflects the overall fair provision of resources to each part of an education system, providing similar resources to those alike. Second, vertical equity involves giving additional resources to disadvantaged groups or schools based on their needs. Equitable education systems are thus defined as those that ensure the achievement of educational potential regardless of personal and social circumstances, including factors such as gender, ethnic origin, Indigenous background, immigrant status, sexual orientation and gender identity, special education needs, and giftedness (Cerna et al., 2021[6]; OECD, 2017[9]).

Inclusion is defined as "an on-going process aimed at offering quality education for all while respecting diversity and the different needs and abilities, characteristics and learning expectations of the students and communities, eliminating all forms of discrimination" (UNESCO, 2009, p. 126[10]). More than a particular policy or practice related to a specific group of students or individuals, this definition identifies an ethos of inclusion and communities of learners, which does not only involve an individual dimension but also a communal one. Inclusive education aims to respond to all students' needs beyond school attendance and

achievement while improving all students' well-being and participation (Cerna et al., 2021[6]).

Figure 2.1. Definitions of equity and inclusion in education

Equity

- Equitable education systems are those that ensure the achievement of educational potential regardless of personal and social circumstances, including factors such as gender, ethnic origin, Indigenous background, immigrant status, sexual orientation and gender identity, special education needs, and giftedness.

Inclusion

- An on-going process aimed at offering quality education for all while respecting diversity and the different needs and abilities, characteristics and learning expectations of the students and communities, eliminating all forms of discrimination.

Note: The definitions were adopted by the Education for Inclusive Societies (and the previous Strength through Diversity) project. Other organisations, projects, countries and researchers may use different definitions.
Source: OECD (2023[8]), Equity and Inclusion in Education: Finding Strength through Diversity, https://doi.org/10.1787/e9072e21-en and UNESCO (2009[10]), Defining an Inclusive Education Agenda: Reflections around the 48th session of the International Conference on Education, https://unesdoc.unesco.org/ark:/48223/pf0000186807 (accessed on 25 March 2024).

These definitions are supported by Gottschalk and Weise (2023[11]), who provide a detailed conceptualisation for defining equity and inclusion in regard to digital technologies in education (Table 2.1). Digital equity in education promotes fairness and equity in student access to digital technologies, skills, uses and attitudes. As such, digital tools for equity in education provide additional learning resources for students in need and help them participate fully in education (Gottschalk and Weise, 2023[11]). Digital inclusion, in turn, overcomes barriers to participation based on student differences. Digital technologies for inclusion are then adapted to acknowledge, accept and respect student differences. They also ensure that students feel included, promote their well-being and sense of belonging, and ensure non-discrimination (ibid.).

Table 2.1. Conceptualising equity and inclusion regarding digital technologies in education

	In education	For equity/inclusion in education
Equity	Digital equity in education: Promoting fairness and equity in access to digital technologies (including hardware, software, high-quality broadband, etc.), digital skills, uses and attitudes for all students.	Digital technologies for equity in education: Using digital technologies to promote equity in education, such as providing additional learning resources for students in need to promote equitable outcomes to help them participate fully in (digital) education.
Inclusion	Digital inclusion in education: Overcoming barriers to participation in digital education based on student differences. This would also involve ensuring digital tools in education are designed and used to promote participation and inclusion of all learners.	Digital technologies for inclusion in education: Adapting digital technologies and learning environments to promote inclusion in education, acknowledging, accepting and respecting student differences. Using digital technologies to promote inclusion in education should aim to ensure students feel included, promote belonging and a sense of well-being, while ensuring non-discrimination.

Source: Gottschalk and Weise (2023[11]), Digital equity and inclusion in education: An overview of practice and policy in OECD countries, Table 1.1., https://doi.org/10.1787/7cb15030-en.

Having defined AI, equity and inclusion, it is worthwhile to explore how AI can be applied in educational contexts before moving on to more specific cases. To that end, differentiating between AI techniques and AI technologies can be a helpful approach (UNESCO, 2022[12]). The former refers to methods, approaches

and algorithms used in AI to solve specific tasks or problems (Table 2.2). They are the underlying mathematical and computational processes that enable AI systems to learn, reason and make decisions. AI technologies, in turn, encompass the hardware and software infrastructure that facilitates AI systems' development, deployment and operation. Individual AI tools will then deploy AI techniques and technologies to address a particular issue. For instance, intelligent tutoring systems (section Learner-centred tools to support equity and inclusion) can use a variety of AI techniques (commonly, e.g. machine learning) to train on vast amounts of data and then deploy AI technologies (commonly, e.g. chatbots) to interact with the user.

Table 2.2. AI techniques and technologies

	Definition	Examples
AI techniques	Methods and approaches used to solve specific tasks or problems, as well as underlying mathematical and computational processes that enable AI systems to learn, reason, and make decisions.	Machine learning algorithms, deep learning, supervised and unsupervised learning, neural networks.
AI technologies	Hardware and software instruments, frameworks and platforms that enable the implementation of AI techniques to create AI applications.	Autonomous agents (avatars, chatbots, robots), image and speech recognition, natural language processing.

Source: UNESCO (2022[12]), K-12 AI curricula: a mapping of government-endorsed AI curricula, https://unesdoc.unesco.org/ark:/48223/pf0000380602 (accessed on 15 January 2024).

Guidelines and frameworks related to artificial intelligence in education

Given the globalised nature of technology developments, policies addressing the use of AI to foster equity and inclusion in education are not necessarily constrained by country borders. Furthermore, international policy frameworks can influence national directives. This section outlines some prominent guidelines and frameworks focusing on AI in the context of equitable and inclusive education. Within the OECD, the Council's Recommendation on Artificial Intelligence lays the foundation for how governments and other actors can develop a human-centric approach to trustworthy AI (OECD, 2023[4]). As a legal instrument, its principles represent a common aspiration for OECD countries. In regard to equity and inclusion, the first principle targets inclusive growth, sustainable development and well-being. Countries are called upon to consider how AI can advance "the inclusion of underrepresented populations, reducing economic, social, gender and other inequalities" (OECD, 2023, p. 7[4]). Furthermore, the OECD Secretariat has joined forces with Education International, a global federation of teacher unions, to develop nine opportunities, guidelines, and guardrails for the effective and equitable use of AI in education (OECD, 2023[13]). These aim to help educational stakeholders navigate some of the fast-moving developments in AI, and a notable focus is on equity of access and use (ibid.).

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) also provides several guidelines and frameworks on AI in education. The Recommendation on the Ethics of Artificial Intelligence marks a consensus among 193 member states concerning the core values, principles and policies that should drive the advancement of AI (UNESCO, 2022[14]). It outlines practical approaches, such as tools, methodologies and initiatives intended to maximise AI's beneficial influence on society while mitigating associated risks (ibid.). Moreover, the Beijing Consensus on Artificial Intelligence and Education codifies the agreements on the ethical use of AI in education (UNESCO, 2019[15]). It is complemented by guidelines for policy makers on leveraging the opportunities and addressing the challenges and risks associated with AI and education (UNESCO, 2021[16]). The guidelines outline the definitions, techniques and technologies of AI, and analyse some emerging trends and implications of AI for teaching and learning. More recently, UNESCO published guidance on generative AI in education and research, marking the first attempt to create a global standard for the use of generative AI (UNESCO, 2023[17]). Additionally, UNESCO is working on AI competency frameworks for students and teachers, as well as on a global survey on the

governmental use of AI as a public good for education, including existing AI competency frameworks and continuing professional learning programmes on AI for teachers (UNESCO, 2023[18]).

Looking at other international organisations, the United Nations Children's Fund (UNICEF) provides policy guidance on AI for children, presenting recommendations for building AI policies and systems that uphold child rights (UNICEF, 2021[19]). The policy guidance advocates for children's rights within both government and private sector, and seeks to enhance awareness of how AI systems can support and compromise children's rights (ibid.). These guidelines go beyond education and present a more holistic discussion on how AI can impact children's lives. Furthermore, the European Commission launched the Digital Education Action Plan (2021-2027), a policy initiative that, among other things, includes ethical guidelines on the use of AI and data in teaching and learning (European Commission, n.d.[20]). The guidelines are designed to help teachers and educators understand AI tools' potential in education and raise awareness of possible risks (ibid.).

Some national examples of guidelines and frameworks for AI in education can also be found. The United States Department of Education published recommendations on the future of teaching and learning in the context of AI. The recommendations also focus on using emerging AI technology for digital equity and inclusion (U.S. Department of Education, Office of Educational Technology, 2023[21]). In England (United Kingdom), the Department for Education published a policy paper on using generative AI in the education sector, including large language models like ChatGPT and Google Bard (Department for Education, 2023[22]). It discusses the potential of these tools to reduce workload and enhance teaching while cautioning about their limitations and the need for professional judgment to ensure content accuracy and appropriateness (ibid.). It also emphasises the importance of data privacy, intellectual property rights and the integration of AI into formal assessments and future skills training (ibid.). In Norway, the Directorate for Education and Training provides regularly updated guidance on integrating AI in schools, emphasising the need for schools to evolve with society and technology (Directorate for Education and Training, 2024[23]). It highlights the rapid development of AI, along with its challenges and opportunities, and stresses the importance of addressing these issues immediately and over the long term (ibid.). The Directorate also outlines specific advice for schools on incorporating AI into education, including updating curricula to prepare students for a future influenced by AI, emphasising critical thinking and ethical considerations, and fostering a culture of experimentation and evaluation in pedagogical practice (ibid.).

Taxonomy to analyse the impact of artificial intelligence on equity and inclusion in education

Having defined the concepts and outlined some available guidelines and frameworks, this section explores which conceptualisations and taxonomies are available in the literature. For instance, Pons (2023[24]) differentiated between the impacts inside and outside the classroom. Chen, Chen and Lin (2020[25]) considered the functions of AI in administration (e.g. AI can perform some administrative tasks faster or more cost-effectively and can help teachers in data-driven work), instruction (e.g. analyse course materials, help create learning plans), and learning (e.g. uncover learning shortcomings, apply intelligent adaptive interventions). The primary focus of this working paper is to help policy makers orient themselves in the vast array of tools and their impacts on equity and inclusion in education. To this end, the authors adopted and adjusted the taxonomy by Holmes and Tuomi (2022[2]). The rationale for this taxonomy of AI tools in education – categorising them into learner-centred, teacher-led-and other institutional tools (Table 2.3) – is primarily based on each tool's primary beneficiary and intended application. This taxonomy allows for a clearer understanding of how AI is applied in different facets of the educational ecosystem, addressing distinct challenges and objectives in each sector. Furthermore, this taxonomy comes with a

helpful categorisation of the vast amount of AI tools (Holmes, 2023[3]; Holmes and Tuomi, 2022[2]).[2] This provides a solid base to elaborate on the more specific focus of this working paper on equity and inclusion in education. While this categorisation might be helpful in some contexts, overlaps exist among the categories. For instance, learner-centred AI tools indirectly benefit and support teachers, as they can save them time. Furthermore, it could be argued that most, if not all, of the tools discussed in this working paper have been developed to improve student academic and well-being outcomes.

Table 2.3. Taxonomy of AI tools in education

	Purpose	Examples of AI tools
Learner-centred tools to support equity and inclusion	Designed to enhance the learning experience of students.	Intelligent tutoring systems, AI-enabled simulations, AI-enabled tools to support students with special education needs, etc..
Teacher-led tools to support equity and inclusion	Assist teachers in their instructional and administrative roles.	AI-powered robots, assistants with assessment and classroom management, continuing professional learning coaches, etc..
Other institutional tools that can foster equity and inclusion	Aimed at addressing broader institutional objectives such as improving operational efficiency and managing admissions.	Smart admission systems, tools for identifying at-risk students and assistants with data-based decision making.

Note: Categories can overlap in regard to purpose and examples.
Source: Holmes and Tuomi (2022[2]), State of the art and practice in AI in education, https://doi.org/10.1111/ejed.12533.

Learner-centred AI tools (section 3) are designed to enhance students' learning experience. They can provide adaptive learning and offer support in areas where students may struggle. This category includes tools like intelligent tutoring systems, AI-enabled simulations, AI-enabled tools to support students with special education needs and others. These technologies have not necessarily been designed for students and to be used by students (Holmes and Tuomi, 2022[2]). Instead, they were often repurposed for learning (ibid.).

Teacher-led AI tools (section 4) assist teachers in their instructional and administrative roles. They are designed to streamline tasks like assessment, curation of learning materials and classroom management, thereby enhancing teaching efficiency and effectiveness. AI-powered robots, tools that enable smart curation of learning materials, assistants with assessment and classroom management, tools that help identify some special education needs, and continuing professional learning coaches fall into this category.

Finally, other institutional tools (section 5) aim to address broader institutional objectives, such as improving operational efficiency and managing admissions. They can be used at a higher administrative level and impact the institution as a whole. Examples include smart admission systems, tools for identifying students at risk of early leaving from education and training, and assistants with data-based decision making.

[2] Holmes (2023[3]) also provides an elaborate overview of AI tools in each of the categories.

3 Learner-centred tools to support equity and inclusion

Learner-centred AI tools are designed to improve students' educational experiences. They aim to enable tailored learning experiences and furnish assistance in subjects where students might face difficulties. They have the potential for adaptivity, enriching content, assistance in learning, and informing and advising students. However, these tools also come with several challenges. These include access disparities, dangers of techno-ableism, various inherent biases, socio-emotional implications, and privacy and accountability concerns.

Opportunities of learner-centred AI tools for equity and inclusion

Learner-centred AI tools have the potential to mark a transformative moment in education, opening doors to new opportunities for equity and inclusion. Intelligent tutoring systems exemplify this shift, offering adaptive learning experiences that have the potential to enhance educational outcomes for a diverse student body. Similarly, AI-enabled simulations can enrich content, making learning more engaging and culturally rich, thereby catering to a varied student demographic. For learners with special education needs, AI tools can provide additional support and equalise access to educational content. Furthermore, AI-powered tools, such as chatbots, have the potential to play a role in promoting inclusivity. They can offer rapid, universal access to information and support mental health. As these technologies evolve, they might play an increasingly significant role in fostering inclusive and equitable learning environments.

Adapting learning

Adaptivity in learning, sometimes referred to as “personalisation”[3], has been highlighted as one of the most defining features of AI tools (Khosravi et al., 2022[26]). In particular, intelligent tutoring systems (ITS) can significantly advance educational technology, combining AI techniques with pedagogical methods to tailor instructional activities to individual learner profiles. These systems adjust content, pace and difficulty level in real-time, responding to the unique characteristics, needs and performance of each student (Conati et al., 2021[27]; Keleş et al., 2009[28]; Mousavinasab et al., 2018[29]). Indeed, adaptive learning is a significant advantage of ITS (de la Higuera and Iyer, 2024[30]). Such adaptability can result in more inclusive education responsive to the varied learning requirements of a diverse student body. For example, Carnegie Learning's adaptive learning platform provides a customised learning experience that aims to adapt in real-time to each student's interactions. Khan Academy’s Khanmigo offers AI one-on-one tutoring to students by, e.g. mimicking a writing coach by giving prompts and suggestions to move students forward as they write, debate and collaborate. Furthermore, individuals for whom English is not their first language

[3] Some researchers observed that the term “personalisation” is imprecise (Plass and Pawar, 2020[144]). For some educators, it can mean tailoring activities to each student, for others it might mean giving learners voice and choice. Furthermore, many education technology products “personalise” in limited ways (U.S. Department of Education, Office of Educational Technology, 2023[21]).

can benefit from AI tools that rewrite the text into grammatically correct and stylistically appropriate English – provided that they understand, access, navigate, expertly prompt, corroborate, and ethically and effectively incorporate text generated by AI tools (Warschauer et al., 2023[31]). Another key opportunity ITS presents is catering to gifted students (Johns Hopkins Center for Talented Youth, 2023[32]). These systems could provide enriched content along with adapted enrichment activities (Johns Hopkins Center for Talented Youth, 2023[32]; Pons, 2023[24]). Such an approach matches gifted students' academic abilities, and promotes independent exploration and research, thus fostering a conducive learning environment for their skills and talents (Rutigliano and Quarshie, 2021[33]).

This tailored approach has the potential to help struggling students catch up academically so they do not remain disadvantaged due to educational setbacks. Indeed, there is some emerging evidence suggesting that ITS help disadvantaged students and ethnic minorities (Huang et al., 2016[34]). This can potentially address the gap in educational equity, as these students often lack access to individualised support that can be pivotal in their academic development (OECD, 2020[35]). However, more research of higher quality is needed, with a recent meta-analysis reporting mixed results (Wang et al., 2023[36]). In particular, a lack of research is visible on the heterogeneous effects of ITS on diverse learners.

An indirect effect of ITS can be alleviating some tasks performed by school staff members, enabling them to focus on more complex aspects of teaching and learning. This can enhance the quality of education and contribute to a more sustainable workload for educators. For instance, Carnegie Learning's technology aims to support teachers by providing detailed insights into student performance, enabling them to intervene more effectively and efficiently. While system-level implementation of ITS remains rare, some countries, such as Austria, Korea, Luxembourg and Türkiye, are pioneering these (OECD, 2023[37]).

Enriching content

AI-enabled simulations, encompassing game-based learning, chatbots, virtual reality (VR) and augmented reality (AR), can offer interactive and immersive experiences that enhance learning. The integration of AI-enabled simulations, tailored to cultural specificities, has the potential to make curriculum content more tangible and engaging. For instance, in medical sciences, a VR heart anatomy system enhanced students' anatomy learning experience and understanding, compared to traditional physical models (Alfalah et al., 2018[38]). Varjo can help medical students prepare for challenging real-life scenarios. Chatbots, such as ChatGPT, were used in interactive medical simulations, such as forming independent diagnostic and therapeutic impressions over an entire patient encounter (Scherr et al., 2023[39]). In science and history education, AI-enabled simulations can foster the exploration of scientific phenomena, historical events and cultural practices that are difficult or impossible to replicate in a physical classroom (Holmes, 2023[3]). This aspect is particularly valuable for overcoming budgetary, geographical and physical constraints limiting educational experiences. Several private companies offer solutions. Google Virtual Field Trips, among others, aims to enable students to experience various environments: history and natural history, geography, arts, science and technology. Other reviews have shown that AI-enabled simulations can enhance learning and memory, although more research is needed (Papanastasiou et al., 2018[40]; Pellas, Dengel and Christopoulos, 2020[41]). In particular, studies need to be conducted using more robust designs and with control groups placed in appropriate settings (e.g. comparing AI-enabled simulations with older simulation tools such as 2D simulations).

Furthermore, AI-enabled simulations can provide a supportive environment for students to develop essential skills such as problem-solving, social interaction and collaboration (Dai and Ke, 2022[42]; Wu et al., 2019[43]). These environments can be conducive to students with particular special education needs. For instance, Brain Power, an AR system empowering people with autism, aims to help to teach these individuals social and cognitive skills. AR solutions can also help students with disabilities to play and exercise with their peers. iGYM, for instance, is an AR designed for school and community-based sport or

recreation facilities seeking to provide novel and accessible ways for people with motor disabilities and their non-disabled peers to play and exercise together (Graf et al., 2019[44]).

AI-enabled simulations can also play a role in enhancing cultural diversity and individualising learning contexts. For instance, these technologies can promote the appreciation of Indigenous and minority cultures (Reihana et al., 2023[45]). Culturally contextualised digital technologies can enable more meaningful learning experiences for students from diverse backgrounds. Indeed, Google Arts & Culture can provide educators and students with extensive cultural content, including collections on Black and Indigenous history and culture in the United States. This platform utilises interactive camera features, making learning about cultural artefacts engaging and dynamic.

Assisting learners with special education needs

AI-enabled tools designed to support learners with special education needs (SEN) are technologies that assist in overcoming a range of visual, auditory, physical and cognitive impairments (Holmes, 2023[3]). A growing body of literature emphasises the role of AI in facilitating special needs education (Gottschalk and Weise, 2023[11]; OECD, 2021[46]; Vincent-Lancrin and van der Vlies, 2020[47]). These AI tools aim to adapt to individual needs and abilities, offering learning experiences potentially tailored to each student's unique skills and requirements (Hopcan et al., 2022[48]). They can make learning experiences more accessible and enhance the educational process for students with various disabilities, impairments and difficulties. By employing AI-enabled tools, educators can significantly improve the accessibility of educational content and experiences for these students (Holmes, 2023[3]).

One of the potential benefits of these AI tools is the facilitation of including students with SEN in standard classroom settings. Integrating AI tools into the classroom can allow students with SEN to participate alongside their peers to a greater extent, contributing to a more diverse and inclusive learning community. These tools have the potential to assist the students in accessing the curriculum, and also enrich the educational experience for all students by fostering an environment of diversity and mutual understanding. For example, students with visual and auditory impairments can benefit from AI tools that provide customised support. A notable advancement in this area is the development of AI assistive devices for learners with hearing impairments. Microsoft Translator, for instance, has created a device equipped with a headset that translates speech signals into written captions in real-time. This device employs deep learning and AI technologies, including VR and AR, to deliver a customised hearing experience featuring sound scene analysis, sound protection, real-time language translation, etc. (Roach, 2018[49]). Moreover, the tool supports translation to over 60 languages, making it beneficial to many students who do not speak the language of instruction with or without SEN (ibid.). Similarly, Deaf AI is developing digital sign language interpreters for real-time interpreting of voice to sign languages.

Other tools utilise AI to foster social communication skills in children with autism spectrum disorders (OECD, 2021[46]). ECHOES, for instance, is a technology-enhanced learning environment where young learners can explore and practise skills needed for successful social interaction, such as sharing attention with others, turn-taking, initiating and responding to bids for interaction (Bernardini, Porayska-Pomsta and Smith, 2014[50]). By integrating playful activities within a virtual "magic garden" and interaction with a virtual character named Andy, ECHOES operates on the SCERTS model principles of Social Communication, Emotional Regulation, and Transactional Support (ibid.). This approach demonstrates the potential of AI tools in enhancing educational experiences for students with SEN by providing environments that stimulate their unique learning requirements (Porayska-Pomsta et al., 2018[51]). Evaluation of the ECHOES environment highlighted a nuanced increase in social initiations from children, both towards human partners and the AI agent, underscoring the effectiveness of AI in engaging students with some SEN in meaningful educational interactions (ibid.).

Informing, advising and supporting students

AI-powered chatbots are tools designed to simulate interactive conversations with human users by adapting to new information and user interactions (Holmes, 2023[3]). Chatbots in education can provide quick and universal access to information (Okonkwo and Ade-Ibijola, 2021[52]). Students may sometimes prefer to use chatbots for information retrieval over traditional counselling methods. For instance, many students would like not to have sexual education content delivered by familiar teachers as it could "blur boundaries and introduce awkwardness into the teacher-pupil relationship" (Pound, 2017, p. 1[53]). To this end, the Roo chatbot aims to provide users with answers related to sexual education. Such chatbots can offer immediate access to information and can keep students engaged and motivated (ibid.). The implications this could have for education are yet to be determined. On the one hand, chatbots could make sexual education more comprehensive and less "awkward". On the other hand, the potential lack of alignment with official curricula could be viewed as problematic.

From an equity standpoint, chatbots can present a budget-friendly solution for equitable distribution of information and assistance. They can give all students instant access to essential details like class timings, venue information, submission deadlines and educational materials. EduBot by INNODATATICS, for instance, can offer help-desk support in, e.g. courses and curriculum at a school or higher education institution. In addition to providing real-time responses, it features speech recognition and emotion analysis that reads the user's emotions and aims to respond appropriately. CareerChat, a chatbot powered by AI, aims to provide career support services to students, and save time, energy and resources for career development professionals, thus enabling them to help students more effectively (Hughes, 2023[54]).

AI-enabled tools, including chatbots, are also being used to detect and support student health issues. These tools can analyse various data sources, such as behaviour patterns, sleep quality, heart rate and academic performance, to identify signs of mental health struggles or well-being issues (Holmes, 2023[3]). Implementing such tools can be particularly beneficial in disadvantaged areas, where resources fostering well-being might not be easily accessible. Indeed, chatbots can offer 24/7 non-judgmental listening, providing information about available resources, coping strategies and guidance to appropriate professional help where needed (ibid.). This round-the-clock availability ensures that students have constant access to support, which is particularly important in times of crisis or when immediate help is required. Confidentiality and anonymity are often cited as advantages of chatbots, particularly for those seeking support and information without the fear of stigmatisation (Abd-alrazaq et al., 2019[55]). This aspect is crucial in creating an inclusive and supportive educational environment where all students feel comfortable seeking help. For instance, the ADMINS project by the Institute of Educational Technology is creating a chatbot assistant that can enable more effective access to support by providing an alternative to filling in forms. By supporting dialogue, the assistant aims to guide the student to provide information that helps the educational institution understand their needs, allow them to ask questions and understand more about the available support. While chatbots show potential in this area, more research is needed to confirm their clinically significant effects and safety (ibid.).

Challenges of learner-centred AI tools for equity and inclusion

Integrating AI in education confronts significant challenges in ensuring equity and inclusion. Issues of access and the digital divide spotlight the need to bridge technological gaps and address socio-technical factors contributing to the AI divide. Concurrently, techno-ableism might necessitate the involvement of disabled individuals in AI development to create inclusive and empathetic educational tools. Compounding these challenges are inherent biases in AI, reflecting societal prejudices, and requiring a diverse and critically aware approach to AI implementation. Equally critical are the socio-emotional implications of AI in education, including the potential reduction in human interaction and its impact on social skills and mental health. Finally, integrating AI in educational settings raises essential data privacy and security

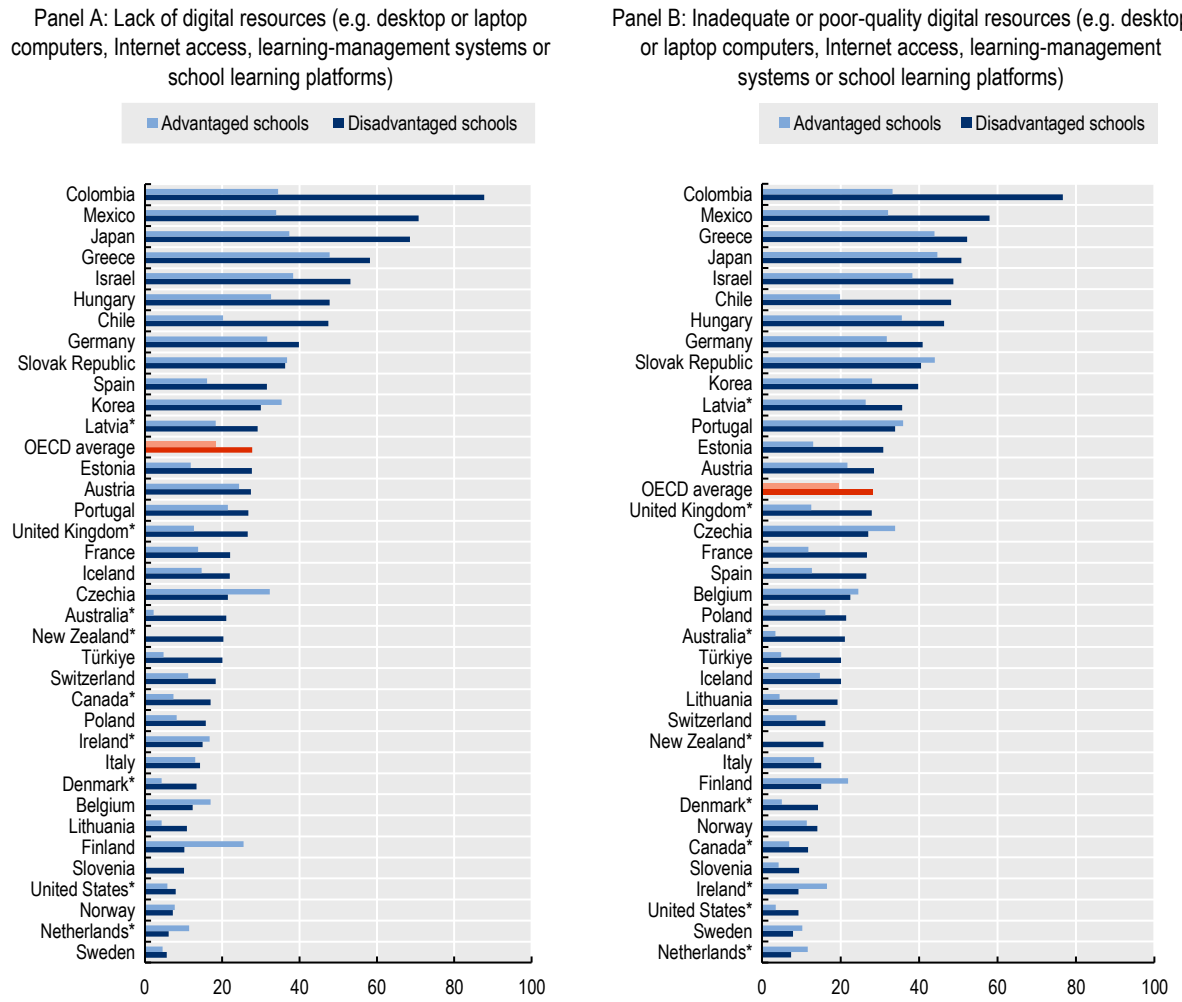
concerns, emphasising the need for informed consent, transparent AI systems and robust privacy protection regulations. This section examines these complex issues, underscoring the importance of navigating these challenges to realise the potential of learner-centred AI tools in creating equitable and inclusive educational environments.

Accessing AI tools

The increasing integration of AI-powered education technologies can present challenges for equity and inclusion in education, mainly due to varying degrees of access to the technology. This so-called "digital divide" can present challenges in terms of technical components, socio-technical and social factors (Carter, Liu and Cantrell, 2020[56]). Technical factors, such as technology availability, broadband speed and computational data, are crucial for the effective use of AI tools. These technologies often require internet access for optimal functionality, as the internet enables AI systems to access databases, online resources and real-time data essential for up-to-date information. For instance, cloud-based AI services and interactive tools depend heavily on internet connectivity to offer adaptive, real-time and enriched educational experiences (ibid.). However, schools with high shares of socio-economically disadvantaged students already report a more significant lack of and inadequate quality of digital resources (Figure 3.1). On average across OECD, almost 30% of students in disadvantaged schools had principals who reported a lack of digital resources, or an inadequate or poor-quality thereof in 2022. In contrast, less than 20% of students in advantaged schools had principals who reported similar concerns.

Figure 3.1. Quantity and quality of digital resources by socio-economic profile of schools (2022)

Percentage of students in schools whose principal reported a lack of digital resources (panel A), or inadequate or poor-quality digital resources (panel B), to some extent or a lot



Note: * Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4 in OECD (2023[57])). The PISA Index of Economic, Social and Cultural Status (ESCS) measures the schools' socio-economic profile. A socio-economically disadvantaged (advantaged) school is in the bottom (top) quarter of the ESCS index in the country.
Sorted in descending order of the percentage of students in disadvantaged schools whose principal reported a lack of digital resources, or inadequate or poor-quality digital resources.
Source: OECD (2023[58]), PISA 2022 Results (Volume II): Learning During – and From – Disruption, Tables II.B1.5.19-20, https://doi.org/10.1787/a97db61c-en.

Social factors include demographic and socio-economic characteristics of users that can impact who accesses AI tools (e.g. gender, age, income, family size, educational level) (Carter, Liu and Cantrell, 2020[56]). These also include other social factors such as culture, regulations and policies that determine access to AI tools (ibid.). These social factors are highly relevant to inequities in education as they can determine who has access to and can benefit from AI technologies in learning environments. For instance, disadvantaged students may have limited access to AI-enhanced educational tools. Cultural factors and regulations also play a role in how AI is integrated into education systems, potentially creating disparities in the quality of education received. Such socio-economic and cultural divides can lead to a widening gap in educational outcomes, reinforcing existing inequalities.

Finally, socio-technical factors include skills, digital literacy, beliefs, mistrust, risk perceptions and privacy concerns (Carter, Liu and Cantrell, 2020[56]). For instance, an earlier cycle of PISA revealed that a higher percentage of advantaged students reported using information and communication technology outside of school for reading news (70%) or obtaining practical information (74%) in comparison to disadvantaged students (55 and 56%, respectively) (OECD, 2016[59]). Similarly, results showed that 93% of advantaged students thought the internet was a good resource for obtaining information compared to 84% of disadvantaged students (OECD, 2017[60]). Disadvantaged socio-economic background is also associated with underperformance in computer and information literacy and computational thinking (Fraillon et al., 2020[61]). Socio-economically disadvantaged students are also less likely to use the internet to e.g. search for information about careers or higher education programmes than their less advantaged peers (OECD, 2019[62]). Access disparities also extend to cultural differences in the adoption of AI technologies. Students from less trusting cultures may not access AI tools that support, e.g. health and well-being. These skills and attitudes can influence how users interact with and perceive AI innovations, thus shaping inequities in access to AI technologies.

Some AI technologies can present financial barriers for many schools and families. Thus, integrating AI tools, such as game-based learning, VR and AR, can widen the gap between resource-rich and resource-poorer schools and families. The cost of VR/AR equipment and content development can be prohibitively expensive, leading to a situation where institutions that can afford these technologies provide enhanced educational experiences to students who already have more advantages, thus exacerbating existing inequalities. The cost of such tools can significantly influence the adoption and use of these tools (Alzahrani, 2020[63]). Furthermore, the costs involved in installing, maintaining and repairing AI tools can be a barrier for these schools. The equity impacts can also be less direct. For instance, even if more research is needed on the actual learning impacts of these new tools, some schools could use them to attract socio-economically advantaged students, leading to greater segregation between schools and eventually higher performance gaps.

While access to AI tools represents a significant challenge, it needs to be viewed in a broader context and one should be cautious when drawing parallels between a “digital divide” and an “AI divide”. It is considered a net good for students to have access to the internet, hence also the human rights mandate to freedom of opinion and expression “through any media and regardless of frontiers” (UN, n.d.[64]). From an equity perspective it is, therefore, necessary to bridge this digital divide and lack of access is viewed as problematic in principle. However, this is not the case with AI tools now. As is elaborated throughout this working paper, there is insufficient research on AI tools’ implications for equity and inclusion, necessitating further and interdisciplinary collaboration to develop practical applications impacting learning outcomes (Zhang and Aslan, 2021[65]).

Moreover, in some instances, there appear to be differences in how AI tools are used by schools. For instance, AI is sometimes present in cameras with facial recognition technology to check who should be allowed to enter a school building or identify someone who should not be there, according to a survey of teachers in secondary schools in the United States (Laird, Dwyer and Grant-Chapman, 2023[66]). At the same time, parents, teachers and students with diverse backgrounds continue to worry about school data and technology practices and the digital footprints that are created in this way (ibid.). Meanwhile, some socio-economically advantaged institutions try to filter out screen time for students to benefit from, e.g. relationship-rich education (Bowles, 2018[67]; Bowles, 2019[68]; Felten, 2020[69]). All of this suggests that access to AI tools may not necessarily be viewed as a “net good”.

These changes are happening in a broader context where the rapid advancement of AI can reshape global economic and social landscapes. The current trajectory of AI development, primarily steered by high-income countries, presents significant challenges in terms of exacerbating inequalities between economies (Dutta and Lanvin, n.d.[70]). For instance, AI innovations predominantly cater to capital-intensive applications in richer nations, potentially undermining the labour-intensive economic structures of poorer

countries (ibid.). This issue is further exacerbated by the fact that relatively cheap labour in the Global South (including individuals in refugee camps) was sometimes used for training of AI systems in labour-intensive, time-consuming and repetitive tasks (e.g. data labelling) in often adverse working conditions (e.g. working with toxic content) (Gray and Suri, 2019[71]; Jones, 2021[72]; Perrigo, 2023[73]). Discussions about inequities in access to AI tools, therefore, need to consider the global context of AI development.

Confronting techno-ableism

Techno-ableism refers to a tendency to argue that technology is a "solution" for a disability and, as such, that people with disabilities need to be "fixed" (Shew, 2020[74]). Often, when AI is developed with disability in mind, it is done so to help disabled individuals to better assimilate into an able-bodied and neurotypical world. This approach inherently frames disability as an individual problem that technology, specifically AI, can help to solve or mitigate (ibid.). In educational contexts, where foundational views and values are formed, techno-ableism presents a significant challenge for equity and inclusion. Education systems shape the perspectives of future generations, and when these systems are imbued with techno-ableism, they perpetuate a narrow understanding of disability (Dolmage, 2017[75]). This approach is at odds with, for instance, the social model of disability, which originated in the United Kingdom in the 1970s. This model posits that disability is not necessarily an impairment of the body or brain but rather a relationship between individuals with impairments and a discriminatory society (Shakespeare, 2004[76]; Smith and Smith, 2020[77]).

Techno-ableism in educational AI tools can inadvertently reinforce the notion that the problem lies with the individual rather than addressing the societal structures that create barriers for people with disabilities (Selwyn, 2023[78]). By focusing on "fixing" the individual, these tools can fail to challenge or change the underlying societal discrimination and exclusion that define disability. Moreover, techno-ableism in education can lead to a lack of support tailored to the diverse needs of disabled students. When educational digital tools (including AI tools) are not designed with inclusion in mind, they are less likely to be effective or relevant for students with diverse needs (Gottschalk and Weise, 2023[11]). This oversight can further disadvantage or exclude those who are most vulnerable (ibid.).

Addressing the continuous challenge of bias

Bias in AI, particularly in equitable and inclusive education, poses a complex challenge that encompasses a spectrum of issues from algorithmic biases to cultural insensitivity and stereotyping. AI tools, which can inherit biases from training data or encode the biases of their developers and society, have the potential to perpetuate and reinforce existing inequalities and discrimination towards specific groups (Baker and Hawn, 2021[79]). Bias in AI can take various forms (Box 3.1) and can lead to allocative harms, affecting those who receive resources or opportunities, and representational harms, such as denigration and stereotyping based on gender, ethnicity or other characteristics (ibid.).

Box 3.1. Algorithmic biases

Broadly, six categories of algorithmic bias can be distinguished:

- **Historical bias** involves modelling decisions that replicate real-world inequalities, such as using student demographics to predict grades, leading to improved accuracy at the expense of potentially perpetuating bias. This bias can persist even if demographic information is not explicitly included in models, as unintended proxies may influence predictions.
- **Representation bias** occurs when underrepresented groups in training data lead to poorer predictions. For instance, Anderson, Boodhwani and Baker (2019[80]) found a college graduation prediction model to work inadequately for Indigenous learners due to their small representation in the assessed data.
- **Measurement bias** stems from selecting inadequate variables that do not validly represent the intended factors, causing unequal predictions among different groups. For example, a model predicting school violence may lead to unfair outcomes if the labelling process is prejudiced, e.g. the same violent behaviour is flagged for members of one ethnic group but not for members of another one.
- **Aggregation bias** results from combining several distinct groups in a single model, rendering the model ineffective for some or all groups. For instance, a prediction model of student performance trained on a combination of urban and rural students can create generalised recommendations that fail to effectively address the specific learning needs of either group, resulting in suboptimal or ineffective predictions.
- **Evaluation bias** occurs when the dataset on which models are tested fails to represent the eventual application population for which the models are intended. Models in educational data mining can be developed on non-representative populations and provide no information on what populations they were tested on.
- **Deployment bias** arises when a model designed for one purpose is eventually used for another, such as utilising a student disengagement identification model for grading participation.

Source: Suresh and Guttag (2021[81]), A Framework for Understanding Sources of Harm throughout the Machine Learning Life Cycle, https://doi.org/10.1145/3465416.3483305.

Other adverse consequences of bias in AI include insensitivity towards human qualities like empathy, ethics, solidarity, and concern for others and the environment (Selwyn, 2023[78]). For instance, AI technologies developed primarily by Western and Chinese organisations can reinforce existing power dynamics and disregard local contexts (Holmes, 2023[3]; Munn, 2023[82]). Some Indigenous groups expressed concerns about human dignity, collective interests, communal integrity and environmental impact, contrasting sharply with the dominant Western framings of AI (Munn, 2023[82]). Some AI tools have also been criticised for perpetuating gender stereotypes, e.g. many AI personal assistants have female-sounding voices and names that can reinforce traditional gender roles and discriminatory visions (UNESCO/EQUALS Skills Coalition, 2019[83]). Indeed, generative AI, by its nature, is designed to generate text based on the content it has been trained on. This approach often echoes prevailing opinions, reflecting dominant viewpoints regardless of the user's location or background (Holmes, 2023[3]). Such a mechanism can inadvertently amplify the marginalisation of already marginalised voices, as these AI systems might not adequately represent diverse perspectives and experiences (ibid.).

All these issues can then permeate AI tools in education. Some studies have shown that AI can provide more accurate predictions for some groups of students than others based on demographic characteristics

(Anderson, Boodhwani and Baker, 2019[80]; Gardner, Brooks and Baker, 2019[84]; Khosravi et al., 2022[26]). Language bias was also observed, with AI models unfairly categorising students' posts in discussion forums based on whether English was their first language (Sha et al., 2021[85]). Ethnically related misuses and systematic discrimination through AI technologies are also a concern, particularly when AI is trained on datasets reflecting historical biases and deployed in structurally racist settings (Benjamin, 2019[86]). This can lead to AI-powered educational software, such as grading systems, favouring certain writing styles, languages or cultural references, thereby penalising students from different ethnic and Indigenous backgrounds (Anderson, Boodhwani and Baker, 2019[80]; Gardner, Brooks and Baker, 2019[84]).

Moreover, groups such as disadvantaged learners and students with SEN are often underrepresented in the research on algorithmic bias (Baker and Hawn, 2021[79]). Research on algorithmic bias in regard to students with intersecting identities is also insufficient (Baker and Hawn, 2021[79]; Cabrera et al., 2019[87]). Furthermore, the effectiveness of ITS for diverse learners is largely unknown due to the lack of data on their efficacy by gender or race (Martin et al., 2022[88]). VR/AR educational content and gamified environments might reflect biases or stereotypes, potentially alienating or misrepresenting certain groups of students (Holmes, 2023[3]). Chatbots can also suffer from underrepresentation of cultural diversity (ibid.).

Navigating the challenges related to bias will likely occupy the research and educational sector in the upcoming years. There are two pertinent questions in this context: a) Is AI more or less biased compared to teachers?[4]; b) Are we more likely to successfully address AI's or teachers' biases? Both of these require increased attention from the research and academia, as well as a nuanced understanding of the educational contexts in which teachers and AI are more or less biased. In regard to question a), while research is only emerging, results suggest that AI, when applied as a trainer of a strategic board game, for instance, can lower pre-existing gender gaps in tournament data relative to human trainers (Bao and Huang, 2022[89]). The researchers argue that AI trainers' non-discriminatory emotional status can explain the improvement in gender equality (ibid.). Moreover, a study from the People's Republic of China exploring fairness perceptions among higher education students suggests that AI algorithms are perceived as fairer evaluators than teachers, particularly in formative evaluations (Chai et al., 2024[90]). This perception is attributed to AI algorithms' higher perceived information transparency (ibid.). However, when explanations for the evaluation process are provided, the gap in perceived fairness between AI and teachers diminishes, indicating that transparency plays a significant role in fairness perception (ibid.). Some researchers have also suggested that AI tools can help address teacher biases in assessment, although not corroborated by robust evaluations (Gauthier et al., 2022[91]). Nevertheless, the nuanced nature of this field underscores that some AI tools could serve as complementary to human judgment, potentially offering a pathway to mitigate biases that teachers might hold.

In regard to question b), successes have been seen in the past in reductions in both AI and teacher bias. As mentioned before, biases can seep into AI tools through various channels, such as biased training data, flawed algorithm design and lack of diverse representation in development teams. Addressing AI bias thus involves diverse and representative data collection, thorough evaluation of training data, transparency in AI development processes and continuous monitoring for bias throughout the lifecycle of AI systems (Ferrara, 2023[92]; Nazer et al., 2023[93]). Additionally, fostering diversity and inclusivity within AI development teams can help mitigate biases (ibid.). At the same time, it may not be possible or realistic to reduce biases in datasets in some instances (European Union Agency for Fundamental Rights, 2022[94]). For example, if data are heavily biased against certain groups, it may be difficult to "unbias" them or their predictions (ibid.). To address teacher bias, successful approaches revealed that evaluators need to be trained to recognise and address conscious and unconscious bias in the classroom (Alesina et al., 2024[95];

[4] Rater or evaluator bias (i.e. the tendency of raters to be influenced by non-performance factors when rating), has long been recognised as an issue in teachers' processes to assess students (OECD, 2023[8]). Evaluator bias can be influenced by stereotypes, preconceptions and socio-economic factors that impact students' academic performance (Milanowski, 2017[143]).

OECD, 2023[8]). The evaluation process needs to be adjusted to ensure that it is fair and equitable for all teachers, regardless of their background and the students they teach (OECD, 2023[8]).

Assessing the impact on socio-emotional learning

Integrating AI in educational settings, while offering advancements in adaptive learning, also poses challenges to students' socio-emotional learning, which is crucial for holistic development (Holmes, 2023[3]; UNESCO, 2023[17]). Indeed, the goal of inclusive education is to respond to all students' needs, going beyond school attendance and achievement, while improving all students' well-being, including in the domain of socio-emotional learning (OECD, 2023[8]). Some AI-driven tools might impede students' sociability, sense of trust and empathy for others by inadvertently reducing the need for human interaction, leading students to rely more on digital interfaces (Pons, 2023[24]; UNESCO, 2023[17]). This is all happening in a context where some researchers have raised concerns in regard to the ability of AI tools to read cognitive or emotional states, with disproportionate inaccuracies affecting people with disabilities or different cultural backgrounds (Holmes and Porayska-Pomsta, 2022[96]). The socio-emotional gap caused by AI technologies can thus significantly impact the inclusive aspects of education, which are fundamental for fostering a sense of belonging and community within educational settings.

Furthermore, students excluded from social participation in school settings could turn to their "digital friends" without tackling the roots of the problem. This raises concerns about the worsening of loneliness and isolation, which are already significant, particularly among vulnerable student cohorts, and thus hindering the inclusive processes in schools. AI tools, while beneficial in many ways, cannot replace the nuanced understanding and empathy educators and support staff provide (Holmes, Bialik and Fadel, 2019[97]). Furthermore, this may erode crucial social interactions for building inclusion and engagement within and beyond educational settings (Holmes, 2023[3]).

Balancing AI Integration with privacy and accountability

Integrating AI in educational settings has raised concerns about data privacy and security, posing significant challenges for equity and inclusion in education (Holmes et al., 2021[98]). Many AI technologies gather and store vast amounts of student data. While beneficial for adaptive learning, such as ITS, this information risks misuse and commercialisation, raising ethical and privacy concerns (Holmes, 2023[3]; Holmes et al., 2021[98]; Huang, 2023[99]). One key issue is the potential for information monopolies by the designers of AI tools (Huang, 2023[99]). These platforms process and analyse personal data extensively, which can inadvertently expose sensitive information, such as about a student's minority status (OECD, 2023[37]). This situation becomes more complex with younger learners, where obtaining informed consent is challenging due to their limited capacity to understand the implications of data sharing (UNESCO, 2023[17]). Indeed, the risks to student privacy were starkly illustrated during the COVID-19 pandemic. According to Human Rights Watch (2022[100]), many education technology products used data practices that compromised children's rights. These products collected detailed personal information, including location, activities, family information and socio-economic status. Children, parents and teachers were often unaware of these practices (ibid.).

Accountability in AI technology usage in education is critical yet challenging to ensure. Porayska-Pomsta and Rajendran (2019[101]) emphasise the importance of accountability for inclusion, diversity and fairness in educational interventions and AI interactions. However, it remains unclear who bears responsibility when AI technologies lead to discriminatory outcomes or incorrect guidance (Pedró et al., 2019[102]). These concerns are particularly pertinent in educational settings, where inaccurate or biased AI-generated responses can significantly affect students' learning and development. This uncertainty extends to various educational AI applications, from ITS to chatbots (Holmes, 2023[3]). When AI provides incorrect or biased information or advice, determining who is responsible for rectifying these errors and their consequences is complex.

4 Teacher-led tools to support equity and inclusion

Teacher-led AI tools aim to enhance teaching effectiveness and efficiency across various functions. These include classroom assistance, curating learning materials, student assessment and classroom management support, identifying some special education needs, and new continuing professional learning opportunities. While promising, these tools also face challenges. This section focuses on costs, the commercialisation of education, and issues surrounding teacher training in regard to the use of AI.

Opportunities of teacher-led tools for equity and inclusion

Teacher-led AI tools have the potential to influence educational practices significantly, mirroring the impact of learner-centred AI (see section 3). These tools encompass various functionalities to enhance teaching efficiency and effectiveness. AI-powered robots can assist with classroom management and support students with special education needs. At the same time, AI-driven curation of learning materials can adapt and diversify educational content, overcoming language and cultural barriers. In assessment and classroom management, AI tools have the potential to foster greater fairness and inclusivity by assisting in evaluation methods. AI tools can also aid school staff in identifying some special education needs. The success of these technologies depends on teachers' continuing professional learning. Indeed, deploying AI-supported virtual facilitators acting as human instructors is a notable innovation in this field, offering opportunities for training in the domain of AI and beyond.

Supporting teaching with AI-powered robots

AI-powered robots can offer a range of benefits, from teaching and promoting soft and social skills to providing individualised learning support (OECD, 2021[46]). Under teachers' or other school staff's guidance, they can advance diverse learning needs in educational settings, particularly for students needing psychological and behavioural support (ibid.). Indeed, robots were applied to assist students with emotional, behavioural and neurodevelopmental disorders (Bertacchini et al., 2023[103]). Students can interact with the robots without the fear of judgment or embarrassment, an aspect crucial for encouraging repeated practice and enhancing learning outcomes (OECD, 2021[46]). This factor is significant for students who might feel self-conscious or anxious in traditional learning environments (ibid.).

Teaching and enhancing soft skills and social skills can also be beneficial for children with autism spectrum disorders. For instance, robots like NAO have been employed to practice social skills using therapeutic approaches like Applied Behaviour Analysis. This method can help internalise social skills through repeated practice in a non-threatening environment (Panke, 2023[104]; Woo et al., 2021[105]). NAO and similar robots can personalise interactions by incorporating the learner's hobbies, interests, and names of friends and family, which can positively impact student motivation and learning outcomes (OECD, 2021[46]). Other robots are designed with the aim to amplify learning for children with autism spectrum disorder, positively impacting their well-being (Lemaignan et al., 2022[106]).

AI-powered robots are not intended to replace teachers or therapists (OECD, 2021[46]). Instead, they aim to function as tools or extensions of human instruction, enhancing the educational experience rather than substituting for human interaction and decision-making (ibid.). They can support and augment traditional teaching methods, providing additional resources for students requiring more specialised attention (ibid.). Indeed, the potential for AI to replace teachers is a topic of debate, with some arguing that AI can enhance teaching and learning without replacing human educators (Chan and Tsi, 2023[107]). The limitations of current AI applications suggest that AI cannot replace experienced teachers (Chan and Tsi, 2023[107]; Kolchenko, 2018[108]). The unique qualities of human teachers, such as critical thinking and creativity, make them irreplaceable (ibid.). Moreover, it has been argued that AI cannot replace human expertise in teaching existential reflection, norms and values, and a sense of self, history and society (Felix, 2020[109]). Nevertheless, research also indicates that a substantial proportion of primary and lower secondary teachers' time could be automated and directed towards other tasks (Box 4.1).

Box 4.1. Aspects of teaching that AI could support

Based on the McKinsey Global Teacher and Student Survey, some AI tools' impact on teacher tasks in primary and lower secondary education shows significant potential for automating certain aspects of teaching. The survey included over 2 000 teachers from four countries with high adoption rates of education technology: Canada, Singapore, the United Kingdom and the United States. The survey results suggest that 20% to 40% of teacher hours are spent on activities that could be automated using existing technology. This could translate to approximately 13 hours per week that teachers could redirect toward activities that lead to higher student outcomes and teacher satisfaction (Table 4.1). The area with the most considerable automation potential is one that teachers deal with before they even get to the classroom: preparation. AI could also assist teachers with evaluation and feedback, administration, student instruction and engagement, and continuing professional learning.

With the time saved through automation, teachers could use this opportunity to engage in more personalised learning, direct coaching, mentoring and fostering one-on-one relationships with students. This additional time can also support the development of 21st-century skills necessary for students to thrive in an increasingly automated workplace. Furthermore, teachers could dedicate more time to continuing professional learning and collaborative planning, enhancing their teaching methods and student learning outcomes.

Table 4.1. Teacher activities and AI

Teacher activity	Hours per week in 2020 in the sample	Hours per week potentially with AI	Use of reallocated time for teachers
Preparation	10.5	5.0	Enhanced planning for personalised learning
Evaluation and feedback	6.5	3.0	More time for individualised student feedback
Administration	5.0	2.5	Engaging in professional development and collaboration
Student instruction and engagement	14.5	2.0	Fostering one-on-one relationships with students
Professional development	3.0	0.5	Greater use of direct coaching and mentoring

Note: Research was conducted before the wide-spread use of large language model chatbots, such as ChatGPT.
Source: Bryant et al. (2020[110]), How artificial intelligence will impact K-12 teachers, https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers (accessed on 11 January 2024).

Curating learning materials

The curation of learning materials through AI tools represents a significant shift in educational practices, offering the potential for supporting teaching and enhancing equity and inclusion in education. AI tools' ability to identify, curate, adapt and translate learning content such as books, videos and websites can reshape how educational resources are accessed and utilised in classrooms. In England (United Kingdom), for instance, some educators use AI tools, such as ChatGPT and Copilot with Bing Chat, to create learning resources, e.g. materials for lessons, and support students with learning outside of the classroom (The Open Innovation Team and Department for Education, 2024[111]). Khanmigo, an

AI-powered teaching assistant, is designed to help educators create lesson plans, learning materials and assessments. Another example of this shift is Korea's initiative to implement AI-powered learning systems and digital devices, replacing traditional paper-based textbooks in all public schools (Joo-heon, 2023[112]). This "paradigm shift" is designed to transform the nation's education culture by offering learning solutions tailored to all children, including those with multicultural backgrounds and language difficulties (ibid.). The digital textbooks, set to be distributed in 2025, will have smart tutoring systems, metaverse capabilities and conversational AI (You-jin, 2023[113]). One of the key benefits of this approach is the support it offers to students whose first language is not Korean. Language translation and interpretation tools integrated into digital textbooks can help overcome language barriers, facilitating these students' integration into the classroom (Joo-heon, 2023[112]). This technology allows students who are not proficient in the instruction language to participate in learning processes. Such an approach can significantly enhance the educational experience for these students, promoting better understanding and integration. Moreover, the Ministry's plan to train teachers for this digital shift, with a pilot programme for 400 teachers expanding to 1 500 by 2025, highlights the importance of preparing educators for this new educational landscape (You-jin, 2023[113]). Teacher training is crucial for effectively integrating AI tools in teaching, ensuring educators can utilise these technologies to their full potential (see section Offering continuing professional learning opportunities).

Assisting with assessment and classroom management

The ability of AI to create assessments, evaluate student responses and assign grades can impact teaching efficiency, streamline the assessment process and enhance learning outcomes. By facilitating assessments through various means, such as simulations, vocational hands-on assessments or essay scoring, AI showcases its capability to refine traditional assessment methods (OECD, 2021[46]). These AI tools can enable the use of real-time data and feedback, allowing for different learning and assessment pathways (including the development of testing questions/items), and tailoring them to the needs of students (ibid.). Moreover, some AI tools' precision in assessment can lead to more consistent grading (e.g. among teachers), thus promoting fairness in evaluation processes (Holmes, 2023[3]). The systematic review by Salas-Pilco, Xiao and Oshima (2022[114]) highlights some AI tools' capacity to improve performance and self-efficacy among socio-cultural minorities through personalised feedback, which is crucial for fostering an inclusive educational environment where every student feels valued and understood. Other researchers showed that human raters were generally better at giving high-quality feedback to students compared to ChatGPT 3.5 (Steiss et al., 2024[115]). Nevertheless, they also argued that ChatGPT shows promise at giving feedback, particularly when considering the trade-off between quality and time (ibid.). More broadly, AI tools can help to fasten the process of evaluating large-scale assessments. In Czechia, for instance, an AI tool is assisting to evaluate some items in the standardised unified entrance examination to upper secondary schools (Deník N, 2024[116]).

Furthermore, integrating classroom analytics into AI tools' capabilities offers a nuanced approach to understanding and enhancing classroom dynamics. Classroom analytics can enhance classroom management by, e.g. providing teachers with a dashboard that indicates struggling learners or suggests the optimal timing for transitioning to new activities. This functionality not only aids classroom management but can also lead to improved learning outcomes (Holstein, McLaren and Aleven, 2018[117]). Classroom analytics extend to monitoring a variety of learning activities, thereby supporting the rich pedagogical concept of "classroom orchestration" (OECD, 2021[46]). This approach does not replace the teacher's decision making but empowers them with contextual information to make more informed choices, acknowledging that factors such as illness, peer support or technical issues might influence a student's performance (ibid.). ExamSoft, for example, is designed to provide robust reporting and analytics tools that enable educators to align student performance with remediation efforts and measure course objectives against accreditation standards. Zelexio is a cloud-based platform that aims to help teachers monitor learners' progress and create evaluation grids for all assessments. AI can also assist teachers in identifying

instances of academic misconduct, including AI-generated outputs. Copyleaks, for instance, was developed to detect potential plagiarism using a text-matching algorithm.

Aiding in the identification of some special education needs

Navigating the complexities of identifying special education needs, such as dysgraphia, requires a nuanced approach that balances specialist assessments with the subtleties of each condition. Diagnosing dysgraphia presents numerous challenges, stemming from the requirement of specialist assessment and the variability of symptoms such as distorted handwriting and difficulties forming letters (OECD, 2021[46]). The process is often lengthy, subjective and stressful for families, requiring standardised tests focusing more on the output than the writing process. However, some AI tools offer promising opportunities for early detection and intervention. Tools that enable teachers to recognise developmental differences provide the potential for faster initiation of the diagnostic process. Such technologies can also provide specialists with detailed information, facilitating more timely and accurate diagnoses. This is crucial as early intervention tailored to an individual's needs can significantly impact a learner's educational journey and future (ibid.).

Several research teams have developed AI tools to ease the diagnostic assessment of dysgraphia. Some systems can accurately detect dysgraphia in children using a standard tablet, overlaying a sheet of paper to mimic traditional writing practices (Asselborn et al., 2018[118]). By analysing handwriting data from nearly 300 children, the tool achieved approximately 96% accuracy in dysgraphia detection. It identifies specific handwriting features, such as pen tilt, pressure and speed variations, enabling a detailed analysis of the writing process. This approach not only distinguishes dysgraphic handwriting from that of typically developing children, but also facilitates the provision of targeted support (ibid.). In another example, Dystech has introduced an AI tool for dyslexia detection based on audio records. The approach leverages machine learning algorithms to analyse audio recordings of children reading aloud (Radford et al., 2021[119]). This method focuses on extracting features from these recordings, such as variations in reading speed, pronunciation accuracy and other audio cues that may indicate dyslexia. The AI tool has demonstrated a high degree of accuracy, offering a non-invasive, fast and cost-effective means for early dyslexia screening (ibid.). These examples do not aim to replace the role of teachers and other specialists in diagnosing special education needs, but they can complement existing methods by providing an additional layer of analysis that can be particularly useful in settings where access to specialised assessment services is limited.

Offering continuing professional learning opportunities

AI-based teacher training and development present opportunities for enhancing teaching practices and addressing educational disparities. Continuing professional learning programmes can yield positive changes in teacher instruction and help reduce the achievement gap in student academic performance, particularly when tailored to a specific subject and focusing on both content knowledge and pedagogical content knowledge (Copur-Gencturk et al., 2024[120]; Scher and O'Reilly, 2009[121]). Furthermore, programmes involving active, collaborative learning among educators have been shown to be most effective (Darling-Hammond, Hyler and Gardner, 2017[122]). To this end, deploying AI-supported virtual facilitators acting as human instructors is a notable innovation in this field, with a potential to fill some of the continuing professional learning gaps related to diversity, equity and inclusion elaborated on in the Equipping educators with knowledge and skills section. These facilitators present teaching-related problems to educators and provide feedback on their responses, simulating a dynamic learning environment for continuing professional learning (Copur-Gencturk et al., 2024[120]). Edthena, for instance, employs an "AI Coach" to guide teachers through self-observation and action planning, potentially creating a dynamic and interactive learning environment. Through tools like video coaching and video learning, the platform aims to amplify coaching capacity and deliver feedback, thereby making data-driven decisions to improve teaching practices (ibid.). Similarly, Copur-Gencturk et al. (2024[120]) developed an online

continuing professional learning programme with natural language processing integrated into the system. Based on a randomised controlled trial, the authors showed that teachers improve students' mathematics performance by obtaining personalised and real-time feedback from a virtual facilitator (ibid.).

Challenges of teacher-led tools for equity and inclusion

Challenges related to teacher-led AI tools encompass several areas significantly impacting equity and inclusion in education. Firstly, overcoming the costs associated with AI tools, particularly in under-resourced schools, can lead to disparities in educational access to AI tools that teachers can use. Secondly, the increasing commercialisation of education through AI tools raises concerns about prioritising financial gains over educational outcomes, and additional worries regarding privacy, data security and algorithmic bias. Lastly, the need to equip educators with the necessary knowledge and skills to integrate AI effectively into their teaching practices is highlighted, acknowledging the disparities in training opportunities. Additionally, these AI tools face similar challenges described in the section Challenges of learner-centred AI tools for equity and inclusion.

Overcoming the costs of AI tools

Similar to learner-centred AI tools, one of the primary concerns with teacher-led tools is the inequity stemming from the costs involved in installing, maintaining and repairing AI tools. These costs can be prohibitive, especially for under-resourced schools, leading to disparities in the quality of education offered. Schools in affluent areas or with better funding can afford (more) advanced digital tools, including AI tools, and the associated costs, thereby enhancing their educational offerings and classroom experiences (Gottschalk and Weise, 2023[11]). In contrast, schools with limited resources struggle to access these technologies. For instance, the cost of advanced robotic systems can present a significant challenge. The price of a robot like NAO (see section Supporting teaching with AI-powered robots) can reach EUR 7 200 (euros), and this does not include the cost of specific applications, which can vary significantly (United Robotics Group, 2023[123]). This cost can be prohibitive for many schools, potentially exacerbating existing inequalities in access to advanced educational technologies (OECD, 2021[46]). While the cost aspect is apparent for physical AI applications such as robots, it may seem less intuitive for software-based solutions like chatbots, e.g. ChatGPT. Yet, even here, costs play a role, albeit in a different form. Illustrating on the example of ChatGPT, while the basic 3.5 version is free and the more advanced 4.0 version free within limits, the most advanced 4o version with its features requires additional investment (OpenAI, n.d.[124]). Thus, despite their generalist nature and broad utility, some AI tools still present cost-related barriers.

The disparity is not limited to within countries but extends across different education systems globally. There is a notable inequity across countries in adopting and integrating AI in education. Some education systems plan to systematically offer AI-based classroom solutions (e.g. Korean example Curating learning materials). Other systems are yet to explore AI options, but barriers exist. For instance, at the basic level, few countries even monitor and evaluate investments in digital education tools and resources (OECD, 2023[37]). This divide raises concerns about global educational equity and inclusion. Without concerted efforts to address these disparities, AI in education risks exacerbating existing inequalities rather than narrowing them. This is further complicated in a context where much of the research on AI tools in education is concentrated in the United States (OECD, 2023[37]; Zhang and Aslan, 2021[65]). Finally, the discussion on costs and access to AI tools needs to be balanced, viewed in a broader context when drawing parallels between a “digital divide” and an “AI divide”, and caution needs to be exercised when viewing AI tools as a “net good” given the often limited research (see section Accessing AI tools).

Striking a balance with the commercialisation of education

The increasing presence of AI tools in education has raised concerns about the commercialisation of this sector (Holmes, 2023[3]). The involvement of corporate entities indicates a growing trend where commercial interests could potentially overshadow educational and equity objectives (Holmes et al., 2021[98]). This commercialisation raises critical questions about the primary focus of educational tools and resources. While some AI tools have the potential to enhance educational quality and accessibility, there is a risk that the profit motives of commercial entities could lead to a prioritisation of financial gains over educational and equitable outcomes (Holmes, 2023[3]). This tension might necessitate careful management to ensure that the development and deployment of AI tools in education primarily serve students' needs rather than companies' commercial interests. The commercialisation of education through AI tools also brings additional concerns regarding privacy, data security and the risk of algorithmic bias, elaborated on in the section Challenges of learner-centred AI tools for equity and inclusion. As commercial entities gain access to vast amounts of student data, privacy issues and the potential misuse of this data emerge (Holmes, 2023[3]). These concerns are particularly pertinent given the sensitive nature of educational data, which can include personal and demographic information about students.

Moreover, as delineated in the OECD Digital Education Outlook, countries' flexible and varied procurement strategies highlight a complex ecosystem where the commercialisation of education through AI tools could further complicate the landscape. While some governments strive for economies of scale, security and compliance with data protection regulations, the predominant trend is towards decentralised procurement decisions, often leaving the selection of digital tools to local governments or schools (OECD, 2023[37]). This decentralisation could exacerbate the risk of commercial interests overshadowing educational and equity goals. The emphasis on procedural rather than substantive regulation in procurement and the challenges of setting rigid standards that accommodate future innovations could inadvertently foster a market environment where a few large providers dominate, potentially stifling innovation and leading to vendor lock-in effects (ibid.).

The nuanced understanding of procurement strategies across different governance models suggests that while there is potential for aligning digital tool selection with educational goals and equity, the reality is fraught with challenges. Governments' efforts to foster interoperability, equity and effectiveness in digital tools are commendable but remain limited in scope (OECD, 2023[37]). This scenario underscores the importance of establishing good public-private partnerships and spaces for collaboration between schools and the education technology sector to navigate commercialisation risks effectively. Aligning procurement strategies with governance models and policy objectives is crucial to mitigate the impact of commercial interests and ensure that AI in education serves its primary purpose of enhancing educational quality and accessibility for all students.

Equipping educators with knowledge and skills

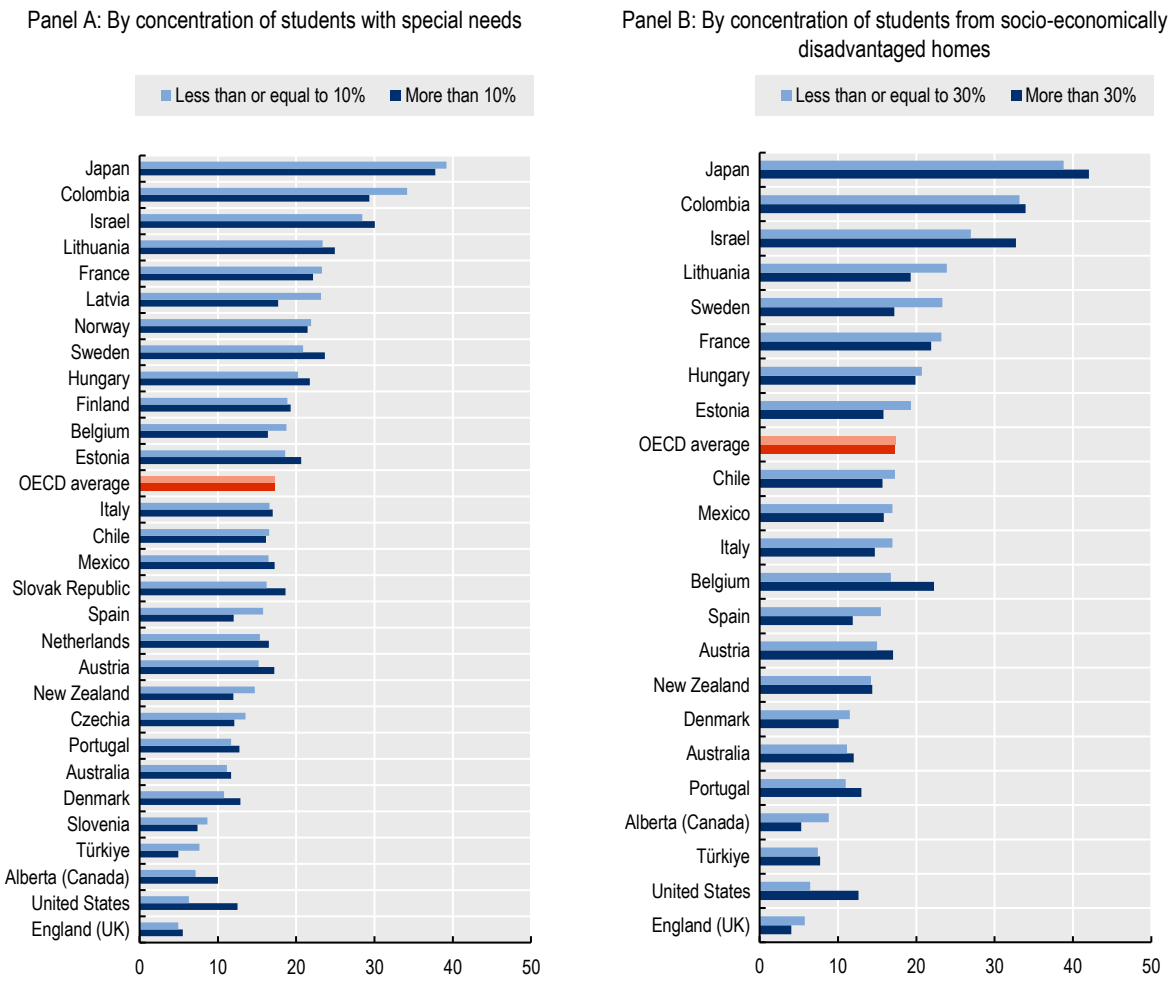
While AI tools offer opportunities for enhancing teaching practices and addressing disparities in education (section Offering continuing professional learning opportunities), effective integration of AI-powered tools also hinges on teachers' ability to use these technologies within their teaching strategies (Pons, 2023[24]). This requirement demands significant investment in time and resources for teacher training, which can be a substantial barrier for many educational institutions. The challenge lies not just in the need for training but in the depth and quality of the training provided, particularly in reaping AI tools' benefits for equity and inclusion. Some initiatives are addressing these issues. For instance, the “AI4T - Artificial Intelligence for and by teachers” is a three-year experimental project aimed at improving the use of AI tools in education (France Éducation international, n.d.[125]). The project involves a professional training pathway for teachers in five European countries (France, Italy, Ireland, Luxembourg and Slovenia) focusing on innovative continuing professional learning methods for teachers (ibid.). Still, within initial teacher education, according to preliminary data from the OECD AI Policy Observatory, the number of AI courses among

Education and Training higher education study programmes (in English language) remains negligible (OECD, 2024[126]).

The complexity of equipping educators with knowledge and skills is heightened by the reality that there is already a notable disparity in training opportunities for teachers in different educational settings, both within some countries and globally. Gottschalk and Weise (2023[11]) have identified widespread challenges in training teachers and staff for digital use and literacy. While not specific to AI, 17.7% of lower secondary teachers on average across OECD countries have identified a high level of need for professional development in information and communication technology (ICT) skills for teaching in 2018 (OECD, 2019[127]). On average across OECD countries, the situation did not differ by the concentration of students with special education needs or socio-economically disadvantaged students (Figure 4.1). However, in some education systems, such as in the United States, teachers reported a much higher need for professional development in schools with relatively high shares of students with special education needs and disadvantaged students. Furthermore, Marino et al. (2023[128]) emphasise the difficulties in equipping educators with AI knowledge and skills in special needs education. Disparities in training opportunities can contribute to widening the gap in the effective use of AI technologies in education, potentially exacerbating inequalities. Students in disadvantaged schools are at risk of being left behind in the rapidly advancing digital landscape due to their teachers' unmet needs in regard to high-quality training.

Figure 4.1. Continuing professional learning needs by school characteristics (2018)

Percentage of lower secondary teachers reporting a high level of need for professional development in ICT skills for teaching



Note: Students with special needs are those for whom a special learning need has been formally identified because they are mentally, physically or emotionally disadvantaged. Socio-economically disadvantaged homes refer to homes lacking the basic necessities or advantages of life, such as adequate housing, nutrition or medical care.

Sorted in descending order of the percentage of lower secondary teachers reporting a high level of need for professional development in schools with less than or equal to 10% of students with special needs (panel A) or less than or equal to 30% of students from socio-economically disadvantaged homes (panel B).

Source: OECD (2018[129]), TALIS 2018 Database, https://www.oecd.org/education/talis/talis-2018-data.htm (accessed on 25 January 2024).

5 Other institutional tools that can foster equity and inclusion

In addition to learner-centred and teacher-led AI tools, education systems and schools can utilise AI for various other functions. This section focuses on three: a) increasing efficiency of higher education admissions processes, b) better identifying students at risk of early leaving from education and training, and c) assisting with data-based decision making. While not as visible as the other AI tools, they can potentially become most influential in the future (Holmes, 2023[3]). These tools face challenges, including inherent AI biases, and privacy and accountability concerns. Given that these challenges have been elaborated on before, these will only be mentioned briefly.

Opportunities of institutional tools for equity and inclusion

AI-powered institutional tools present promising opportunities for enhancing equity and inclusion in education systems. The application of AI in higher education admissions, for example, uses algorithms and data analytics to streamline the admissions process, potentially reducing biases and improving fairness in candidate selection. Similarly, AI tools designed to identify students at risk of leaving education can provide crucial insights, allowing for timely school interventions. Additionally, AI can facilitate data-based decision making, enabling more efficient and targeted distribution of resources to areas of greater need.

Increasing efficiency of admissions in higher education

The application of AI tools in education admissions is a growing trend, particularly in higher education (Holmes, 2023[3]). These AI tools, employing algorithms, machine learning and data analytics, analyse vast amounts of data about applicants to create detailed candidate profiles and facilitate comparisons with peers (ibid.). Applying complex pattern recognition, adaptability and learning from diverse data sources, AI has the potential to, for instance, assess the qualities of applicants (Lira et al., 2023[130]). This approach can improve prediction accuracy, speed up the admissions process, and, theoretically, reduce subjectivity and bias inherent in human decision making, thereby enhancing the fairness and equity of the selection process (ibid.). Indeed, implicit biases, e.g. racial bias, in some higher education institutions can impact the decision to admit or reject an applicant (Capers et al., 2017[131]). For instance, the University of Texas at Austin (United States) launched an AI system to recommend whether applicants should be accepted based on test scores, academic background and textual input (Waters and Miikkulainen, 2014[132]). In theory, this could reduce the subjectivity and bias of human decision makers and increase fairness. In practice, however, this system had to be dropped precisely due to its various biases (Holmes et al., 2022[133]). In another example, iSchool360 uses AI to enhance recruitment processes in higher education institutions by automating filtering, identifying candidates and nudging them through the process. The technology can potentially limit biases, save admissions teams' time and make informed enrolment decisions.

Identifying students at risk of early leaving from education and training

AI tools for identifying students at risk of dropping out analyse data on student attendance, grades, test scores, behaviour and demographic information to identify patterns that may indicate a student is struggling (Holmes, 2023[3]). As teachers are often burdened with heavy workloads, they may find it challenging to identify and support at-risk students effectively. AI drop-out systems can alleviate some of this pressure by gathering and analysing data to understand better the factors leading to student disengagement and drop outs, and offer a more efficient system for identifying at-risk students (Goel and Goyal, 2020[134]; Lee and Chung, 2019[135]). This capability is vital in contexts where resources are limited, and teachers are under significant pressure, such as in schools with high shares of disadvantaged students. For instance, Azure Machine Learning, a cloud based predictive analytics service, processes complex data, including student performance and characteristics (such as gender, academic performance and socio-economic background), school infrastructure and teacher capabilities (OECD, 2021[46]). This tool aims to uncover drop-out patterns and identify high-risk students, highlighting over 60 reasons for early leavers. For example, outdated study materials, struggles in English or mathematics and dysfunctional school toilets (particularly impacting girls) were identified as contributing factors in Andhra Pradesh (India) (ibid.). This approach demonstrates how AI tools can enhance the capacity of education systems to pre-emptively address factors leading to early leaving from education and training, thereby supporting at-risk students more effectively. Such interventions are crucial for fostering more equitable educational environments, especially in regions where resource constraints and socio-economic factors pose significant challenges to student retention and success.

Assisting with data-based decisions

Data-based decision making in education systems, involving the systematic collection, analysis and interpretation of various data types, is crucial in improving student outcomes and fostering equity and inclusion (OECD, 2023[8]). This approach includes the analysis of inputs like resources and teacher characteristics, processes within the education system, and outcomes such as student achievement and teacher well-being (Mezzanotte and Calvel, 2023[136]). Effective data usage can increase student learning and achievement, ensuring that students from all backgrounds have equal opportunities for success (Schildkamp, 2019[137]; van Geel et al., 2016[138]).

However, challenges exist in fully implementing data-based decision making in educational settings. School staff and policy makers often lack data collection and analysis training, and time and budget constraints can impede effective data usage (Schildkamp, 2019[137]). AI tools have the potential to bridge this gap by analysing data to detect resourcing needs. With their capability to process extensive datasets rapidly, identify patterns, forecast trends and communicate the results in “natural language”, some AI tools have the potential to efficiently highlight areas needing attention, facilitating more innovative and targeted distribution of resources (Teng, Zhang and Sun, 2022[139]). This advancement could ensure that schools with greater needs receive the necessary support more timely and effectively, contributing to a more equitable educational landscape.

Challenges of institutional tools for equity and inclusion

Challenges of institutional tools for equity and inclusion are similar to those mentioned in other sections (see Challenges of learner-centred AI tools for equity and inclusion and Challenges of teacher-led tools for equity and inclusion). One concern is the risk of algorithmic bias in AI systems. For instance, AI systems used for admissions and identifying at-risk students analyse data on student performance, demographic information and other factors, and can inadvertently perpetuate existing biases if the data or algorithms themselves are biased (Lira et al., 2023[130]; Tay et al., 2022[140]). The system might favour certain

demographic groups over others based on historical data patterns, leading to unfair and discriminatory practices (Lira et al., 2023[130]). Similarly, AI tools used to identify students at risk of dropping out may rely on data that, due to general population distribution or imperfect sample procedures, do not account well for the experiences of marginalised groups. As a result, they might potentially misclassify students and exacerbate inequalities (Gardner, Brooks and Baker, 2019[84]; Lee and Chung, 2019[135]).

Another critical challenge is the potential for unintended consequences, such as the stigmatisation or labelling students based on AI-derived categorisations (Holmes, 2023[3]; OECD, 2023[37]). This issue can lead to discrimination and exclusion, particularly for students from marginalised communities. For example, students identified as at risk by AI systems might be unfairly labelled, affecting their educational experiences and opportunities (Holmes, 2023[3]). Furthermore, privacy and data security concerns are paramount when dealing with sensitive student information (Holmes and Porayska-Pomsta, 2022[96]). The collection and analysis of extensive datasets by AI systems, while beneficial for understanding student needs and optimising resource allocation, must be managed with strict adherence to data protection and privacy standards (Holmes, Bialik and Fadel, 2019[97]; Holmes et al., 2021[98]; OECD, 2023[37]; Pedró et al., 2019[102]; UNESCO, 2021[16]; UNESCO, 2023[17]). Without appropriate safeguards, there is a risk of data breaches and misuse, potentially harming students who are most vulnerable (ibid.).

Another challenge in this field relevant for all three types of AI tools is concerns about the generalisability and transferability of research findings in this area. Most studies are conducted by the developers of AI tools, often from commercial entities, and with a limited participant pool (Holmes and Tuomi, 2022[2]). Independent, large-scale studies, mainly from the United States, are rare, casting doubt on the broader claims of AI in education (UNESCO, 2021[16]). Moreover, research tends to focus narrowly on AI's technical efficacy in improving academic outcomes, overlooking its broader implications on classroom dynamics and the wider educational ecosystem (ibid.). The discussion extends to AI tools' potential cognitive and developmental impacts, with historical analogies to technology's influence on human cognition and specific concerns about children's development (Gottschalk, 2019[141]). In fact, UNESCO (2021[16]) calls for more systematic, interdisciplinary and cross-national research to thoroughly understand AI tools' effects on learning and educational practices.

6 Conclusions

This working paper delves into the potential of AI in fostering equity and inclusion in education, examining learner-centred, teacher-led and institutional AI tools. It highlights the opportunities offered by AI tools, such as adaptive learning experiences, enriched content, and improved efficiency in processes like admissions and data-based decision making. However, it also addresses significant challenges, including access issues, potential biases, the high costs associated with AI tools and the need for comprehensive teacher training. Importantly, while acknowledging these new challenges, viewing them in light of the challenges already present in schools is essential. For instance, we should not assume that "traditional" teaching methods and tools are flawless. The paper emphasises the importance of weighing AI tools' benefits for educational enhancement against the complexities and ethical considerations to avoid exacerbating existing disparities or creating new ones. By highlighting this comparison, the paper aims to present a balanced view that acknowledges both the promise and the pitfalls of integrating AI tools into educational settings. While the previous sections delved into each category of opportunities and challenges in greater detail, some overarching messages and policy implications are summarised below.

Embracing the potential for adaptive learning while addressing privacy, ethical and accountability issues

AI tools are used for their potential in adaptive learning experiences. They can offer a tailored approach that caters to individual student needs, thereby enhancing the effectiveness and inclusivity of education. These can be seen in ITS, AI-enabled simulations, AI-powered robots, AI-based systems that identify students at risk of early leaving from education and training, and others. As such, they have potential to level the field for students with diverse needs.

However, developing these (and other) tools hinges on access to a wide range of data with student characteristics. While beneficial for adaptive learning, this information risks misuse and commercialisation, raising ethical and privacy concerns. Moreover, accountability in AI technology usage, i.e. the responsibility when AI technologies lead to discriminatory outcomes or incorrect guidance, is challenging to ensure. Inaccurate or biased AI-generated responses can have significant implications for students' learning. In fact, concerns about the use of AI have led to the creation of a journal focused on "ethical, regulatory, and policy implications that arise from the development of AI", *AI and Ethics* (Springer Link, 2024[142]). Policy makers and other stakeholders could thus embrace the potential of AI in education for adaptive learning while evaluating privacy and ethical concerns, and accountability for responsible AI usage.

Recognising the potential to enhance cultural responsiveness while keeping in mind inherent biases

AI tools can be culturally responsive by, e.g. providing more targeted content. They can break the barriers in a language different from the language of instruction. They can also enhance teacher capacities directly and indirectly. Directly, by helping teachers in, e.g. curating learning materials, assisting with the assessment, classroom management and identifying some special education needs. Indirectly by freeing

teachers' time that could be used more productively to support students' needs. While these potentials are not without caveats, they promise to foster inclusion in the classroom through cultural responsiveness.

While offering numerous potential benefits, AI tools are not without significant caveats, particularly concerning bias. Bias in AI encompasses a range of issues, from algorithmic biases to cultural insensitivity, potentially perpetuating inequalities and discrimination. These biases manifest in various forms, such as historical, representation, measurement, aggregation, evaluation and deployment biases, each affecting different aspects of AI tools' application in education. For instance, AI systems might reinforce stereotypes, neglect local contexts and Indigenous perspectives, and inadvertently favour certain demographic groups over others. This includes language processing and assessment biases, which can disadvantage non-native English speakers and students from diverse ethnic backgrounds. In addressing these challenges, balancing data protection and privacy issues with actively improving fairness and equity by identifying and mitigating biases is important. This may require a nuanced collection of personal data to pinpoint and address these biases effectively. Therefore, policy makers and other stakeholders should recognise that while AI tools in education have the potential to enhance cultural responsiveness and foster inclusion, inherent biases must be carefully managed. This might include adopting an adaptive and forward-looking regulatory or guidance framework that keeps pace with rapid advancements in AI, ensuring that efforts to mitigate biases and promote equity do not inadvertently hinder innovation or the uptake of beneficial technologies in the classroom.

Balancing the potential for accessibility with challenges such as techno-ableism and impact on socio-emotional skills

AI-enabled tools designed to support learners with SEN illustrate a significant opportunity in education. By adapting learning experiences and enhancing accessibility, these tools can facilitate the inclusion of some students with SEN in classroom settings, fostering a diverse and inclusive learning community. For instance, AI assistive devices like real-time language translation headsets and digital sign language interpreters offer advancements in supporting students with auditory and visual impairments, potentially contributing to a more equitable educational environment.

Contrasting these opportunities, however, are significant challenges. Techno-ableism in AI tools risks perpetuating a narrow view of disability, framing it as a problem to be fixed rather than addressing societal barriers. This approach can lead to further exclusion and inadequate support for students with diverse needs. Additionally, AI tools' impact on socio-emotional learning presents multifaceted challenges. The potential for increased loneliness and isolation, for instance, especially among vulnerable student cohorts, highlights the need for human interaction in education. Therefore, policy makers and other stakeholders should recognise that AI tools not only enhance accessibility for learners but also raise challenges like techno-ableism and the impact on socio-emotional skills.

Developing and improving teacher training in AI

AI-based teacher training and continuing professional learning offer opportunities to enhance teaching practices and address educational disparities. Innovations like AI-supported virtual facilitators and platforms can provide dynamic and interactive environments for teacher training, amplifying coaching capacity and enabling data-driven improvements in teaching practices.

However, AI tools include various possible uses with disparate outcomes. Teachers' mediation is thus vital to maximising many of the benefits of AI tools, underscoring the need for continuing AI-related professional learning (whether with the help of AI tools or not). Moreover, equipping educators with the necessary knowledge and skills to effectively integrate AI into their teaching is difficult. This challenge is compounded

by the significant investment in time and resources for teacher training, which can be a substantial barrier, particularly for under-resourced educational institutions. The disparity in training opportunities is pronounced within and across countries, with schools in disadvantaged communities often facing shortages in continuing professional learning resources. This gap in training and development opportunities risks exacerbating inequalities, as students in some schools may be left behind in an increasingly digital educational landscape. Therefore, to fully realise the benefits of AI tools in education, educators need AI training and continuing professional learning.

Exploring how to maintain educational integrity amidst the growing commercial influence in the sector

Some AI tools have the potential to further bolster equity by serving as a cost-effective resource that can be readily scaled among schools. For example, AI tools could facilitate communication processes and operate as self-services for learners and parents. The most common applications in that field are chatbots used for counselling in administrative questions.

While some AI tools are scalable, concerns exist in regard to the financial accessibility of others. For instance, AI-enabled simulations (AR/VR) and AI-powered robots might not be accessible to all schools that need them. Moreover, some issues arise around the increasing commercialisation of this sector. The growing involvement of corporate entities in educational AI tools has led to concerns that commercial interests might overshadow educational objectives. This trend raises critical questions about the primary focus of educational tools, with the risk that the profit motives of commercial entities could prioritise financial gains over educational outcomes. As these entities access vast amounts of sensitive student data, the potential for misuse becomes severe. Therefore, policy makers and other stakeholders could explore options for maintaining educational integrity amidst the growing commercial influence in the sector.

Encouraging research on the implications of AI for equity and inclusion in education, and clarifying the role of institutions at the national level in its systematic implementation

The integration of AI tools in education, while promising, should not be viewed as a quick fix for educational challenges. There is a notable lack of research on the implications of AI tools for equity and inclusion in education. This includes a scarcity of data and robust evaluations. Interdisciplinary research involving educators and educational researchers is essential for creating practical applications of AI that directly or indirectly influence learning outcomes in educational settings (Zhang and Aslan, 2021[65]). To this end, policy makers should encourage researchers to ask nuanced questions. For instance, in the domain of bias, one of the high-stakes questions is not *whether* AI tools are biased, but whether they are *more or less* biased compared to teachers in, e.g. assessment, and how this bias amplifies for specific subgroups. In another example, rather than asking whether VR/AR tools improve, e.g. learning outcomes, it might be more important to ask whether they improve outcomes more than traditional 2D tools already present in many schools. In other words, rather than asking about the *absolute* value of AI tools, it might be relevant to start asking about AI tools' *relative* effects.

Furthermore, research needs to be expanded to analyse the impact of AI at institutional, regional and national levels over extended time frames. Studies are unevenly distributed across various AI tools, focusing on ITS and adaptive learning systems, while other tools are less examined. Research is also unevenly split between English- and non-English-speaking countries, stemming from the reality that many AI tools target English speakers. However, wherever possible, educational research should also focus on

non-English speaking jurisdictions, and the impacts of English or other language AI tools on educational institutions.

Additionally, the role of institutions at the national (or sub-national) levels (e.g. ministries) in promoting or hindering the use of AI tools in schools remains unclear, with few national (or sub-national) examples of institutions or agencies with a mandate to regulate the systematic use of AI in education. Therefore, policy makers and other stakeholders could encourage comprehensive research and evaluation of AI and its implications for equity and inclusion, and clarify the role of central institutions or agencies in regulating its systematic implementation.

The role of institutions at the national (or sub-national) level should also be clarified in regard to ensuring equitable access to AI tools. In many jurisdictions, policy responsibilities for digital and traditional education governance are devolved to lower levels of government, e.g. in the provision and procurement of digital tools and resources (OECD, 2023[37]). The devolution of responsibilities has advantages, e.g. AI tools may align more closely with local needs. However, from the equity perspective, it may result in discrepancies in access and use of AI tools. Therefore, policy makers could view this as an opportunity to introduce responsibilities at higher governance levels. This may include assuming the role of provider (e.g. for digital infrastructure) or standard setter (e.g. for procurement practices and continuing professional learning).

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