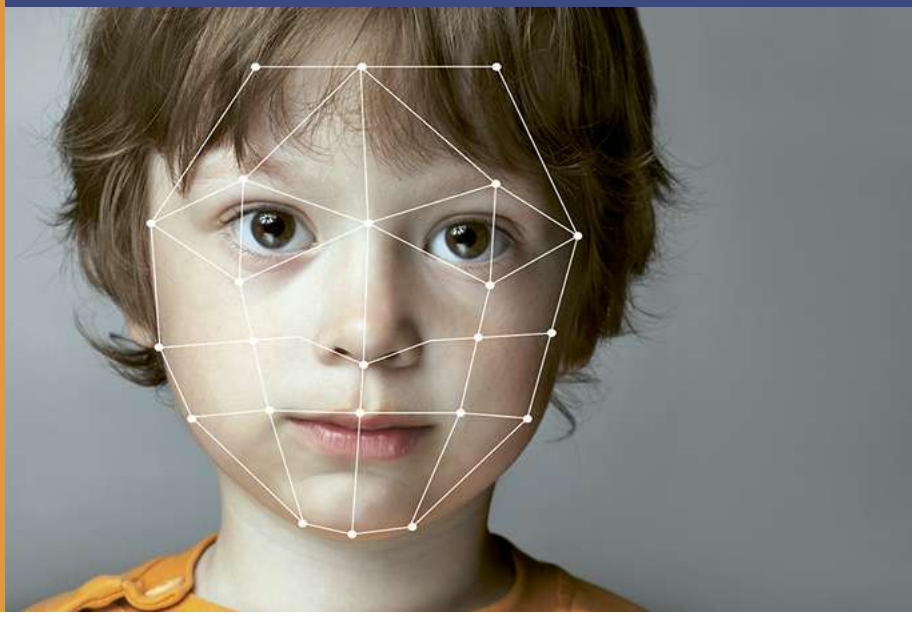
ARTIFICIAL INTELLIGENCE AND EDUCATION

A critical view through the lens of human rights, democracy and the rule of law



COUNCIL OF EUROPE
CONSEIL DE L'EUROPE

ARTIFICIAL INTELLIGENCE AND EDUCATION

A critical view through the lens of human rights, democracy and the rule of law

Wayne Holmes,
Jen Persson,
Irene-Angelica Chounta,
Barbara Wasson
and Vania Dimitrova

Council of Europe

All other correspondence concerning this document should be addressed to the Education Department Council of Europe Agora Building 1, Quai Jacoutot 67075 Strasbourg Cedex France education@coe.int

Cover design: Documents and Publications Production Department (SPDP), Council of Europe

Layout: Jouve, Paris

Cover photo: Shutterstock

Council of Europe Publishing F-67075 Strasbourg Cedex http://book.coe.int

ISBN 978-92-871- 9236-3

Printed at the Council of Europe

This report was prepared within the scope of the Council of Europe's intergovernmental project on Artificial Intelligence and Education.

Acknowledgements
The authors would like to thank the Council of Europe Education Department for their support and guidance throughout the drafting of this report, more specifically

- Villano Qiriazi, Head of the Education Department
- Michael Remmert, Head of the Education Policy Division
- Ahmet-Murat Kiliç, Programme manager
- Gülden Serbest, Project assistant
- Benedita Santos Silva, Trainee

The authors would also like to thank Nezir Akyeşİlmen, Brian O'Neill, Pascale Raulin-Serrier and Janice Richardson (members of the Council of Europe Digital Citizenship Education Expert Group), Yannick Meneceur, Head of the Central Division, DG I – Council of Europe for their insightful comments on earlier drafts of the report, and Judy Kay, Vincent Aleven and Ben du Boulay, for kindly identifying key reviews of AIED research (Appendix IV).

Contents

Definitions

Adaptive tutoring systems, intelligent tutoring systems (ITS), intelligent interactive learning environments or personalised learning systems (NB some of these terms are contested): AI-driven tools that might provide step-by-step tutorials, practice exercises, scaffolding mechanisms (e.g. recommendations, feedback, suggestions and prompts) and assessments, individualised for each learner, usually through topics in well-defined structured subjects such as mathematics or physics.

AI literacy: Having competencies in both the human and technological dimensions of artificial intelligence, at a level appropriate for the individual (i.e. according to their age and interests).

AI systems: Shorthand term encompassing AI-driven tools, applications, software, networks, etc.

Artificial intelligence (AI): Artificial intelligence is notoriously challenging to define and understand. Accordingly, we offer two complementary definitions:

> A set of sciences, theories and techniques whose purpose is to reproduce by a machine the cognitive abilities of a human being. Current developments aim, for instance, to be able to entrust a machine with complex tasks previously delegated to a human. (Council of Europe 2021)[1]

> Machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations or decisions that influence real or virtual environments. AI systems interact with us and act on our environment, either directly or indirectly. Often, they appear to operate autonomously, and can adapt their behaviour by learning about the context. (UNICEF 2021: 16)[2]

To further illustrate the range of definitions of artificial intelligence, some alternatives are given in Appendix I.

Artificial intelligence and education (AI&ED): The various connections between AI and education that include what might be called "learning with AI", "learning about AI" and "preparing for AI". Learning with AI has also been called "artificial intelligence for education".[3]

Artificial intelligence in education (AIED): An academic field of enquiry, established in the 1980s, that primarily researches AI tools to support learning (i.e. learning with AI).

Automatic writing evaluation: AI-driven tools that use natural language and semantic processing to provide automated feedback on writing submitted to the system.

1. www.coe.int/en/web/artificial-intelligence/glossary.
2. www.unicef.org/globalinsight/reports/policy-guidance-ai-children.
3. Recommendation CM/Rec(2019)10 of the Committee of Ministers to member States on developing and promoting digital citizenship education.

Big data: Large heterogeneous and volatile data sets, generated rapidly from different sources, that are cross-referenced, combined and mined to find patterns and correlations, and to make novel inferences.[4] The analysis of big data is too complex for humans to undertake without machine algorithms.

Chatbots: Systems designed to respond automatically to messages through the interpretation of natural language. Typically, these are used to provide support in response to queries (e.g. "Where is my next class?", "Where can I find information about my assessment?").

Dialogue-based tutoring systems: AI-driven tools that engage learners in a conversation, typed or spoken, about the topic to be learned.

e-proctoring: The use of AI-driven systems to monitor learners taking examinations with the purpose of detecting fraud and cheating.

Educational data mining: See **Learning analytics**.

Educators: Shorthand term encompassing teachers and other professionals in formal education and early childhood care, including school psychologists, pedagogues, librarians, teaching assistants and tutors.

Embodied AI and **Robotics**: Movable machines that perform tasks either automatically or with a degree of autonomy.

Exploratory learning environments: AI-supported tools in which learners are encouraged to actively construct their own knowledge by exploring and manipulating elements of the learning environment. Typically, these systems use AI to provide feedback to support what otherwise can be a challenging approach to learning.

GOFAI: "Good old-fashioned artificial intelligence", a type of AI more properly known as "symbolic AI" and sometimes "rule-based AI', which was the dominant paradigm before machine learning (ML) came to prominence.

Intelligent interactive learning environments: See **Adaptive tutoring systems**.

Intelligent tutoring systems (ITS): See **Adaptive tutoring systems**.

K12: Children in primary and secondary education (i.e. from kindergarten to kindergarten to the end of secondary schooling.

Learners: Shorthand term to encompass children and young people in formal education (i.e. pupils and students) and people of all ages engaged in formal, informal or non-formal education (in accordance with the principle of lifelong learning).

Learning analytics and **Educational data mining**: Gathering, analysing and visualising big data, especially as generated by digital devices, about learners and learning processes, with the aim of supporting or enhancing teaching and learning.

Learning network orchestrators: AI-driven tools that enable and support networks of people (e.g. learners and their peers, or learners and teachers, or learners and people from industry) engaged in learning.

4. www.coe.int/en/web/artificial-intelligence/glossary.

Machine learning (ML): A type of AI, the type that is currently dominant, which uses algorithms and statistical models to analyse big data, identify data patterns, draw inferences and adapt, without specific step-by-step instructions.

Natural language processing (NLP) or **Speech to text** and **Natural language generation**: Systems that use AI to transcribe, interpret, translate and create text and spoken language.

Personalised learning systems: See **Adaptive tutoring systems**

Plagiarism checking: AI-driven content scanning tool that helps identify the level of plagiarism in documents such as assignments, reports and articles by comparing a submitted text with existing texts.

Profiling: The automated processing of personal data to analyse or predict aspects of a person's performance, economic situation, health, personal preferences, interests, reliability, behaviour, location or movements.

Robotics: See **Embodied AI**.

Smart curation of learning materials: The use of AI techniques to automatically identify learning materials (such as open educational resources) and sections of those materials that might be useful for a teacher or learner.

Speech to text: See **Natural language processing**.

Executive summary

As noted by the Council of Europe's Committee of Ministers in 2019, artificial intelligence (AI) is increasingly having an impact on education, bringing opportunities as well as numerous threats. It was these observations that led to the commissioning of this report, which sets out to examine the connections between AI and education.

In fact, AI in education (AIED) has already been the subject of numerous international reports (see Appendix III) – so what differentiates this one? There are three unique characteristics. First, in this report, we explore both the application and the teaching of AI in education, which we refer to collectively as "AI and education" (AI&ED). Second, we approach AI&ED through the lens of the Council of Europe's core values: human rights, democracy and the rule of law. And third, rather than assuming the benefits of AI for education, we take a deliberately critical approach to AI&ED, considering both the opportunities and the challenges. Throughout, the aim is to provide a holistic view to help ensure that AI empowers and not overpowers educators and learners, and that future developments and practices are genuinely for the common good.

The report begins with an introduction to AI (what it is and how it works) and to the connections between AI and education: "learning with AI" (learner-supporting, teacher-supporting and system-supporting AI), using AI to "learn about learning" (sometimes known as learning analytics) and "learning about AI" (repositioned as the human and technological dimensions of AI literacy). In Part II, we examine some key challenges for AI&ED. These include the choice of pedagogy adopted by typical AIED applications, the impact of AIED applications on the developing brain and learner agency, the use of emotion detection and other techniques that might constitute surveillance, digital safeguarding, the ethics of AI&ED, the political and economic drivers of the uptake of AI in educational contexts and AIED colonialism.

We continue, in Part III, by exploring AI&ED through the lens of the Council of Europe's core values – human rights, democracy and the rule of law – noting that currently there is little substantive relevant literature. Accordingly, we start with the Turing Institute's report, commissioned by the Council of Europe, "Artificial intelligence, human rights, democracy, and the rule of law: a primer" (Leslie et al. 2021), identifying and cross-checking the pertinent issues for education.

With regard to human rights, we examine the impact of AI&ED on a child's rights to education, to human dignity, to autonomy, to be heard, to not suffer from discrimination, to privacy and data protection, to transparency and explainability, to be protected from economic exploitation and to withhold or withdraw consent for their involvement with any technology. With regard to democracy, we consider how AI&ED might both support and undermine democratic values, how democratic education, which depends on open access and equity, may be compromised by the dominance of commercial AIED applications, how certain tools promote individualism at the expense of the collaborative and social aspects of teaching and learning

and the impact of AI models representing the world as a function of the past. With regard to the rule of law, we identify and examine several cases in which the use of AI algorithms in education have been subject to legal challenge – the use of historical school-level data to grade individual learners, learning data traces and biometric data. We then ask three key questions: Can children be required to use any particular AI system? Can AI ever meet the test of necessity and proportionality and be lawful at all? Must schools respect parents' or children's wishes or can they make the use of certain AI systems compulsory?

We end the report, in Part IV, with a conclusion and provisional needs analysis of open challenges, opportunities and implications of AI&ED, designed to stimulate and inform further critical discussion. Anticipated needs include: the need to identify and act upon linkages across the Council of Europe's work; the need for more evidence of the impact of AI on education, learners and teachers; the need to avoid perpetuating poor pedagogic practices; the need for robust regulation, addressing human rights, before AI tools are used in education; the need for parents to be able to exercise their democratic rights; the need for curricula that address both the human and technological dimensions of AI literacy; the need for ethics by design in the development and deployment of AI tools in educational contexts; the need to ensure that data rights and intellectual property rights remain explicitly with the learners; and the need for the application and teaching of AI in education to prioritise and facilitate human rights, democracy and the rule of law.

Introduction

In 2019, the Council of Europe's Committee of Ministers adopted a recommendation on digital citizenship education in which a key focus was the application of artificial intelligence (AI) in educational contexts:

> AI, like any other tool, offers many opportunities but also carries with it many threats, which make it necessary to take human rights principles into account in the early design of its application. Educators must be aware of the strengths and weaknesses of AI in learning, so as to be empowered – not overpowered – by technology in their digital citizenship education practices. AI, via machine learning and deep learning, can enrich education … By the same token, developments in the AI field can deeply impact interactions between educators and learners and among citizens at large, which may undermine the very core of education, that is, the fostering of free will and independent and critical thinking via learning opportunities … Although it seems premature to make wider use of AI in learning environments, professionals in education and school staff should be made aware of AI and the ethical challenges it poses in the context of schools. (Council of Europe 2019)[5]

This report builds on these prescient observations and concerns to explore in detail the connections between AI and education through the lens of the Council of Europe's mandate to protect human rights, to support democracy and to promote the rule of law.[6] Accordingly, this is not a review of the more than 40 years of academic research into the application of AI in education (see Appendix IV for reviews of academic research of AI in education). Instead, it is a critical analysis of what is happening now, with AI tools developed by multi-million-dollar-funded commercial players increasingly being implemented in classrooms, in parallel with a growing demand from policy makers for AI curricula designed for school students. Globally, AI in education is often welcomed with enthusiasm – with many international reports and recommendations painting unquestioned glowing pictures (see Appendices II and III for lists of related reports). Here, to help rebalance the discussion, we take a more realistic perspective, specifically focusing on the many complex challenges raised by the connections between AI and education (AI&ED), to provide a holistic view in order to ensure that future developments and practices are genuinely for the common good.

The work was carried out in the context of the Digital Citizenship Education Project (DCE), which aims to empower children through education and active participation in the increasingly digital society.[7] AI is fast becoming a cross-cutting issue that draws on, and relates to, other work undertaken by the Council of Europe's Education

5. Recommendation CM/Rec(2019)10 of the Committee of Ministers to member States on developing and promoting digital citizenship education, https://search.coe.int/cm/Pages/result_details.aspx?ObjectID=090000168098de08.
6. The Council of Europe, Values, www.coe.int/en/web/about-us/values.
7. Council of Europe, "Digital Citizenship and education", www.coe.int/en/web/digital-citizenship-education.

Department, especially with respect to literacy and life skills. In addition, AI cuts across the Council of Europe's directorates' focus on data protection, children's rights and competences for democratic culture.[8]

The Council of Europe's Ad hoc Committee on Artificial Intelligence (CAHAI)[9] was tasked with examining the feasibility and potential elements on the basis of broad multi-stakeholder consultations, of a legal framework for the development, design and application of artificial intelligence, based on the Council of Europe's standards on human rights, democracy and the rule of law. To this end, CAHAI focused its work on mapping relevant international and national legal frameworks and ethical guidelines, while analysing the risks and opportunities arising from AI. However, although otherwise comprehensive, the current work by CAHAI has not included education as one of its AI domains. CAHAI has now been superseded by the Committee on Artificial Intelligence (CAI).[10]

Accordingly, our motivation was to address this core gap, with a report that focuses on education as a key AI domain, and that is written for the Council of Europe's core audience. The aim was to develop a high-level mapping of key topics and issues identified in the field, in order to complement CAHAI's work, to enhance what is known more widely about the connections between AI and education and their impact on human values, and to provide a foundation for future related work.

The scope of the material reviewed for this report includes:

- academic and peer-reviewed publications;
- open access policy guidelines and frameworks including those developed by international, national and intergovernmental agencies; and
- other relevant literature produced by civil society, regulators and protection agencies, and third sector organisations.

The report was guided by the following questions (all through the lens of the Council of Europe's core values):

- What is meant by AI and education, what does it involve, and what are its potential benefits?
- What key issues and potential risks may arise in this context, and what are the possible mitigations?
- What are the gaps in what is known, documented and reported, and what questions still need to be asked?

The review is organised into four main parts. In Part I, we map the connections between AI and education. In Part II, we identify and explore some potential challenges of AI and education. In Part III, we explore AI and education through the lens of the Council of Europe's core values (human rights, democracy and the rule of law) and critically reflect on our findings. In Part IV, we conclude with a discussion and needs

8. Council of Europe, Reference Framework of Competences for Democratic Culture (RFCDC), www.coe.int/en/web/reference-framework-of-competences-for-democratic-culture.
9. Ad hoc Committee on Artificial Intelligence, www.coe.int/en/web/artificial-intelligence/cahai.
10. www.coe.int/en/web/artificial-intelligence/cai.

analysis of open challenges, opportunities and implications of AI and education. Our analysis includes the need to identify and act upon linkages across the Council of Europe's work, to increase understanding in and between policy makers, of the challenges that AI poses across the directorates and member states, where children's lives are affected, in and beyond the context of education.

In addition, this report also includes a list of alternative definitions of AI (see Appendix I), a list of related reports in this area (see Appendices II and III), a list of articles that review academic research in AI in education (see Appendix IV) and a list of examples of commercial learning with AI tools (see Appendix V).

Finally, in parallel with this report, the Council of Europe's Digital Citizenship Education Unit is carrying out a survey of member states to better understand national initiatives linked to AI and education, and is holding a multi-stakeholder conference (September 2022). The survey and conference, together with this report, are all designed to help establish a foundation for the Council of Europe's future work in AI&ED.

PART I

The connections between AI and education

Following the societal changes brought about by the Covid-19 pandemic and its impact on the educational landscape and the use of digital technologies (Council of Europe 2021),[11] exploring the link between the technologies of AI and education is timely:

> Technology and innovation matter … but the picture is much more complex, much more non-linear, much more dynamic than simple plug-and-play metaphors. There can be dangerous unintended consequences from any single seemingly promising solution. We must reorient our approach from solving discrete siloed problems to navigating multidimensional, interconnected and increasingly universal predicaments. (UNDP 2020: 5)

It is precisely this complexity that we aim to address in this exploration of the connections between AI and education.

11. *Higher education's response to the Covid-19 pandemic: building a more sustainable and democratic future*, https://rm.coe.int/prems-006821-eng-2508-higher-education-series-no-25/1680a19fe2.

1.1. Defining AI

In order to explore the multiple connections between AI and education, we first have to define AI. This is, however, immediately challenging. In fact, the description and boundaries of AI are contested, without a universally accepted single definition (see Appendix I for some examples of the different ways in which AI has been defined), and are constantly shifting:

> [A] lot of cutting-edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it is not labelled AI anymore. (Bostrom n. d.)[12]

Artificial intelligence, human rights, democracy, and the rule of law: a primer, prepared by the UK's Alan Turing Institute (Leslie et al. 2021), draws on the Council of Europe's Ad hoc Committee on Artificial Intelligence (CAHAI) Feasibility Study, and defines AI systems as follows:

> AI systems are algorithmic models that carry out cognitive or perceptual functions in the world that were previously reserved for thinking, judging, and reasoning human beings. (Leslie et al. 2021: 8)[13]

Given that this definition itself contains words and concepts that are not immediately transparent for a general audience (e.g. algorithmic), we prefer a complementary definition that is provided by UNICEF (which, in turn, is derived from a definition agreed by the Organisation for Economic Co-operation and Development (OECD) member states):

> AI refers to machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations, or decisions that influence real or virtual environments. AI systems interact with us and act on our environment, either directly or indirectly. Often, they appear to operate autonomously, and can adapt their behaviour by learning about the context. (UNICEF 2021: 16)

We prefer this definition for several reasons. First, it does not depend on data, although it does accommodate data-driven AI techniques such as artificial neural networks and deep learning; second, it therefore also includes rule-based or symbolic AI and any new paradigm of AI that might emerge in future years; and third, it highlights that AI systems necessarily depend on human objectives and sometimes "appear to operate autonomously", rather than assuming that they do operate autonomously, which is key given the critical role of humans at all stages of the AI development pipeline (Holmes and Porayska-Pomsta 2022). None of the multiple other definitions given in Appendix I has all these features. However, inevitably, the UNICEF definition is not perfect. An element that we find less helpful is the notion of an AI system "learning" – something that, it might be argued, requires the consciousness or agency that, now and for the foreseeable future, machine-based systems entirely lack (Rehak 2021). However, the use of anthropomorphic terms to describe these

12. The Oxford philosopher Nick Bostrom cited in http://edition.cnn.com/2006/TECH/science/07/24/ai.bostrom.
13. http://rm.coe.int/cahai-2020-23-final-eng-feasibility-study-/1680a0c6da.

machine-based systems (including "intelligence", "learning" and "recognition", as in "facial recognition") are so part of the AI narrative that, although distracting and unhelpful, they are unlikely to change anytime soon.

The term artificial intelligence itself was coined at a workshop at Dartmouth College in 1956. From that time, AI experienced periods of huge interest and grand predictions, punctuated by periods known as AI winters, when the grand predictions failed to materialise and so the funding all but dried up. From its earliest days, AI researchers have been interested in two parallel approaches. First, there is the "symbolic" AI approach, which focused on encoding principles of human reasoning and on knowledge engineering (encoding the knowledge of experts), and which led to "expert systems". This approach is often referred to as "rule-based" or "good old-fashioned AI" (GOFAI). Second, although beginning at around the same time, there was AI inspired by how the human brain is structured (its neurons) and which draws inferences from usually large amounts of data. This artificial neural network (ANN) approach is one of several data-based approaches (which also include support vector machines (SVM), Bayesian networks and decision trees), which are collectively known as machine learning (ML).

In the late 20th century, most of the progress made in AI involved symbolic AI, but progress was stalled by multiple roadblocks, leading to the AI winters. In the early 21st century, thanks to much faster processors and the availability of huge amounts of data (mainly derived from the internet), ML became dominant – and it is ML that has led to most of the dramatic achievements of AI in recent years (such as automatic translation between languages[14] and figuring out what shapes proteins fold into[15]). Interestingly, some researchers now argue that ML is soon to hit its own development ceiling, such that significant further progress will only happen if there is a new paradigm (which might involve bringing together GOFAI and ML) (Marcus 2020).

Despite some impressive achievements and its broad presence in everyday life, AI often suffers from overselling and hyperbole,[16] which raises multiple issues:

> The hype around AI can result in unrealistic expectations, unnecessary barriers and a focus on AI as a panacea rather than as a tool that can support positive impacts. (Berryhill et al. 2019: 27)

For example, AI systems can be brittle: a small change to a road sign can prevent an AI image-recognition system recognising it (Heaven 2019). They can also be biased, because the data on which they are trained is biased (Access Now 2018; Ledford 2019). AI language models such as GPT-3 (Romero 2021), again while

14. For example, the OBTranslate foundation (www.obtranslate.org) is a deep learning, online CAT (computer-assisted translation) tool, neural machine translation (NMT) and AI platform for languages. Its parent company is OpenBinacle.
15. Google DeepMind (2021), AlphaFold which addresses a 50-year-old grand challenge in biology, https://deepmind.com/blog/article/alphafold-a-solution-to-a-50-year-old-grand-challenge-in-biology.
16. To give one example, it is often said that in some circumstances AL is "better than humans", www.theguardian.com/global/2015/may/13/baidu-minwa-supercomputer-better-than-humans-recognising-images. However, there is little evidence that this is accurate.

impressive, often write nonsense (Hutson 2021; Marcus and Davis 2020), while AI approaches made little impact on addressing Covid-19 when the pandemic was at its height (Benaich 2020; Heaven 2021; Roberts et al. 2021; Walleser 2021). That said, the concerns that often feature in science fiction, such as the Singularity (Kurzweil 2006) or superhuman AI machines that cannot be controlled by humanity,[17] remain mythical.

Much of the problem begins, as noted earlier, with the language used to name these technologies (Rehak 2021). The early decision to call the field artificial "intelligence" effectively presupposes that the creation of a non-human intelligence is possible. This anthropomorphism of AI also inevitably suggests agency (for example, "learning" requires someone or something that "learns"). In any case, it is important to note that AI should not be thought of in purely technical terms; instead, AI is a complex sociotechnical artefact that needs to be understood as something that is constructed through complex social processes (Eynon and Young 2021). In other words, when we consider AI, we must consider both the human dimensions and technological dimensions in tandem.

One example is the potential impact of AI on jobs. Many claims have been made about how AI will change the nature of employment (e.g. Arntz et al. 2016; Bughin et al. 2017; Susskind and Susskind 2015). In an influential paper, Frey and Osborne estimated the impact on more than 700 occupations and identified a trend towards labour market polarisation, "with growing employment in high-income cognitive jobs and low-income manual occupations, accompanied by a hollowing-out of middle-income routine jobs" (2013: 14). One example of the low-income jobs that AI is currently creating are the so-called "hidden ghost work" of AI: the data cleaning, image labelling and content moderation being undertaken by usually poorly-paid workers in developing economies (Gent 2019; Raval 2019). Furthermore, while the total number of jobs might grow, many individuals might still become terminally unemployed, and it is not likely that those middle-income employees will be able to transfer easily to the high-income cognitive jobs. Either way, the impact of AI on employment is complex, and is yet to be fully revealed.

Other examples of issues relating to both the human aspects and the technical aspects of AI include gender equity, surveillance and the impact of AI on sustainable development – each of which we consider in more detail below.

1.2. The connections between AI and education

Frequently (e.g. Davies et al. 2020; OECD 2021; Seldon and Abidoye 2018), although rarely with strong evidence (Miao and Holmes 2021a), AI is hailed as a solution to many of education's core problems (e.g. the lack of qualified teachers, student underachievement and the growing achievement gap between rich and poor learners). Nonetheless, this raises the need to consider multiple issues: the aims of using AI in education, where it is used, by whom (by individuals, institutions or industry), how

17. https://en.wikipedia.org/wiki/Skynet_(Terminator).

it is operationalised, at what levels (from the single learner to whole classrooms, collaborative networks and national and transnational levels), how it works and so on.

Although the boundaries are not rigid, the connections between AI and education (AI&ED) have elsewhere been grouped under four headings: "Learning with AI", "Using AI to learn about learning", "Learning about AI" and "Preparing for AI" (Holmes et al. 2019).

Learning with AI involves the use of AI-driven tools in teaching and learning, and includes:

- the use of AI to support learners directly, involving tools such as those known as intelligent tutoring systems, dialogue-based tutoring systems, exploratory learning environments, automatic writing evaluation, learning network orchestrators, chatbots and AI to support learners with disabilities;
- the use of AI to support administrative systems (such as recruitment, timetabling and learning management);
- the use of AI to support teachers directly (although, with the exception of smart curation of learning materials, there are few examples).

Using AI to learn about learning is not strictly AI, which almost always means some kind of automation, but does involve the analysis of the same or similar data to that used by "learning with AI" tools, and uses similar analytical techniques. Here, the data are used to learn about how learners learn, learning progression, or which learning designs are effective – the aim being to inform learners', teachers' or other stakeholder practices, or to support admissions, retention of students and programme planning. This overlapping but nonetheless distinct field is usually known as learning analytics or educational data mining.

Learning about AI involves increasing the AI knowledge and skills of learners of all ages (that is, from primary education, through secondary, to tertiary) and their teachers, covering the techniques of AI (e.g. ML) and technologies of AI (e.g. natural language processing), together with the statistics and coding on which it all depends (Miao and Holmes 2021a). Henceforward, in this publication, we refer to learning about AI as **AI literacy: the technological dimension**.

Preparing for AI involves ensuring that all citizens are prepared for the possible impacts of AI on their lives – helping them to go beyond the hype in order to understand issues such as AI ethics, data biases, surveillance and the potential impact on jobs. In fact, preparing for AI should always be integrated within learning about AI; it is separated out only to ensure that it receives the attention it deserves and does not become a tick box exercise. Henceforward, we refer to preparing for AI as **AI literacy: the human dimension**.

1.3. Learning with AI

Learning with AI has been the focus of the AI in education (AIED) academic research field since at least the 1980s. The *International Journal of Artificial Intelligence in Education* was first published in 1989, while the International AI in Education Society (IAIED) was established in 1993. However, the origins of AIED are in the 1930s, which

saw the development of "teaching machines" and their twin promises of personalised learning and saving teacher time (Watters 2021).

As noted, "Learning with AI" might be further divided into learner-supporting AI, teacher-supporting AI and institution-supporting AI.

1.3.1. Learner-supporting AI

Over the past three decades, most of the AIED research focus has been on learner-supporting AI, which by definition aims to automate teacher functions, so that learners can learn independently of teachers – or that they have their own artificial personal tutor and can leverage the Bloom 2-Sigma effect.[18] However, much of this adopts a rather primitive approach to pedagogy, and all too often focuses on automating poor pedagogic practices rather than innovation (for example facilitating examinations rather than devising innovative ways to assess and accredit learning).

Nonetheless, the use of learner-supporting AI is fast becoming popular in mainstream education (Becker 2017; Holmes et al. 2019; Miao and Holmes 2021a) and in related areas (e.g. legal education, Carrel 2018; science inquiry, Gobert et al. 2013; dentistry education, Majumdar et al. 2018; medical education, Sapci and Sapci 2020; and engineering education, Silapachote and Srisuphab 2016). The AIED research community has demonstrated the efficacy of various learner-supporting AI tools, although usually in short studies researched in limited contexts in universities and high schools[19] (e.g. Beal et al. 2007; Gobert et al. 2018; Mendicino et al. 2009; VanLehn et al. 2005)[20] which have been summarised in meta-analyses (e.g. Ma et al. 2014). However, robust, independent evidence remains scarce. Accordingly, many claims (such as the use of AI in education will dramatically improve the way learners learn, Davies et al. 2020; OECD 2021; Seldon and Abidoye 2018) remain aspirational (Holmes et al. 2019).

Over the many years, learner-supporting AI has developed to include, for example: adaptive learning tools "for complex domains such as programming languages, mathematics, medicine, physics, avionics troubleshooting, pulp and paper mill factories, and electronics" (Wasson 1997: 572); the capture and analysis of a broad range of classroom signals (e.g. measuring attention, empathy and emotion), the use of an increasing range of hardware (from mobile phones to EEG headsets), the development of chatbots designed to give learners 24/7 support, learning network orchestrators designed to build communities of learners, automatic writing evaluation,

18. The US researcher Benjamin Bloom determined that learners receiving one-to-one tuition achieved two standard deviations more progress than learners participating in classroom learning. This observation has been the basis for much work in the AIED research community, which has aimed to create machine-driven or automated one-to-one tuition (partly because one-to-one tuition provided by humans is expensive and out of the reach of most children). See Bloom (1984).
19. "There have been relatively few studies of ITS software designed for use by younger learners in classroom settings" (Beal et al. 2010: 66).
20. Gobert et al. (2018) demonstrated the efficacy of INQ-ITS intelligent scaffolding of the development of science inquiry skills when 40 days after the scaffolding is removed learners demonstrated continued growth of inquiry performance.

the inclusion of open learner models (that the learners can inspect themselves to better understand their own learning) and the provision of teachers' oversight functionality by means of the ever-present data dashboards (cf. Holmes et al. 2018; Tuomi 2018; Woolf 2010).

While the use of learner-supporting AI appears to be growing in classrooms across the world, as evidenced by the many multi-million-dollar-funded AIED companies globally,[21] there is actually surprisingly little to justify its wide use in well-resourced classrooms, other than the marketing materials and mostly unsubstantiated hopes expressed by many policy makers (Miao and Holmes 2022).

> Artificial Intelligence in Education (AIED) is one of the currently emerging fields in educational technology. Whilst it has been around for about 30 years, it is still unclear for educators how to make pedagogical advantage of it on a broader scale, and how it can actually impact meaningfully on teaching and learning. (Zawacki-Richter et al. 2019: 1)

In fact, recent work (e.g. Centre for Data Ethics and Innovation 2020; Tuomi 2018) highlight the technical, social, scientific and conceptual limits of AI in education systems and flag the lack of robust independent evidence for their efficacy or success in delivering the intended outcomes. However, notable exceptions are the homework-oriented ITS ASSISTments[22] (Roschelle et al. 2017), the geometry Cognitive Tutor[23] (Pane et al. 2010), and Multi Smart Øving[24] (Egelandsdal et al. 2019; Kynigos 2019).

The argument for using AI to support learners in contexts where there are few experienced or qualified teachers, such as in rural areas in developing countries, might be stronger. However, using technology to substitute for teachers addresses the symptom of this key problem (children not receiving the education to which they have a human right) rather than the cause (the global shortage of teachers). While some children might benefit, the long-term effects of using this techno-solutionist approach to solve what is essentially a social problem remains unknown (Morozov 2014).

In addition, AIED developers tend to be based in high-income WEIRD countries (western, educated, industrialised, rich and democratic, Pinkwart 2016), and are therefore less familiar with the needs of young people in developing countries (Schiff 2021). At the same time, although no specific evidence is available, it is likely AIED suffers from the same lack of diversity for which AI in general is well-known (West et al. 2019). All of this potentially results in skewed or biased AIED data and algorithms. In any case, while the issue of bias in data and algorithms has been the subject of much research (e.g. Baker and Hawn 2021; Suresh and Guttag 2019), bias is actually a social problem that might never have a technical fix (Powles 2018).

---

21. In 2015, Susskind and Susskind identified at least 70 companies that were providing adaptive learning systems. For some current examples, please see Appendix V.
22. ASSISTments was developed at Worcester Polytechnic Institute, https://new.assistments.org/research.
23. Emerging from research at CMU and published by www.carnegielearning.com.
24. A digital learning tool for practice and mass training in mathematics in primary school years 1-7, www.gyldendal.no/grunnskole/matematikk/multi-smart-oving.

A final issue to be mentioned here, in the context of learner-supporting AI, is that of trust. If AI tools are to become even more widely used in classrooms, it is essential that teachers, learners, parents and other stakeholders can trust that they will be beneficial – that they will enhance learning and not cause any harm. In fact, conversations about stakeholder trust in AI tools designed for classrooms are only just beginning. However, all too often the onus is placed on the classroom stakeholders (to trust the learner-supporting AI tools) rather than on the providers (to provide learner-supporting AI tools that are trustworthy). For example, a recent paper proposed eight factors that influence teachers' trust in adopting AI-based educational tools, all of which focus on the teachers, and none of which require the AI developers to make their tools trustworthy (Nazaretsky et al. 2021); in short, the European Commission's *Ethics guidelines for trustworthy AI*[25] should be applied to AIED systems too.

1.3.2. Teacher-supporting AI

While many writers and government ministries have expressed their hope that AI will save teacher time (Bryant et al. 2020; Miao and Holmes 2021b), others have suggested that AI will at some point make teachers *de facto* redundant – or at least their role will be reconfigured as classroom orchestrators/technology facilitators, tasked with managing learner behaviour and ensuring that the technology is switched on (e.g. Seldon and Abidoye 2018). The reality is that, throughout its 30 plus years, most AIED research and development has focused on using AI to support learners directly, with the aim of enhancing learning, usually by taking over (namely, replacing) teacher functionalities, such as by means of AI-powered adaptive tutoring (du Boulay 2016).

During that time, there has been very little focus on AI designed specifically to support teachers (aside from the dashboards that are common in educational technologies, Holstein et al. 2018; Jivet et al. 2017). More recently, however, there has been some research, such as AI to scrape the internet in order to curate resources (e.g. X5Learn, Perez-Ortiz et al. 2020), and tools designed to analyse and support teacher practices, time-management and course planning (e.g. Chounta et al. 2021; Holstein et al. 2017; Martinez-Maldonado et al. 2021). However, very little of this has been taken up by the commercial players or is widely available.

There has been a focus over many years on AI tools that aim to automatically assess learner assignments, again mostly with the intention of saving teacher time (which neatly illustrates how the teacher-supporting/learner-supporting categories, although helpful, are not rigid). However, AI is not capable of the depth of interpretation or accuracy of analysis that a human teacher can give (Byrne et al. 2010; Holmes et al. 2019), a concern that led Australia to abandon plans to use automated marking for state-wide exams in 2018 (Hendry 2018). Even if AI was capable of fair and accurate marking of free text, implementing such a system would also ignore how much a teacher learns about their learners when they read what the learner has written – insights that no dashboard will ever give. This is understood by a novel approach

25. European Commission (2019), Directorate-General for Communications Networks, Content and Technology, *Ethics guidelines for trustworthy AI*, Publications Office, https://op.europa.eu/en/publication-detail/-/publication/d3988569-0434-11ea-8c1f-01aa75ed71a1.

which might be worth exploring that uses AI to support teachers while they grade their learners' work, by automatically offering prompts and shortcuts (that is, the teacher does the grading, the AI only supports that process).[26] There is also the use of AI to formatively assess assignments, guiding learners how to improve their first draft assignments before submitting them for summative assessment, which is fast becoming an area of interest.[27] In summary, while AI might save teacher time, although there's little evidence for that, it remains unclear what the impact might be on the quality of teaching and learning.

1.3.3. Institution-supporting AI

While there is little evidence of AI being used to support directly primary or secondary education institutions, a recent systematic literature review of AI applications in higher education (Zawacki-Richter et al. 2019) noted that almost half (48%) of the included studies explored AI-support for administrative and institutional services. Three main types of institution-supporting AI are automating processes related to learners' admissions, facilitating communication with learners and planning resources allocation.

Many higher education institutions, mainly in the USA, use AI-supported software (primarily offered by private companies) for supporting their admission processes.[28,29] For example, the University of Texas at Austin launched an AI system named GRADE to recommend whether an applicant should be admitted, based on their test scores, prior academic background and textual input, such as recommendation letters (Waters and Miikkulainen 2014). However, by 2020, GRADE had been dropped because of its various biases.[30] Nonetheless, AI is increasingly being used to support admissions, with a focus on fairness and the institutions' reputations (Dennis 2018; Marcinkowski et al. 2020; Zeide 2019).

Another focus of institution-supporting AI is the use of chatbots to facilitate communication with learners and to provide self-services operating 24/7. For example, Georgia State University launched a chatbot, Pounce, in an attempt to support learners who were seeking support and counselling, especially those who were transitioning from high school to college and were not familiar with academic life (Page and Gehlbach 2017). This approach was closely followed by other institutions.

---

26. www.graide.co.uk.
27. Bolton College, UK, AI Cloud FirstPass tool, https://ufi.co.uk/voctech-directory/formative-assessment-bolton-college; and Assessment Standards Knowledge exchange, Oxford Brookes University (2021), Guide to Turnitin, https://radar.brookes.ac.uk/radar/file/8ff7698b-72a1-9750-b982-1cc9080b421a/2/Turnitin.pdf.
28. USA Today (2021), "Artificial intelligence grading your "neuroticism"? Welcome to colleges' new frontier", https://eu.usatoday.com/story/news/education/2021/04/26/ai-infiltrating-college-admissions-teaching-grading/7348128002.
29. Pangburn D. (2019), "Schools are using software to help pick who gets in. What could go wrong?" www.fastcompany.com/90342596/schools-are-quietly-turning-to-ai-to-help-pick-who-gets-in-what-could-go-wrong.
30. Tweet from the Computer Science Dept UT Austin (2020), https://twitter.com/UTCompSci/status/1333890167782957060.

Nonetheless, a recent literature review on the use of chatbots in education showed that although there is evidently research interest on the use of chatbots as assistants, there remain challenges and limitations regarding the evaluation, the potential and the capabilities of this AI-enhanced technology that need to be addressed before moving towards its widespread adoption (Wollny et al. 2021).

In order for institutions to plan and allocate resources, it is important for them to know the numbers and distribution of the learner population. Therefore, institutions are also investing in analytical tools for predicting learner dropouts. A well-known example is the Course Signals system at Purdue University, which initially appeared to have a positive impact on learner retention (Arnold and Pistilli 2012), but this was followed by controversial discussions regarding the findings (Sclater 2016). Using AI to predict dropouts is also a popular area of research, especially in MOOCs (massive open online courses) where dropout rates can reach up to more than 90%. The aim is to understand factors that can impact dropouts, to predict them and to reduce them (Dalipi et al. 2018; Feng et al. 2019; Goel and Goyal 2020) – although there remains little evidence for the effectiveness of such systems, or whether the connections are predictive or causal.

1.4. Using AI to learn about learning

1.4.1. Digital traces

As we noted earlier, AI's recent massive growth was partly made possible by the availability of huge amounts of data (often known as big data). Now, the AI systems are themselves collecting similarly large amounts of data. In AIED, this includes data representing the learner responses to questions, what they say, their affective state (e.g. interested or distracted), what they click and how they move their mouse across the screen, to name just a few (Chassignol et al. 2018). A single session, with a child interacting with an AI or other electronic education system (such as a MOOC or a serious game, Hwang et al. 2020), can generate "around 5-10 million actionable data points per student each day".[31] These data points are collectively known as a learner's digital traces (Pardo et al. 2019),[32] and are of interest to three complementary and often overlapping academic fields: learning analytics and educational data mining, both of which are "concerned with gathering, analysing and visualising data about learners and learning processes, so as to increase stakeholders' understanding of these and hence to improve learning and the environments in which it occurs" (du Boulay et al. 2018: 270), and AIED, which uses similar data but to automate something (e.g. an adaptive learning platform).

Although these fields (AIED, learning analytics and educational data mining) have developed over many years, the capture and processing of data to represent learners and learning raises multiple issues that are yet to be fully considered. Predictive

31. Jose Ferreira, CEO of Knewton, an ITS company, talking at the Office of Ed Tech at the White House Education Datapalooza event, 2012, www.youtube.com/watch?v=GeajedxpWJA.

32. For an example of how digital traces are used, see *Predicting PISA scores from students' digital traces*, https://ojs.aaai.org/index.php/ICWSM/article/view/14996.

analytics and AI may be used to look for and act on patterns in learner participation in class, approve or deny learner places at institutions, and to identify patterns of participation at national levels. Questions raised include: who is permitted to collect those digital traces, how are they transformed into useful knowledge, how may and how is that knowledge used, who has access to it and who uses that knowledge and who benefits from it? Ostensibly, although there is still little evidence that data analytics and the resultant visualisations are actionable and improve teaching and learning (Ferguson et al. 2016), it is the learner who supposedly benefits. However, presumably so do the AIED providers, which raises further questions: how do the AIED providers benefit, how do they use the data for business intelligence purposes and how, if at all, does this trickle down to the learners, teachers, school, or the education system more broadly?

1.4.2. What commercial organisations are learning

As noted earlier, learner-supporting AI has been the subject of research for 30 plus years. However, for almost a decade AIED tools have "escaped" from the laboratory to be developed into commercial products by a growing number of multi-million-dollar-funded AIED companies around the world and it is these products that are being implemented in schools. So, while the original research was undertaken in academia with the explicit aim of enhancing teaching and learning, can we be so certain of today's many commercial products? Instead, have these good intentions been overtaken by commercial imperatives? Given that the children's interactions with these AI systems generate both technical knowledge about how the product works and market knowledge about how the product is used, are children in classrooms around the world being recruited by stealth to create and supply business intelligence designed to support the corporations' bottom lines – and is this being prioritised over the child's learning and cognitive development? If the children were to create an image or a piece of writing, they would own the intellectual property rights (IPR). Why then can commercial operators assume the IPR of data that has also been created by the children? Educators and other stakeholders also have to negotiate the many hyperbolic claims of the corporations. For example, IBM writes that their Watson's Education Classroom helps teachers realise "impressive outcomes" in the classroom, without providing any robust independent evidence to support those claims.[33]

In addition, the nature of private companies means that they do not routinely share research about the workings of their systems with others. This limits interoperability as well as auditability of effectiveness. In particular, there is limited transparency of the efficacy or error rates of the many AIED products that are being adopted with limited supporting evidence or oversight in public sector education. There are also many educational products claiming to use AI but not actually doing so (defend digital me 2020). This informational asymmetry disadvantages the state and civil society in procurement, scrutiny and accountability for the public purse.

33. www.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=897/ENUS218-010&infotype=AN&subtype=CA.

This transfer of knowledge and power from the public to the private sector may also have consequences for how future educational systems shape markets, society and nation states – and the lives of individual learners. Meanwhile, multinational companies and their products are not only shaping individual learners and teachers but are also agenda-setting issues related to governance and national policies: "they will impose their standards on what counts as knowledge at all. Knowledge is, or will be, what is or can be formalised in a computational way" (Baker 2000: 127). While there is some literature that addresses what these AIED companies are learning from the learners' use of their systems, where that information flows and what can be extracted from it (e.g. Komljenovic 2021), it still is not clear how this influences or shapes our understanding of how learning happens, how teaching should be changed and how learning should be measured. In any case, the AIED companies keep their information to themselves.

Similarly, while the literature sometimes does address the reduction of agency and autonomy of learners as a result of introducing AI into education (Williamson 2019), there is little that analyses the reduced agency and autonomy of nation states to decide policy, what they procure, and the outcomes of their school systems as a result. Finally, whether AIED governance models should accommodate proprietary and closed systems which, rightly or wrongly, the Chinese Government has put a stop to (McMorrow et al. 2021), or whether governance should instead encourage open source and interoperable systems, are key questions.

1.5. Learning about AI (AI literacy)

1.5.1. Two dimensions of AI literacy

In this literature review, we build on Miao and Holmes (2021a) to include both the technical and human dimensions of AI literacy. We continue to separate these two dimensions, formerly learning about AI and preparing for AI, using different terms, in order to ensure that the human dimension is not forgotten but instead is given equal billing to the technological dimension.

> Member states should invest in the level of literacy on AI with the general public through robust awareness raising, training, and education efforts, including (in particular) in schools. This should not be limited to education on the workings of AI, but also its potential impact – positive and negative – on human rights. (Council of Europe Commissioner for Human Rights 2019: 14)

It has also been suggested (Holmes et al. 2019) that in classrooms these two dimensions of AI literacy should be interwoven throughout: that the human dimension should not be left as some sort of nice-to-have but inessential add-on. In fact, the technological and human dimensions have both been important throughout the development of ICT, but the human dimension has rarely been addressed thoroughly. Now, given that AI techniques in many cases aim to emulate and even surpass human cognitive processes, giving the human dimension of AI equal billing to the technological dimension is crucial.

To enable this discussion in detail, and to be clear about what needs to be taught about AI, we first need to establish how AI fits within education. This in turn begs the questions of what education is for and what should be taught more generally.

1.5.2. The purpose of education

To begin with, some believe that the primary reason for education is the provision of human capital for the economy.[34] Others suggest that education is mostly about knowledge transmission: ensuring that school students learn the content that has been mandated by policy makers, selected by curriculum developers, packaged by textbook publishers, taught by teachers and assessed by exams, and which appears to be the aim of most AI tools that have been designed to support learners (Miao and Holmes 2021a). However, others take a broader view.

For example, the United Nations Convention on the Rights of the Child (UNCRC)[35] states that "education should be directed to: (a) The development of the child's personality, talents and mental and physical abilities to their fullest potential". Subsequently, the World Economic Forum (2015) proposed that education should focus on the so-called 21st-century skills, comprising foundational literacies, competencies and character qualities:

- foundational literacies (how learners apply core skills to everyday tasks): literacy, numeracy, scientific literacy, ICT literacy, financial literacy and cultural and civic literacy;
- competencies (how learners approach complex challenges): critical thinking/problem solving, creativity, communication and collaboration;
- character qualities (how learners approach their changing environment): curiosity, initiative, persistence/grit, adaptability, leadership and social and cultural awareness.

Meanwhile, the Council of Europe's Reference Framework of Competences for Democratic Culture[36] provides an alternative model of the competences that need to be acquired by learners, from pre-school to higher education, so that they might participate effectively in culturally diverse democratic societies. The framework

34. For example, while the EU's European Pillar of Social Rights (2021) begins by recognising: "Everyone has the right to quality and inclusive education", its framing is economic: "in order to maintain and acquire skills that enable them to participate fully in society and manage successfully transitions in the labour market". That is distinct from the aims of the fundamental human right to education, https://ec.europa.eu/info/strategy/priorities-2019-2024/economy-works-people/jobs-growth-and-investment/european-pillar-social-rights/european-pillar-social-rights-20-principles_en.
35. www.unicef.org.uk/wp-content/uploads/2016/08/unicef-convention-rights-child-uncrc.pdf. "The Committee takes note of General Comment No. 13 (1999) of the Committee on Economic, Social and Cultural Rights on the right to education, which deals, *inter alia*, with the aims of education under article 13 (1) of the International Covenant on Economic, Social and Cultural Rights", www.ohchr.org/en/resources/educators/human-rights-education-training/general-comment-no-1-aims-education-article-29-2001.
36. https://rm.coe.int/prems-004721-the-reference-framework-of-competences-for-democratic-cul/1680a27f24.

includes 20 competences, grouped into values, attitudes, skills and knowledge and critical understanding:

- values: valuing human dignity and human rights, cultural diversity, democracy, justice, fairness, equality and the rule of law;
- attitudes: openness to cultural otherness and to other beliefs, world views and practices, respect, civic-mindedness, responsibility, self-efficacy, tolerance of ambiguity;
- skills: autonomous learning skills, analytical and critical thinking skills, skills of listening and observing, empathy, flexibility and adaptability, linguistic, communicative and plurilingual skills, co-operation skills, conflict-resolution skills;
- knowledge and critical understanding: knowledge and critical understanding of the self, of language and communication and of the world: politics, law, human rights, culture, cultures, religions, history, media, economies, environment, sustainability.

Finally here, the 2020 United Nations Development Programme report[37] reiterated that education has more than an instrumental role – its purpose is transformative through exposure to broad human values and the promotion of critical thinking, to foster politically aware and active people. In short, until policy makers are clear about the purpose of education (for example, is it to transfer knowledge, increase exam success, help young people to develop their individual potential and self-actualise, or to promote understanding, tolerance and friendship among all peoples?),[38] and until they have implemented appropriate policies, what should be taught about AI remains moot.

1.5.3. What should be learned about AI

While the need for all citizens to be literate (able to read and write) and numerate (able to understand and work with numbers) has long been recognised, more recently, as we have seen, multiple other literacies have been proposed. These include: scientific literacy (the ability to engage with science-related issues, such as the scientific method), ICT or digital literacy (the ability to use digital technologies in order to function effectively in a knowledge society), financial literacy (the ability to understand and use effectively skills such as personal financial management, budgeting and investing) and cultural and civic literacy (the ability to understand, appreciate, analyse and apply knowledge of the humanities).

While only a small number of a total population of learners may want or need to learn about AI in order to become AI designers or developers, the suggestion is that all citizens should also now be encouraged and supported to achieve a certain

37. https://hdr.undp.org/en/content/human-development-report-2020, p. 134.

38. The Universal Declaration of Human Rights (UDHR) Article 26:2 states that "Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace."

level of AI literacy. They should have the knowledge, skills and values centred on the development, implementation and use of AI technologies:

> The world's citizens need to understand what the impact of AI might be, what AI can do and what it cannot do, when AI is useful and when its use should be questioned, and how AI might be steered for the public good. (Miao and Holmes 2021a: 6)

For various reasons, AI literacy might be considered an extension or specialisation of ICT/digital literacy – and, indeed, that is how it is almost always addressed by the few examples of government-sanctioned AI curricula that UNESCO has identified in its recent mapping exercise (Miao and Shiohira 2022). Indeed, these AI curricula adopt an almost exclusively technological perspective, with AI literacy being conceived as comprising "both Data Literacy, or the ability to understand how AI collects, cleans, manipulates and analyses data, as well as Algorithm Literacy, or the ability to understand how the AI algorithms find patterns and connections in the data" (ibid.: 11). However, if we accept that AI is qualitatively different from most digital technologies, since "often they appear to operate autonomously, and can adapt their behaviour by learning about the context" (UNICEF 2021), AI literacy cannot be limited only to its technological components. Instead, AI literacy should comprise both the technological and the human dimensions of AI, both how it works (the techniques and the technologies) and what its impact is on people (on human cognition, privacy, agency and so on) (Holmes et al. 2019). In short, teaching about AI using simplified technical language is important but teaching about what AI does is incomplete without explanations of the people, power and political motivations behind the adoption of automated decision making.

1.5.4. Where is AI being taught, to whom and by whom?

As we have noted, AI can be, and indeed is being, taught at all stages of education, from primary, through secondary to tertiary (although almost exclusively in countries that have robust electricity and internet infrastructure). Having said that, it remains the case that AI is mainly covered in tertiary education, either as a core discipline (e.g. in computer science or data science) or as a tool to advance specific application areas (e.g. in "fintech",[39] the creative industries, or in medicine). Indeed, for some time there appears to have been a conveyor belt of AI PhD graduates directly from universities into BigTech (Amazon, Apple, Facebook, Google) and the other technology companies – but, unfortunately, fewer into health or education.

Meanwhile, as noted by UNESCO (Miao and Shiohira 2022), some aspects of AI technologies are increasingly being included in secondary education, usually as part of overall digital literacy and mostly in computing classes, and very occasionally as part of an AI curriculum. In fact, there are many available resources for teaching the

39. "Fintech" refers to computer programs and other technology used to support or enable banking and financial services.

techniques and technologies of AI that teachers might use,[40] with Scratch[41] from MIT being especially popular. In addition, many leading technology companies (such as Microsoft, IBM and Adobe) have also developed AI curricula and tools for use in secondary education.[42] In addition, there are various non-governmental organisations (NGOs) who offer some form of AI curriculum or training (e.g. Teens in AI[43] and AI4K12[44]), in Ukraine, for example, the STEM IS FEM initiative taught coding and AI to girls aged 12-17 years, while in Egypt AI is being used to match young people's skills with available jobs (ITU 2020). Finally, the teaching of AI is also increasingly being introduced in primary education, for example in Canada by Kids Code Jeunesse, which aims to put "coding, Artificial Intelligence, ethics, and the UN's Global Goals for Sustainable Development at the forefront of kids' education,"[45] and for all citizens, for example with Finland's Elements of AI which aims "to encourage as broad a group of people as possible to learn what AI is, what can (and can't) be done with AI, and how to start creating AI methods".[46]

While all such resources are to be welcomed, and corporations and NGOs are simply filling the void left by the lack of government AI curricula and training for young citizens, the easy availability of well-funded commercial AI curricula and AI curricula developed by AI experts rather than by educators again raises the frequently asked, vexing questions of what involvement the private sector should have in education, and what is the impact on school students of their commercial imperatives.

1.5.5. AI literacy: the technological dimension

Inevitably, each of these many initiatives adopts a slightly different perspective. However, as we have noted, all of them tend to focus on the technological dimension of AI to the exclusion of the human dimension, save for a brief foray into AI ethics, usually tagged onto the end of the course. Nonetheless, here we should summarise the technical aspects covered by most curricula/courses, which may be divided into the techniques, technologies and applications (Miao and Holmes 2021a).

AI techniques include the classical AI or GOFAI approach, ML (including supervised, unsupervised and reinforcement learning), artificial neural networks and deep learning, to name a few core ones. Inevitably, this is a fast-moving space, with new techniques constantly in development, and the cutting-edge approaches frequently being disputed by leading AI researchers (for example, as we have mentioned, while some claim that ML will lead to human level artificial general intelligence, others argue that this will only be possible with a new AI paradigm which might combine

40. For examples, see http://teachingaifork12.org.
41. Scratch is the world's largest coding community for children and a coding language with a simple visual interface from the Scratch Foundation, a non-profit organisation, https://scratch.mit.edu.
42. Microsoft Computer Science Curriculum Toolkit, White Paper, https://edudownloads.azureedge.net/msdownloads/Microsoft_CSCT_WhitePaper.pdf.
43. www.teensinai.com.
44. https://ai4k12.org.
45. https://kidscodejeunesse.org/partners.
46. www.elementsofai.com.

ML and GOFAI). Nonetheless, these techniques form the basis of the multiple AI technologies with which we are becoming increasingly familiar, including natural language processing (NLP) and generation, speech, image and facial recognition, affect detection, recommenders and artificial creativity, again to name just a few. Finally, these techniques and technologies are combined to create a range of applications, including but not limited to autonomous agents and service chatbots, auto-journalism, AI-driven shopping and entertainment platforms, AI legal services, AI weather forecasting, AI fraud detection, AI-driven business processes, smart cities, AI robots and deep-fakes. Together, these techniques, technologies and applications constitute the major part of the teaching of AI today. However, while the teaching of this technological dimension is necessary, it is not sufficient (Holmes et al. 2021). Indeed, any teaching of AI, it has been argued (Holmes et al. 2019), should also consider the human dimension – to which we turn next.

1.5.6. AI literacy: the human dimension

With AI becoming ubiquitous in everyday life, preparing for the impact of AI is increasingly important for everyone (Markauskaite et al. 2022). The aim of addressing the human dimension of AI literacy is to enable everyone to learn what it means to live with AI and how to take best advantage of what AI offers, while being protected from any undue influences on their agency or human dignity. To begin with, young people should be helped to understand how AI, automation and especially automated decision making, may affect their treatment in society. In other words, if they are to be literate in AI as they are literate in mathematics, all young people need to understand whether the AI with which they knowingly or unknowingly engage has treated them fairly. This is not to relieve AI providers of their responsibilities, but the onus should always be on the provider not the user to prevent harm. Instead it recognises that knowing about AI, going beyond the hype and misinformation, is in the best interests of all.

To date, teaching about AI has largely been the preserve of computer scientists. The resultant inevitable focus on the technological dimension of AI has tended to misdirect policy making away from the social and cultural implications. Instead, there needs to be a holistic understanding of the environment into which AI is introduced, both outside and within education. Outside education, this raises issues such as the accumulation of data and AI expertise by BigTech, while inside education it includes how AIED is used to manage the educational infrastructure and deliver the teaching and learning.

One way in which these issues might begin to be addressed is by encouraging all teachers of subjects ranging from the sciences to the humanities and arts, and not just the ICT or computer science teachers, to explore with their students the potential uses, benefits, impacts, challenges and risks of AI in their subject areas. For example, given that AI might be used to automatically generate novel digital images[47] and

47. https://hotpot.ai/art-maker.

"write" poems,[48] art teachers and literature teachers might ask their students: if a machine might be capable of creative acts, what does it mean to be a human?

Other issues that should be considered, as identified in the Montréal Declaration for Responsible Development of Artificial Intelligence (2018),[49] include well-being, respect for autonomy, protection of privacy, solidarity, democratic participation, equity, diversity, prudence, responsibility and sustainable development. Other important issues include the use of AI for surveillance, what it means for AI to be thought of as intelligent, empowering AI tools (giving AI autonomy), the potential impact on jobs, inclusion and gender equity (Samuel 2018) and trust. Many of these issues are addressed by the updated European Digital Competence Framework for Citizens[50] (DigComp 2.2), which has a new focus on citizens' AI competencies (Vuorikari and Holmes 2022).

In addition, all citizens should be enabled to understand the role of humans in AI, in its development and control – with some calling for a human in the loop (e.g. Zanzotto 2019),[51] ensuring that humans have control of the output of the AI system, and others suggesting that should be reversed: humans should be in control, while AI should be in the loop (Holmes et al. 2021).

48. https://sites.research.google/versebyverse.
49. www.montrealdeclaration-responsibleai.com.
50. The European Commission Digital Competence Framework 2.0, https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework.
51. "Human-out-of-the loop" systems are those that function without any human oversight or control.

PART II

Some challenges for AI and education

In Part II we move on to consider a range of issues or challenges centred on the connections between AI and education: AI and learners (pedagogy, equity and inclusion, learner agency, privacy and cognitive development), the ethics of AIED, AI and the educational ecosystem and transnational issues.

2.1. AI and learners

2.1.1. AI applications and pedagogy

Despite using state-of-the-art technologies and often being grounded in the cognitive sciences (Anderson et al. 1995), almost every existing commercial AI tool designed to support learners effectively embodies a naïve approach to teaching and learning. The dominant approach involves spoon-feeding pre-specified content, adapted to the individual's achievements, while aiming to avoid failure. In other words, despite suggestions to the contrary, the approach is effectively behaviourist or instructionist, and ignores more than 60 years of pedagogical research and development (in, for example, deep learning, Entwistle 2000; guided discovery learning, Gagné and Brown 1963; productive failure, Kapur 2008; project-based learning, Kokotsaki et al. 2016; and active learning, Matsushita 2018). This behaviourist approach, especially the spoon-feeding, prioritises remembering over thinking, and knowing facts over critical engagement, thus undermining learner agency and robust learning.

To give a parallel example, considerable effort has been expended by the research community and commercial organisations to develop AI-driven e-proctoring. During the pandemic, as a great deal of education moved online, so did many assessments – leading the company businesses of automated exam monitoring, e-proctoring, to grow massively. But the use of e-proctoring is controversial, and has been accused of intrusion, racial discrimination, failing to work properly, preventing learners taking their exams and exacerbating mental health problems, while having little impact on cheating or attainment (Brown 2020; Conijn et al. 2022). This constitutes an example of automating and scaling up poor pedagogic practices, rather than using AI to develop innovative approaches.

A second example is "personalisation", which is often mentioned by the media, EdTech companies and many policy makers, and is an ambition that has been around for almost 100 years (Watters 2021). If we can have personalised recommendations on Netflix, why can't we do that in education? Indeed Pearson, one of the biggest education companies in the world, may be seen as trying to rebrand itself as the Netflix of education: "Much as you would consume movies through Netflix, or buy services through Amazon, we want education to be delivered through this single, quality user experience, but available to all ages and stages of learners."[52] However, Holmes and colleagues argued that this misses the point (2018). Some "learning with AI" tools might provide each learner with their own individual pathway through the materials, but they still take them to the same fixed learning outcomes as everyone else. The pathway may be personalised but not the destination. This is a weak understanding of personalisation.

One could argue that personalisation of learning is not primarily about pathways (the micro level of learning) but about helping each individual learner to achieve their own potential, to self-actualise, and to enhance their agency (the macro level

52. Undelete news (2018), "Pearson aims to become the 'Netflix of education'", https://uk.undelete.news/post/pearson-aims-to-become-the-netflix-of-education/68102.

of learning). This is something that no existing commercial AI tool does (Thompson and Cook 2017), although there is some related academic research (e.g. Järvelä et al. 2021; Molenaar et al. 2021). Education is also about collaboration and the other social interaction aspects of teaching and learning, and although AI-supported collaborative learning has been the subject of academic research (e.g. McLaren and Scheuer 2010), again – to the best of our knowledge – no current commercially available AIED tools appear to address this.

2.1.2. AI applications and identifying learners at risk

AI applications are also used beyond the classroom to inform how education is managed by institutions. For example, the USA has seen a proliferation of consulting firms offering predictive analytics to educational institutions for staff and student recruitment and retention (O'Neil 2017). AI is being used at the state level, for example in India,[53] to address the perennial problem of retention rates beyond primary school, especially for girls. However, such uses of technology can be misleading – as measures of participation are not measures of quality or equity (Aikman and Unterhalter 2005).

While using AI to profile learners may have some benefits, for example to identify students at risk of dropping out (Barrett et al. 2019; Hager et al. 2019), it can also be overly intrusive, undermining a learner's rightful expectation of privacy. It may also have punitive effects on the family where attendance is tied to state welfare payments, such as in the Bolsa Familia programme in Brazil (Canto 2019).

When personal data are being joined up for the purposes of retention, approaches such as using social network posts alongside school records are unlikely to meet the data minimisation requirements of countries where the Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data (ETS No. 108)[54] applies. Nor do such approaches address the argument that children should not be routinely profiled, to avoid ranking or categorising them with a detrimental effect on their development and future selves. In fact, using AI in this way raises many problems that are probably not solvable, especially by the use of more technology.

2.1.3. AI applications and the developing brain

In data protection law, definitions of biometric data tend to focus on the use of data for purposes of identification. Accordingly, data protection laws do not address data processing in which the aim is to influence an individual's behaviour. This lack of adequate protection is particularly concerning when the biometric data is used to

53. The government of Andhra Pradesh, a southern state in India in partnership with Microsoft.
54. Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data (ETS No. 108), www.coe.int/en/web/conventions/full-list?module=treaty-detail&treatynum=108 and the Protocol amending Convention 108 (CETS No. 223), www.coe.int/en/web/conventions/full-list?module=treaty-detail&treatynum=223.

influence the behaviour of children, whose mental processes, values and attitudes are not yet fully formed. In short, we need to carefully consider the impact of AI applications on the development of human cognition and the developing brain, since such technologies may have fundamental consequences especially during critical periods of brain development (Tuomi 2018).

2.1.4. AI applications and learner agency

Since Dewey,[55] a learner-centric approach to teaching and learning has been a recurring theme in education research and practice. This approach gives children significant control over the learning processes, thereby maximising learner agency. However, a learner-centric approach must also account for the fact that children do not have the same capacity as adults. In the context of AI in education, this translates as children not having the same capacity as adults to understand issues such as bias and fairness, to give genuinely informed consent, or to understand or contest the effects of AI-based recommendations and predictions on their lives.

In any case, there is little evidence of the widespread adoption of learner-centric approaches in AI in education, despite claims to the contrary by some commercial players. In fact, when using AIED tools, learners may have less actual control over their learning, the data that their interactions with the system produce, or ownership of any outcome (Lupton and Williamson 2017). In addition, the narrative of child-centred learning in the guise of personalised learning is, like that of children's rights discourses more broadly, challenged by the collection of intimate data that claim to "speak on behalf of children", thus further undermining children's agency.

Finally, the constantly changing boundaries of the education environment, which increasingly includes digital devices that interact with and aim to influence children's behaviour, can also be hard for children to comprehend. This also impacts on their families as it is rarely how parents learned – it is outside their immediate experience of the classroom. In addition, due to the complexity of the implications of the use of AI tools, it is beyond what can be expected of parents. In any case, there is no transparent way that children, staff or parents can independently validate claims about how AI may influence a child's cognitive, social or emotional development. All of this, and more, must be addressed before it is clear what the human rights or legal basis are for the use of AI with children in settings in which they have limited choice or control.

2.1.5. AI applications for children with disabilities

The Council of Europe's study "Two clicks forward and one click back" (Lundy et al. 2019) notes that children with disabilities, irrespective of the nature of their impairment, are disproportionately disadvantaged when using digital technologies. Nonetheless, AI approaches are increasingly being used to support children with

55. Stanford Encyclopaedia of Philosophy (2018) on John Dewey, https://plato.stanford.edu/entries/dewey/.

disabilities (Drigas and Ioannidou 2013); for example, to diagnose dyslexia (Kohli and Prasad 2010), attention deficit hyperactivity disorder (ADHD) (Anuradha et al. 2010) and autism spectrum disorder (Stevens et al. 2019), and to support the inclusion of children with neuro-diversity (Porayska-Pomsta et al. 2018). Common applications being used to support children with disabilities were not originally designed for education, but have been repurposed from elsewhere. These include some assistive technologies, such as text to speech, speech to text, predictive text, spell checkers and search engines (Popenici and Kerr 2017). However, unfortunately, this repurposing is not always successful; for example, the ambient noise in classrooms often means that speech recognition does not work well (Olney et al. 2017). Even when applications have research evidence, market failures often prevent them being rolled out more widely. In addition, to date there has been little work on algorithmic or data biases specific to education and learner disability (Baker and Hawn 2021).

2.1.6. AI applications and parents

The role of parents can be challenged by decisions made in educational settings. The nature of childhood and the evolving capacities of a child mean they are still developing, and parents expect to be involved in a process that is shared between the educational setting and the home. Outcomes of AI applications may not only shape an individual child's experience of education in the moment, but might affect their neurological, cognitive and emotional development, for life – currently, we just do not know (Gottschalk 2019). Nonetheless, the design of how AI tools work in the classroom can influence – and indeed aims to influence – how children think and learn, and how they access and evaluate knowledge. What information is considered valuable or valid by school children is shaped by what shows up at the top of a search engine list, the accuracy of voice-assistants, or the processes prioritised by "intelligent tutoring systems" (Lovato et al. 2019). An intervention of any kind in a child's life within an educational setting has particular complexity due to the non-consensual nature of participation in a relationship in which children and families are disempowered. The rights bearers, often supported in law, are not only children, but also the parents or legal guardians.

Literature that includes the views of parents on AIED is limited. However, the potential and risks of AI and education were mentioned by parents of school-aged children in a survey commissioned by NESTA (Baker et al. 2019). Many of the parents responded that they were concerned about the consequences of AI's determinism (77%), accountability (77%) and privacy and security (73%) in education. Increasingly, parents are realising that, in the age of surveillance capitalism (Rust 2021), data can harm and discriminate, and that individually centred routes for complaint or redress are inappropriate for the systemic inequity of AI and data-driven systems (Barassi 2020). Accordingly, it is essential for governments, businesses and organisations, who act in loco parentis in educational settings, to recognise that algorithms cannot profile humans in just and fair ways, and we must challenge the belief that algorithms are objective and can safely predict human behaviour, especially children's behaviour.

2.1.7. AI applications as "high-risk"

The European Commission has identified "AI systems intended to be used for the purpose of assessing students" and "AI systems intended to be used by children in ways that have a significant impact on their personal development, including through personalised education or their cognitive or emotional development" as "high-risk" and "subject to compliance with certain mandatory requirements"[56] "in relation to data and data governance, documentation and recording keeping, transparency and provision of information to users, human oversight, robustness, accuracy and security."[57]

However, this underestimates how conventional uses of AIED for teaching and learning, which involves profiling patterns of behaviour or attainment scoring to make predictions, can have a significant effect on the mental or emotional state of the developing child, and can do so at scale. The computational learner modelling employed by many AIED tools often uses profiles or stereotypes to predict academic performance and identify learners for early interventions (Chrysafiadi and Virvou 2013). However, this approach can lead to discrimination in underrepresented populations (Sapiezynski et al. 2017). Inferring learner states from indicators or features such as gender, ethnic or cultural background and, even, socio-economic status, also introduces bias and further widens existing gaps.

However, even these obviously intrusive uses of sensitive data may not represent the most important risks of AIED. Instead of looking only at overt or covert discrimination in data, it is important to consider whether and how using the technology is shaping children in ways that schools and parents cannot see. The issues go beyond limiting the child's agency and autonomy to asking how external agents (typically, commercial players) are engineering the child's development in closed and often impenetrable systems. In other words, the questions are less about data protection and more about child protection from an unknown number of external stakeholders interfering negatively with the child's personal development.

Finally, all too often, and almost always with the best of intentions, learners' learning and attendance data are being repurposed in ways for which the data was never designed – and usually without consent (defend digital me 2020). For example, in 2017, the UK's University of Buckingham began monitoring learners' social media posts as proxies for mental health risks: "An algorithm will scour their social media looking for key positive and negative words, which will then be used to determine their levels of happiness, engagement and fulfilment" (Gray 2017). The complex ethical issues that such a practice raises will be self-evident to most observers.

---

56. Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain legislative acts, 2021, Chapter 5.2.3, Amendments, www.europarl.europa.eu/doceo/document/CJ40-PR-731563_EN.pdf.
57. Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain Union legislative acts, 2021. Explanatory memorandum, Section 5.2.3. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021PC0206&from=EN.

2.1.8. AI applications and emotion

The impact of emotions on learning has been well-known for decades (for a summary, see Pekrun 2014). Accordingly, there has recently been much research investigating how AI-driven educational technologies might identify a learner's emotional (affective) state, in order to help move them from a negative to a positive affective state, which is thought to enhance learning (e.g. Blanchard et al. 2009). However, these complicated constructs (positive and negative affective states) are often measured simplistically, by means of, for example, quiz scores, checkbox ticks and reaction times (Jarrell et al. 2015), or by intrusive and unproven technologies such as the Focus1 EEG headsets, which the developers claim can detect a learner's attention by monitoring electrical activity in their brain (Kosmyna and Maes 2019).[58]

Even if detecting, responding to and altering learner affect does improve their learning gains (no evidence from independent large-scale studies was found to support these claims), there are critical concerns regarding exactly how the affect is detected, what the impact is on future learning, educational decisions and even mental health, and whether such practice is ethical or constitutes "machinery for emotional management" (Williamson 2020). In short, affective capture informing behavioural strategies aimed at nudging learners is a form of psychological behavioural control which threatens learner privacy and autonomy (Nemorin 2017), and further, "tools using biometrics such as facial detection in e-proctoring or emotions detection can infringe upon human rights and human dignity" (King and Persson 2022: 32).

In a joint opinion published in response to the EU's "proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence", the European Data Protection Board and the European Data Protection Supervisor comment that "the use of AI to infer emotions of a natural person is highly undesirable, and they recommend it should be prohibited".[59] They also call for a general ban on any use of AI for automated recognition of human features in publicly accessible spaces (faces, fingerprints, DNA, voice, keystrokes and other biometric or behavioural signals) in any context – which presumably includes educational settings.

2.1.9. AI and digital safeguarding

With web filtering software becoming routine in many UK and US schools, there has been a marked increase in the use of AI-based tools that scan and capture a child's digital activity. Monitoring and filtering combined products are used to keep under surveillance all on-screen content, communications, children's web searches and to filter and block URLs and incoming online content matched against known website addresses. This also creates a record of searches and attempted searches.

58. BrainCo grew out of the Harvard Innovation Lab, https://brainco.tech/technology.
59. EDPB-EDPS Joint Opinion 5/2021 on the proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act), June 2021, https://edpb.europa.eu/system/files/2021-06/edpb-edps_joint_opinion_ai_regulation_en.pdf.

Many vendors claim to use AI and automated systems to monitor everything children type on-screen in real time, compare and match this against thousands of words in English and foreign languages libraries,[60] and identify patterns in a learner's search history and activity. Matches trigger the system to create flags indicating risk of radicalisation, extremism, risk to and from others, or self-harm. Consequently, these flags can be used to create covert profiles, opaque for children and their families, for targeting a range of interventions often without informed consent. The UN Special Rapporteur's 2014 report on children's rights and freedom of expression commented that these AI tools can interfere with children's right to access information and make informed choices, around for example issues such as sex education and drug use.[61]

Meanwhile, related work suggests that, as school security measures proliferate, learners actually feel less safe.[62] In any case, when subjected to continuous monitoring, which is by definition invasive, school children tend to alter their behaviour in order to work around the policies and protect their privacy, freedom of expression and freedom of association (Leaton Gray and Kucirkova 2018). In addition, any harms from such prediction-based AI may affect entire communities as well as individuals (Crawford 2021).

Furthermore, "school safeguarding" companies often now present their AI-based surveillance tools, which monitor everything that children do on a device, as solutions for the seamless transition between the use of their tools in education, into what employers want "to improve employee productivity".[63]

2.2. The ethics of AI and education

2.2.1. The ethics of AI

A key set of issues in which all citizens should be encouraged to engage is the ethics of AI. However, the ethics are complex, and so this is not so easy to achieve; in fact, the ethics of AI in general has received a great deal of attention, by researchers (e.g. Boddington 2017; Whittaker et al. 2018; Winfield and Jirotka 2018) and more widely (e.g. the House of Lords,[64] UNESCO,[65] World Economic Forum[66]), with numerous

60. For example, see NetSupport DNA, www.netsupportsoftware.com/20160719all-about-the-new-safeguarding-features-in-dna-v4-3-part-2.
61. LaRue F. (2014), Special Rapporteur on the Promotion and Protection of the Right to Freedom of Opinion and Expression, "Promotion and protection of the right to freedom of opinion and expression: note / by the Secretary-General", https://digitallibrary.un.org/record/780499?ln=en.
62. www.brennancenter.org/our-work/research-reports/school-surveillance-zone.
63. www.netsweeper.co.uk.
64. House of Lords (2019), Select Committee on Artificial Intelligence, Report of Session 2017-19, *AI in the UK: ready, willing and able?* https://publications.parliament.uk/pa/ld201719/ldselect/ldai/100/100.pdf.
65. UNESCO (2021), Draft text of the Recommendation on the Ethics of Artificial Intelligence, https://unesdoc.unesco.org/ark:/48223/pf0000376713.
66. Bossman J. (2016), "Top 9 ethical issues in artificial intelligence", www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence.

institutes for AI ethics being set up (e.g. the Ada Lovelace Institute,[67] the AI Ethics Initiative,[68] the AI Ethics Lab,[69] AI Now,[70] and DeepMind Ethics and Society,[71] to name just a few). In 2019, Jobin and colleagues (2019) identified 84 published sets of ethical principles for AI, which they concluded converged on five areas: transparency, justice and fairness, non-maleficence, responsibility and privacy. However, what each of these means and includes, and how they may be applied both to the development or use of AI, remains subject to ongoing debates. In any case, the hidden harms of exclusion by automated decisions when a computer says no, are already very real. For example, a university recruitment algorithm makes decisions with lifelong consequences and thus threatens how some in society are treated.

Nonetheless, although these ethical questions are clearly important, we still have to accept that the "social ills of computing will not go away simply by integrating ethics instruction or codes of conduct into computing curricula" (Connolly 2020: 54). In fact, although universities do typically have robust research ethics procedures, the majority of university-based or commercial AI research has no oversight of AI ethics (Crawford 2021). This might partly be because, in the early days of AI, research using human data was perceived to pose minimal risks. Worryingly, some leading companies have been accused of undermining their commitment to ethics by removing leading ethics researchers from their teams.[72]

For AI in education, because children are being used by commercial developers to test their AI technologies, it is important to design and implement ethical robust guidelines (OECD 2021) and to avoid any "ethics washing". Ethics "has been used by companies as an acceptable facade that justifies deregulation, self-regulation or market driven governance, and is increasingly identified with technology companies' self-interested adoption of appearance of ethical behaviour. We call such growing instrumentalization of ethical language by tech companies 'ethics washing'" (Bietti 2020).

2.2.2. The ethics of AI is necessary but not sufficient for AI in education

As discussed elsewhere:

> the ethics of AI raises a variety of complex issues centred on data (e.g. consent and data privacy) and how that data is analysed (e.g. transparency and trust). However, it is also clear that the ethics of AIED cannot be reduced to questions about data and computational approaches alone. In other words, investigating the ethics of AIED data

67. The Ada Lovelace Institute, founded in 2018, is part of the Nuffield Foundation, www.adalovelaceinstitute.org.
68. The Initiative is a joint project of the MIT Media Lab and the Harvard Berkman-Klein Center for Internet and Society founded in 2017, https://aiethicsinitiative.org.
69. The AI Ethics Lab is based in Boston (USA) and Istanbul (Turkey), http://aiethicslab.com.
70. The AI Now Institute, founded in 2017, https://ainowinstitute.org.
71. Google DeepMind, https://www.deepmind.com/about/ethics-and-society.
72. MIT Technology Review (2014), "We read the paper that forced Timnit Gebru out of Google. Here's what it says", www.technologyreview.com/2020/12/04/1013294/google-ai-ethics-research-paper-forced-out-timnit-gebru.

> and computations is necessary but not sufficient. Given that, by definition, AIED is the application of AI techniques and processes in education, the ethics of AIED … also needs to account for the ethics of education. Yet, while the ethics of education has been the focus of debate and research for more than 2000 years (e.g. Aristotle, 2009; Macfarlane, 2003; Peters, 1970), it is mostly unacknowledged and unaccounted for by the wider AIED community. (Holmes et al. 2021: 520)

Pertinent issues that the ethics of AI in education must address include:

> the ethics of teacher expectations, of resource allocations (including teacher expertise), of gender and ethnic biases, of behaviour and discipline, of the accuracy and validity of assessments, of what constitutes useful knowledge, of teacher roles, of power relations between teachers and their students, and of particular approaches to pedagogy (teaching and learning, such as instructionism and constructivism). (ibid.: 521)

In contrast with health, where there are long-established ethical principles and codes of practice with regard to the treatment of human subjects, education (outside of university research) does not have the same universal approach or commonly accepted model of ethics oversight committees. When it comes to AI, much of the discussion on ethics frames learners as data subjects, not as people. Accordingly, although a data protection impact assessment is required across Europe, commercial players and schools are able to engage children with AI-driven systems without any ethical or other risk assessment.

Further ethical challenges for AI and education include accountability and the personal data market. For institutions, it is not only a question of if and how children can be "treated" using AI in education, but how accountability and liability should be assigned when educators choose to apply or to override any system recommendation. At industry-wide level, the common practice of purchasing children's data, such as voice or facial imaging data, from deprived populations including some countries in Africa, for use in creating data sets for biometric-based commercial product development in the global north, raises significant ethical issues that need to be properly addressed.

In summary, the ethics of AI and education is complex but under-researched and without oversight or regulation – despite its potential impact on pedagogy, quality education, agency and children's developing minds. Accordingly, "multi-stakeholder co-operation, with Council of Europe oversight, remains key to ensuring that ethical guidelines are applied to AI in education, especially as it affects the well-being of young people and other vulnerable groups."[73]

2.2.3. AI loyalty

Largely missing from the literature and global conversations about AI and education is the concept of conflicts of interest or "AI loyalty" (Aguirre et al. 2021) in educational

73. Recommendation CM/Rec(2019)10 of the Committee of Ministers to member States on developing and promoting digital citizenship education, https://search.coe.int/cm/Pages/result_details.aspx?ObjectID=090000168098de08.

settings. For whom does an AI system work? The learners, the schools, the education system, the commercial players, or politicians and other decision makers? The question therefore is less about the ethics of the technology itself and rather about the ethics of the people in the companies behind their design, implementation and use, and the decision makers. Is the implementation of AI into educational contexts a techno-solutionist approach that distracts from potentially more successful and long-term social approaches (Morozov 2014)? In fact, usually, "AI enters education through mundane back-end AI-as-a-service plug-ins, rather than in the more spectacular guise of automated pedagogic agents or tutoring systems" (Williamson and Eynon 2020). Understanding AI loyalty is therefore about making its ownership and any conflicts of interest explicit.

To increase transparency and the trustworthiness of the effects of AI, system developers and controllers should be obliged to explicitly align the loyalty of their AI systems and governance structures with the best interests of the learner and others affected by the system. This should include measures to involve stakeholders (such as those who represent children and teachers, parents, policy makers, industry and civil society) in the AI tool's design, procurement and deployment.

2.3. AI and the educational ecosystem

2.3.1. Political and economic drivers

When considering the impact of a technology such as AI and its use in education, it is also important to take a macro-perspective: "it is thus not possible to assess or manage societal impacts by examining a technology divorced from its economic, political, and social context" (Parson et al. 2019: 2). This is all the more important because education is prone to being highly politicised (Hickey and Hossain 2019): creating a curriculum or determining how learning should happen are political acts.

For example, it has been suggested that a competency-based approach to learning, as adopted by much AI designed for education, is inevitably utilitarian and geared towards meeting social and economic rather than learner needs (Ashrafi and Javadi 2020). Accordingly, if AI becomes more widespread in education, it could lead to the downgrading of what is valued, with knowledge transfer and easily measured competencies being preferenced over the more humanistic and variable values that are hard to compare: learning that affirms human worth and dignity, reason, compassion, morality, ethics, democracy and inquiry.

The wide use of AI tools in education might also be characterised as privatisation by stealth, given that most AI tools currently in use in educational contexts have been provided by commercial players. The further problem is that these tools are rarely based on proven pedagogical need: "It is this pursuit of marketable products that appears to define the general approach of the private sector, rather than any underlying educational rationale for the design and development of AI applications" (Knox 2020: 16).

Finally, most AI tools for use in education require a certain level of technical competence and language skills. Accordingly, AI may exacerbate rather than mitigate

inequities in education for marginalised communities, between the rich and poor, between the able and learners with disabilities, and between those who have access to reliable broadband infrastructure and those who do not (Biggs et al. 2018). For the same reasons, there is also a critical need for appropriate professional development for teachers (as well as for administrators and policy makers), so that they are able to make informed decisions about which AI tools might be appropriate for their classroom, how those tools broadly work, what they might achieve, how they might best be used, their challenges and risks, and what unintended consequences there might be.

2.3.2. Evaluating AI in education

Despite the wide advocacy for AI in education, there remains a paucity of evidence for its efficacy, or its safety, inclusiveness or ethics. As noted earlier, the research community has conducted a wide range of evaluations over decades; however, this is usually in small-scale settings over short periods of time, and focused on narrow scientific issues. With few exceptions, there is a lack of robust independent evaluations of AI tools being used in educational contexts upon which policy might be developed. Those independent evaluations that do exist typically compare an AI tool with "business as usual" (that is, where no tool is in use), such that any success might be attributed to the use of a technology in general rather than to the particular technology in question. In addition, these "evaluations" only ever consider the learners' academic progress (such as whether they have achieved a higher grade in a standardised test or examination) rather than the tool's impact on learner cognition or mental health, classroom practices, or the teacher's role.

Accordingly, it is unclear why so many governments around the world have bought into and widely rolled out proprietary and commercial AI systems in the absence of sufficient understanding of what the systems do, what they achieve, how they affect learners and teachers, and so on. All too often, failure is identified only in hindsight, after real-world detrimental effects on learners and teachers become obvious, and after long-term contracts have already been signed.

Meanwhile, developers of AI tools being used in state education systems, the vast majority of which are private commercial actors,[74] can continue to sell or offer their product to schools with no accreditation and with no direct accountability towards the learners. Furthermore, even more concerning than monetary costs, are the "data rents" being paid in the form of learner and teacher data (Komljenovic 2021).

In addition, few teachers have the training or skills to assess properly the big claims made by the AI developers, or have the digital literacy skills needed to understand what its data suggests. This shifts decision making from professional teachers to automated systems and commercial players, thus undermining professional authority, while raising issues of corporate accountability that are rarely acknowledged. Further, given that private sector actors dominate the provision of AI in education, and state

74. https://rm.coe.int/t-pd-2019-6bisrev5-eng-guidelines-education-setting-plenary-clean-2790/1680a07f2b.

education systems increasingly rely on outside partnerships for delivery of core educational services, what happens if that commercial player fails or if that commercial player simply decides that their provision is no longer sufficiently profitable? What contingencies have states put in place to mitigate or address such possibilities?

Most importantly, as these systems have an unknown impact on children's developing minds, and are being used at scale, should they not be assessed to similar standards as we assess medical interventions?[75] Medical interventions must demonstrate their efficacy and safety, including foreseeable misuse, for the product's life cycle and the outcomes of its use. In any case, exactly how these systems are best evaluated, what counts as evidence, and where that evidence is applicable remain unclear.

2.3.3. AIED colonialism

In 2020, despite the coronavirus pandemic, venture capital (VC) investments in AI start-ups reached a total of US$75 billion for the year, of which around US$2 billion was invested in AI in education companies, mostly in the US. It is these companies that are selling their approaches globally, creating what has been called an AIED colonialism: companies making claims to territory in the educational landscape around the world, creating asymmetries in power across and between markets and states. In fact, addressing cultural diversity is possibly one of the most complicated AIED topics to consider, especially given the overwhelming balance of research carried out in the global north and challenges in transfer of appropriate and effective policy and practice (Blanchard 2015).

AIED colonialism might constitute the physical adoption by the decision makers of AIED tools created in one context in other places. Territorial gains can be made across schools as institutions, or as segments of entire state education systems, where a country or region adopts a single product across all its schools.[76] A perhaps more subtle example is Google's platform colonialism, which combines structures and practices of data colonialism, surveillance capitalism and platformisation (Sujon 2019).[77] The Google for Education product line[78] is designed to achieve market dominance in and through the classroom, with so-called Google Schools operating as ambassadors, teaching others in their local area about how Google products work – in other words, they act as marketers of the Google products. This spreads territorial gains in both the physical space and the marketplace at the same time. By embedding Google tools into teachers' everyday practices enables Google to influence educational futures. Accordingly, we should be asking: what are the real implications of Google's reach into young people's lives and into public infrastructures and social institutions?

75. See ISO 14971: www.iso.org/standard/72704.html.
76. https://marketbrief.edweek.org/marketplace-k-12/coming-soon-huge-test-coming-artificial-intelligences-role-classrooms.
77. "Platformisation" is the increasing domination of the internet by a number of large companies whose products work as markets between users and other sellers.
78. https://edu.google.com.

A second tool of AIED colonisation is language. Classroom AIED tools tend to be trained and developed in English, and for the most part in standard American English (Cotterell et al. 2020). This raises multiple questions centred on the impact of the English-trained models used by AIED tools in non-English contexts, and on the children who use them (Naismith and Juffs 2021). In sub-Saharan Africa, education conducted through a European language continues to be associated with low school achievement (Clegg and Afitska 2011). This is a situation identified within open educational resources (OER), a field that has noted that linguistic and cultural diversity continue to be a challenge, as the available OER are predominantly in English (Miao et al. 2019). In any case, do the relatively highly funded US-centred AIED tools crowd out less well-funded but locally trained and potentially more locally sensitive AIED tools? In short, the question of language used in AIED tools must be addressed if states are to fulfil their obligations "to protect the existence and the national or ethnic, cultural, religious and linguistic identity of minorities within their respective territories and shall encourage conditions for the promotion of that identity" (United Nations 1992, Article 1).

In conclusion, the notion that existing national policies and frameworks on AI for international co-operation are sufficient for the use of AIED has been challenged (Chander and Jakubowska 2020; Yeung 2020). In any case, AIED has for too long been a domain dominated by computer-centric views without adequate attention paid to pedagogy or the special nature of education and the developing child: "We can either leave it to others (the computer scientists, AI engineers and big tech companies) to decide how Artificial Intelligence in education unfolds, or we can engage in productive dialogue" (Holmes et al. 2019: 180).

PART III

AI, education, human rights, democracy and the rule of law

The impact of AI on the Council of Europe's core values – human rights, democracy and the rule of law – has been examined in detail by the UK's Alan Turing Institute.

> Governments should adopt a precautionary approach in the adoption and regulation of AI that balances the realisation of the opportunities presented by AI while ensuring that risks to human beings and human interests are minimised to the extent possible. (Leslie et al. 2021: 16)

However, that report, "Artificial intelligence, human rights, democracy and the rule of law: a primer" (Leslie et al. 2021) does not specifically address challenges raised by the connections between AI and education.

Part III builds further on the Alan Turing Institute report, by discussing education as a specific application domain for AI. We present work on AI systems for education that touch upon human rights, democracy and the rule of law, and we critically reflect on the challenges and implications for using these systems in education settings.

3.1. AI, education and human rights

3.1.1. What is meant by human rights

To begin with and to provide a firm foundation for this discussion, given the many possible misinterpretations, what exactly are human rights?

> Human rights are about respecting the human being, both as an individual and as a member of the human species and ensuring the dignity of the human being. (Council of Europe n.d.)[79]
>
> Human rights are the basic rights and freedoms that belong to every person in the world, from birth until death. They apply regardless of where you are from, what you believe or how you choose to live your life. They can never be taken away. These basic rights are based on shared values like dignity, fairness, equality, respect and independence. These values are defined and protected by law. (Equality and Human Rights Commission n.d.)[80]

Amnesty International[81] provide the following additional details.

- Human rights are the basic freedoms and protections that people are entitled to simply because they are human beings. They are enshrined in the Universal Declaration of Human Rights.
- Human rights are universal: They belong to everyone, regardless of race, sexuality, citizenship, gender, nationality, ethnicity, or ability.
- Human rights are inherent: We are all born with human rights. They belong to people simply because they are human beings.
- Human rights are inalienable: They cannot be taken away. No person, corporation, organisation or government can deprive a person of his or her rights.
- Human rights can be violated: Although they are inalienable, they are not invulnerable. Violations can prevent people from enjoying their rights, but they do not stop the rights existing.
- Human rights are essential: They are essential for freedom, justice and peace.

3.1.2. International agreements

Since the Second World War, human rights have been encoded in multiple international agreements, beginning with the UN's Universal Declaration of Human Rights (UDHR),[82] agreed in 1948, and the Council of Europe's European Convention

79. www.coe.int/en/web/portal/what-are-human-rights.
80. Equality and Human Rights Commission (UK), www.equalityhumanrights.com/en/human-rights/what-are-human-rights.
81. Amnesty International, *What are human rights?* http://www.amnesty.eu/about-amnesty-international/.
82. www.un.org/en/about-us/universal-declaration-of-human-rights.

on Human Rights (the Convention),[83] agreed in 1953. The Convention, for example, prohibits inhuman or degrading treatment or punishment (such as the death penalty, torture, slavery and discrimination), and protects:

- the right to life, freedom and security;
- the right to respect for private and family life;
- the right to freedom of expression;
- the right to freedom of thought, conscience and religion;
- the right to vote in and stand for election;
- the right to a fair trial in civil and criminal matters;
- the right to property and peaceful enjoyment of possessions.

Of particular importance to this report, Article 2 of Protocol No. 1 in the Convention protects a child's right to education and specifies that "the State shall respect the right of parents to ensure such education and teaching in conformity with their own religious and philosophical convictions".[84]

Finally, the International Covenant on Economic, Social and Cultural Rights (ICESCR) includes two articles specifying a child's right to education, and states that "education shall be directed to the full development of the human personality and the sense of its dignity".[85] Article 13 is both the longest provision in the ICESCR, and the most wide-ranging and comprehensive article on the right to education in international human rights law.

3.1.3. Human rights of children

> Without strong commitment to children, we undermine not only the destiny of many individuals – but also our community's strength. Protecting children's rights and wellbeing should be absolutely basic to who we are. All children possess inherent worth and should have an equal chance to thrive, whatever their social origin, gender, place of birth or family situation … Because if we do not take a stand for children's rights, who are we and what has happened to our humanity and values? Because if we don't act now, when? (Michelle Bachelet, United Nations High Commissioner for Human Rights[86])

Of particular importance for education, UN member states in 1989 agreed the United Nations Convention on the Rights of the Child (UNCRC).[87] At the heart of the UNCRC is respect for the evolving capacities of the child. It recognises that because children are still developing physically, cognitively and emotionally, they need specific and unique additional human rights. These rights of the child include the following:

- the right to life and development;
- the right not to suffer from discrimination;

83. www.echr.coe.int/documents/convention_eng.pdf.
84. Guide on Article 2 of Protocol No. 1 to the European Convention on Human Rights – Right to education, www.echr.coe.int/documents/guide_art_2_protocol_1_eng.pdf.
85. www.ohchr.org/en/instruments-mechanisms/instruments/international-covenant-economic-social-and-cultural-rights.
86. www.ohchr.org/en/statements/2019/05/stop-war-children-symposium.
87. www.unicef.org.uk/wp-content/uploads/2016/08/unicef-convention-rights-child-uncrc.pdf.

- the right to a name and nationality;
- the right to be cared for by parents or other responsible people;
- the right to be protected from all forms of violence and abuse;
- the right to health and healthcare;
- the right to live in good conditions that help a child to develop;
- the right to education;
- the right to leisure, play and culture;
- the right to express views and have them taken into consideration;
- the right to have your own thoughts, beliefs and religion;
- the right to meet and join groups and organisations with other children;
- the right to privacy;
- the right to access to information;
- the right to be protected from economic exploitation;
- the right to special protection for refugee children;
- the right to special protection and support for children with disabilities;
- the right of children of minorities to learn and use the language, religion and traditions of their families;
- the right to special protection of children affected by wars.

It is important to recognise that education has relevance to all children's human rights. Education "is said to act as a multiplier of rights, meaning that all other human rights can be enhanced when it is enjoyed fully and impacted negatively when it is not" (Lundy 2021). It must also be recognised that children's human rights are not without complications. For example:

> a decontextualized discourse does not take into account the living conditions, the social, economical and historical contexts in which children grow up, which can be very diverse, and which are the environments in which children's rights are to be realised. Neither does it take into account the enormous diversity among children, in particular the differentiation between children of different ages. (Reynaert et al. 2009: 528)

In addition, researchers should focus on the child's interests and entitlement, and should be mindful of groups that may face discrimination or whose rights may be infringed (Lundy et al. 2019).

The Convention on the Rights of Persons with Disabilities[88] highlights the right to education for children with disabilities, and obliges signatories to promote access for children with disabilities, on an equal basis with others, to information and communication technologies and systems. Meanwhile, the Committee on the Rights of the Child[89] drew particular attention to indigenous children and their rights, and the

88. The Convention on the Rights of Persons with Disabilities and its Optional Protocol (A/RES/61/106) was adopted in 2006. Article 24 is dedicated to education, www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html.

89. See: www2.ohchr.org/english/bodies/crc/docs/GC.11_indigenous_New.pdf.

need for states to ensure these are adequately reflected in the curricula, content of materials, teaching methods and policies. Inevitably, things are not so straightforward in practice: "problems raised include tokenism, unresolved power issues, being consulted about relatively trivial matters and the inclusion of some children leading to the exclusion of others. Among the excluded groups are disabled children, ethnic minority groups and younger children" (Reynaert et al. 2009: 5).

It also needs to be recognised that the effectiveness of the UNCRC in upholding children's rights is limited due to weak international enforcement mechanisms and uneven domestic incorporation (Collinson and Persson 2021). Nonetheless, the UNCRC remains the most widely ratified international human rights treaty, and remains both a guide to good practices and an ethical or legal framework for assessing corporations' and states' progress or regress.

Finally, the connection between human rights and children goes beyond the fundamental four Ps of rights – protection, prevention, provision and participation – to include the need for young people to learn about and understand their human rights. To this end, in 2010, Council of Europe member states agreed the Charter on Education for Democratic Citizenship and Human Rights Education.[90] This defines human rights education as the need to empower children and other learners "to contribute to the building and defence of a universal culture of human rights in society, with a view to the promotion and protection of human rights and fundamental freedoms" (Council of Europe 2010: 7).

3.1.4. Human rights, AI and education

There is little substantive literature that focuses specifically on, or even mentions in any meaningful way, AI, education and human rights. Accordingly, in the remainder of this section, we draw on the Turing Institute's "Artificial intelligence, human rights, democracy and the rule of law: a primer" (Leslie et al. 2021). We focus on a limited number of specific human rights and rights of the child, and consider the reciprocal implications between these rights and AI and education.

▶ Right to education

AI is often proposed as a way to ensure that all children have access to high-quality education,[91] although what constitutes quality education is complex. In fact, today's learners increasingly depend on digital technologies to meet their right to be educated. This can place learners in a vulnerable position with regard to their human, legal and social rights. At the same time, the human rights discourse has taken a rather narrow view, focusing primarily on legal rights and not fully engaging with sociopolitical contexts that impact human rights and education (Sayed and Ahmed 2011).

90. www.coe.int/en/web/edc/charter-on-education-for-democratic-citizenship-and-human-rights-education.

91. XPRIZE Foundation, www.xprize.org/prizes/global-learning.

Nonetheless, for children in remote areas, the right to education can often be challenging to achieve, especially where too few experienced or qualified teachers are available. The suggestion is that AI tools, such as the so-called intelligent tutoring systems, might be used to alleviate the lack of quality teaching. However, while introducing AI tools might help some children today, this techno-solutionism does little to solve the underlying and long-term human problem – that of too few experienced or qualified teachers. This grand challenge is unlikely to be solved by more adaptive learning or classroom robots. In fact, while AI tools might in some circumstances help ensure that some kind of education is available, there is little evidence that they provide the high-quality education or meet the wider aims of education, to which children have a right. Using AI tools to help enhance, rather than replace, the teaching capabilities of inexperienced teachers might be a better use of available resources. The reasons why there are too few teachers, and that they are hard to retain, will not be solved by more robots or adaptive learning.

▶ Right to human dignity

> Member States should ensure that, where tasks would risk violating human dignity if carried out by machines rather than human beings, these tasks are reserved for humans … The right to refuse interaction with an AI system whenever this could adversely impact human dignity. (Leslie et al. 2021: 18)

In the context of AI and education, this human right implies that the teaching, assessment and accreditation of learning, and all related pedagogical and other educational decisions, should not be delegated to an AI system, unless it can be shown that doing so does not risk violating the dignity of the participating children. Instead, all such tasks should be carried out by human teachers.

▶ Right to autonomy

> The right not to be subject to a decision based solely on automated processing when this produces legal effects on or similarly significantly affects individuals. The right to effectively contest and challenge decisions informed and/or made by an AI system and to demand that such decision be reviewed by a person. The right to freely decide to be excluded from AI-enabled manipulation, individualised profiling, and predictions. (Leslie et al. 2021: 18)

In the context of AI and education, these human rights have multiple implications. In particular, they add to children's right to human dignity by underlining that children should not be subject to decisions made solely by AI systems – for example, for the assessment of learning, for determining individualised learning pathways based on machine-made predictions, or for other decisions that might have significant effects.

In fact, the right to effectively contest and challenge decisions informed and/or made by an AI system, and to demand that such decisions be reviewed by

a person, is set out in law. However the right to freely decide to be excluded from AI-enabled manipulation, individualised profiling and predictions is something that parents and children do not yet have the ability to exercise in consistent or universal ways in state-defined education.

In addition, the use of AI in education to profile children ought to be carefully considered, to ensure that it does not compromise "the right to physical, psychological, and moral integrity in light of AI-based profiling and emotion/personality recognition" (Leslie et al. 2021: 18). If the data and the analysis that is used to determine what the child "should" learn next are inaccurate, children's development and future lives could be compromised.

In fact, currently there appears to be little research into how historic education data, essentially generated by previous cohorts of children, may bias the suggested pathways through the learning materials when used to train ML models. The difficulties of using historical data were also highlighted when various authorities (including the International Baccalaureate Organization and the UK Government) used data and algorithms to grade students who, because of the school shutdowns during the Covid-19 lockdowns, had not been able to sit their high-stakes examinations. The outcomes were controversial (Everett 2020; Evgeniou et al. 2020) and later amended.

▶ Right to be heard

Every child who is capable of forming their own views should be given the opportunity to express those views freely, in all matters affecting them, and those views should be given due weight in accordance with the child's age and maturity. Children also need to be afforded the inviolable right to make significant decisions about their own education, rather than just "being consulted only about relatively trivial matters" (Reynaert et al. 2009: 5). Put another way, children should be considered "as active agents and autonomous, independent human beings in constructing their lives in their own right" (ibid.: 4).

For example, children or their parents should be afforded the right to refuse any involvement with AI classroom tools without such a refusal adversely affecting their education. However, in practice children are rarely allowed that agency: "the embodied and subjective voices of children are displaced by the supposed impartial objectivity provided by the technological mouthpieces of data ... data are positioned in ways that override the rights of children to speak for themselves" (Lupton and Williamson 2017). In other words, it is the technology that *de facto* exercises rights, on behalf of or rather instead of the child.

▶ Right not to suffer from discrimination (fairness and bias)

In addition to the UNCRC, the obligation of states to combat and eliminate discrimination is set out in other international agreements: the International Convention on the Elimination of All Forms of Racial Discrimination, the Convention on the Elimination of All Forms of Discrimination against Women,

and the International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families.

Building on these various conventions, it is clear that wherever AI is implemented, by design it must be non-discriminatory, fair and inclusive throughout its entire lifecycle (from design to use) (Leslie et al. 2021: 18). In education, this means ensuring that all children are able to benefit from the use of technology, not just those from the socio-economic groups who can afford it, thereby avoiding what is known as the Matthew Effect.[92] In particular, as many AI education technologies are often only available online, this also means ensuring the wide availability of robust internet infrastructure, especially in rural areas.

Fairness is also determined by the biases known to compromise many AI systems. Bias in AI systems can arise for various reasons; for example, stereotyping biases, inheriting historic inequality and discrimination entrenched in data sets, and discriminatory algorithmic decisions.

It is well-known that current AI tools often exhibit gender and other biases (Borgesius 2018; Buolamwini and Gebru 2018). For example, Google Translate has been shown to translate gender-neutral terms from gender-neutral languages into masculine terms providing results that reflect existing gender inequality (Prates et al. 2019).

Similarly, AI tools might exhibit biases against those who have a disability. However, discrimination in the context of disability may be perceived as both positive and negative: positive because AI tools might offer benefits to children who would otherwise not receive the same level of inclusion; negative because categorising a person can be the first step towards excluding that person and violating his or her inherent dignity (Karr 2009).

Profiling behaviours could lead to companies inferring or claiming to identify disabilities without the qualified diagnosis one would expect from medical professionals. This has the potential to have lasting effects for a child and brings with it fundamental ethical questions over what constitutes appropriate use by a private company of learner interactions, and what information and interventions they suggest or do not suggest to school staff. Whereas children involved in medical research trials will have ethical oversight and clear discussion of the expectations of what will be done with both the main and incidental findings, no parallel processes exist for the deployment of AIED.

▶ Right to privacy and right to data protection

The reality is that today's data protection legislation does not sufficiently protect children from increasingly invasive uses of personal information, such as their eye gaze, speed of response, gait or emotions – despite these

92. The Matthew Effect, sometimes paraphrased as "the rich get richer while the poor get poorer", takes its name from the "Parable of the Talents" in the Christian Bible's Gospel of Matthew.

being protected as biometrics in data protection law such as Convention 108[93] and the EU General Data Protection Regulation (GDPR). In any case, the right to privacy should not be conflated with data protection rights. Privacy is both a protective right, for example from harmful discrimination, and an enabling right, to rights such as freedom of expression and the right to assembly. However, the right to privacy is often infringed by certain data practices in the context of AI in education.

Data is at the heart of ML, which is the type of AI that has made such dramatic progress in recent years, with ML systems automatically and continuously collecting, aggregating, analysing and acting upon innumerable data points generated by the user's interaction with the system.

> [ML] can make predictions about a person's behaviour, state of mind, and identity by sensing information that is not necessarily considered personal or private, such as facial expressions, heart rate, physical location, and other seemingly mundane or publicly accessible data. This can have the effect of being invasive of a person's sense of privacy, and can also have so-called "panoptic effects" by causing a person to alter their behaviour upon suspicion it is being observed or analysed. (Leslie et al. 2021: 15)

This classroom surveillance by means of AI tools is often compared with the gaze of a teacher; in short, if it is acceptable for a teacher to closely monitor their students, why might it not be acceptable for an AI tool to do the same? However, there are fundamental differences. The AI approach is more long-lasting: the data is retained by the commercial developer, stored off-site, analysed automatically, shared with others, used to benchmark and compare hundreds of thousands of children, and forms a key part of their business model (the use of data to generate income). The human approach, on the other hand, is personal, human and ephemeral. Ultimately, "children should be ensured a free unmonitored space of development and upon moving into adulthood should be provided with a 'clean slate' of any public or private storage of data".[94]

AI-driven tools are increasingly being used, for example, to determine a learner's emotional state. The aim might be laudable: to move a learner from a negative emotional state to a positive emotional state which is generally assumed to be more conducive for learning, or to tailor the feedback or the complexity of the problems. However, while a human teacher is constantly assessing and acting upon the emotional state of their learners, automating this process crosses a privacy Rubicon, especially when the analysis takes place in proprietary systems.

Nonetheless, while commercial AI in education organisations might claim to ensure that they collect minimal data and that the data that they do collect are protected, the use of personal data raises a number of complex problems

93. www.coe.int/en/web/data-protection/convention108-and-protocol.
94. EU Commission High Level Expert Group on AI (AI HLEG) (2019), "Policy and investment recommendations for trustworthy Artificial Intelligence", paragraph 28.3, https://digital-strategy.ec.europa.eu/en/library/policy-and-investment-recommendations-trustworthy-artificial-intelligence.

(Elliot et al. 2018). The problems include how the data is stored and used (Binns 2021). This means that the data is open to hacking and leaks, while even apparently anonymous data can increasingly be de-anonymised. In other words, removing identifiers, such as a child's name, from the data is now rarely sufficient.

▸ Right to transparency and explainability

While not human rights, these data rights are important parts of data protection laws around the world. It is increasingly well-known that ML systems are often opaque, either because they are proprietary or because their methods are impenetrable. While there are many examples of AIED systems that stem from academic research, the majority of AI in education systems have been developed by commercial organisations, whose business plans depend on keeping secret details about how they make their recommendations and decisions. In any case, how ML, which is used in increasing numbers of AI in education tools, generates its outputs is often unknown even to the developers (Rudin 2019). In other words, ML systems are often "black boxes" that are neither transparent nor explainable, because they are both technically complex and frequently proprietary. Further, any "explanation must be tailored to the context and provided in a manner that is useful and comprehensible for an individual, allowing individuals to effectively protect their rights". (Leslie et al. 2021: 15).

In education, when a ML-based AI in education tool decides a child's learning pathway or makes recommendations, while some do provide feedback and explanations, it should be possible for the teacher or parent to identify and understand why that decision has been made and on what parameters it has been based, and to override it if they so choose. However, while there has been extensive academic research in this area (e.g. Conati et al. 2018), we have been unable to find any easily available commercial AI in education tools that genuinely and effectively address this right to transparency and explainability.

▸ Right to withhold or withdraw consent

The question of consent, whether it is genuine and how it might be revoked once personal data has been retained or modified in training data sets, also raises important questions for AI product development. How do we ensure that children have genuinely assented to their data being collected and monetised in AI systems, and how do we ensure that parental consent is given with sufficient understanding? When a school requires the use of AI tools, a consent basis for processing personal data either by the school or by the data processor will not be valid, because consent must be unambiguously freely given and able to be refused without detriment.[95] Again, the argument

95. Guidelines on Children's Data Protection in an Education Setting (2020), Council of Europe Committee on Convention 108, T-PD(2019)06BISrev5.

sometimes made is that teachers have been using educational technology in classrooms for decades without raising complex issues of consent. However, again, there is a qualitative difference between non-AI educational technologies and AI-driven tools – tools that collect huge amounts of data, for many thousands of interaction points, for many thousands of children, which are then stored outside the classroom, aggregated, analysed and monetised. A final question is whether a child or their parent should have the right to withdraw their assent/consent to the use and reuse of the child's data, after that data has been collected, and possibly once it has already been absorbed within the company's data sets?

▶ Right to be protected from economic exploitation

Data rights in different parts of the world may or may not address the questions of ownership and economic exploitation of the data created by and about children, by means of their interactions with commercial AI tools while they are in mandatory education. If a child (or any adult for that matter) creates a poem, a song, or a story, they own that creation. The situation with respect to the data that they create through their interaction with the AI system is not so clear. This is especially important given that the protection of personal data goes beyond privacy to ensuring that the child retains all rights to their own personal data: "child rights need to be firmly integrated onto the agendas of global debates about ethics and data science" (Berman and Albright 2017: 4).

Nonetheless, the idea of personal data ownership, seeing data as an intellectual property, is a US-centric approach, which may be contested from a European human rights perspective: "the protection of personal data is a fundamental right and that therefore personal data cannot be considered as a commodity".[96] The further problem is that educational data is often not only about the child but about the parent and also about the teacher, for whom it might be used to inform performance metrics. In other words, it would be impossible to separate out in practice what data the child owns.

However, when that data is being collected by a third party, such as a commercial AI developer, whose exploitation of that data is a fundamental component of their AI products and business model, how data rights or control can be managed by children and their parents remains unclear. Data protection laws do protect children from commercial exploitation, and there is almost never a lawful basis for it in an educational and not consensual context – although this is not currently being sufficiently enforced by data protection supervisory authorities. Accordingly, it has

96. Directive (EU) 2019/770 of the European Parliament and of the Council of 20 May 2019 on certain aspects concerning contracts for the supply of digital content and digital services (2019), OJ L 136/1, Recital 24.

been argued that states should acknowledge that the digital environment enables commercial exploitation of children in a variety of ways, and should extend the protection of Article 32 of the UNCRC in order to protect children from such practices (Van Der Hof et al. 2020). The United Nations Guiding Principles on Business and Human Rights (United Nations 2011) sets out standards and the scope of social responsibilities for businesses that are of relevance here.

A final and perhaps less obvious relevant issue is the accumulation of data, and thus the power that comes with that data, by a small number of big companies (in particular BigTech): "Overlapping with these human rights concerns is the concentration of power that AI affords to its most influential private and public sector developers and implementers" (Leslie et al. 2021: 15). At present, this is less of an issue for AI in education, as most of the relevant companies are as yet too small to have achieved any dominance. However, there are pockets of crowding out and monopolisation where a single company has been adopted at national or regional level. For example, where AI-assisted child safeguarding platforms have been used in refugee camps run by global NGOs, observational data from media reports and company marketing suggest those authorities tend to buy a single solution.

However, BigTech and the big education publishers (e.g. Pearson) are themselves investing millions of dollars into AI in education tools, such as Google Cloud's AI-powered learning platform and Pearson's IBM Watson Tutor.[97] Meanwhile, the currently independent AIED companies are growing fast. All of this suggests that concentration of power by commercial companies may soon become an issue that will need to be addressed.

▶ Rights of parents

The role of parents in realising a child's right to education is enshrined in Article 26 (3) of the UDHR:

> Parents have a prior right to choose the kind of education that shall be given to their children.

The UNCRC is also clear that the best interests of the child shall be a primary consideration, placing a duty of care on all those who have a legal responsibility for the child (parents, legal guardians, schools and the state), which should be exercised in a manner consistent with the evolving capacities of the child. However, parental rights are complicated by the fact that a parent's decisions may not always align with their child's own views or best interests, making it challenging for schools to address properly. For example, if a parent allows their child to use an AI-powered tool that

97. Pearson Education (2018), *AI-based tutoring: a new kind of personalized learning*, www.pearson.com/ped-blogs/blogs/2018/11/ai-based-tutoring-new-kind-personalized-learning.html.

collects and shares large amounts of personal data, they might in effect be waiving the child's rights to privacy (UC Berkeley Human Rights Center Research Team, 2019).[98]

In any case, the question of whether the state and schools should respect any child's or parents' refusal for the child to be involved with educational technologies such as AI-based tools, without such a refusal adversely affecting the child's education, is yet to be tested in law. In particular, if data are being captured and processed on the basis of consent, such consent must be freely given by parents/legal guardians and the child, and cannot be assumed by the school.

3.1.5. Remedies and redress

The introduction of any technology in education, such as AI, brings with it new actors with a range of aims and interests. As a result:

> Children are often politically voiceless and lack access to relevant information. They are reliant on governance systems, over which they have little influence, to have their rights realised. This makes it hard for them to have a say in decisions regarding laws and policies that impact their rights. (The Committee on the Rights of the Child 2013: 3)[99]

Similarly:

> As bearers of rights, children should have recourse to remedies to effectively exercise their rights or to be able to act upon violations of their rights. Children should have the right to access appropriate independent and effective complaints mechanisms. (Council of Europe 2010: 19)[100]

Despite the right to effective remedy enshrined in Article 13 of the Convention, when it comes to the use of technology in education, these mechanisms are largely absent.

3.2 AI, education and democracy

3.2.1. What is meant by democracy

Democracy can be literally interpreted as "power of (or, to) the people" and it points towards a model of government where the members of the community have the power to choose representatives through established procedures (for example,

98. UC Berkeley Human Rights Center Research Team (2019), "Memorandum on artificial intelligence and child rights", www.unicef.org/innovation/media/10501/file/Memorandum%20on%20Artificial%20Intelligence%20and%20Child%20Rights.pdf
99. Committee on the Rights of the Child, General comment No. 16 (2013) on State obligations regarding the impact of the business sector on children's rights, https://www2.ohchr.org/english/bodies/crc/docs/CRC.C.GC.16.pdf.
100. *Guidelines of the Committee of Ministers of the Council of Europe on child-friendly justice* (2010), https://rm.coe.int/16804b2cf3.

elections).[101] Democracy embodies the ideals of individual autonomy, inclusiveness and equality. At the same time, democracy presupposes that community members are able to make free and informed decisions (Ben-Israel et al. 2020; UNICEF and UNESCO 2007),[102] thus pinpointing the interconnection with human rights and the rule of law.

3.2.2. Democracy and AI

Regarding the role of digital technologies in modern society and their potential negative impact on democracy, Diamond noted that "once hailed as a great force for human empowerment and liberation, social media – and the various related digital tools that enable people to search for, access, accumulate, and process information – have rapidly come to be regarded as a major threat to democratic stability and human freedom" (2019: 20).

Similar concerns extend beyond social media and other internet-based platforms, towards the integration of AI technologies in various aspects of everyday life. Ongoing discussions focus on their potentially negative impact on democracy in terms of cyber-attacks, manipulation of information, propaganda or co-ordinated inauthentic behaviour (Barrett et al. 2021; Hilton 2019; Nemitz 2018). Similarly, Leslie and colleagues (2021) point out that AI can pose a threat to human values such as freedom of expression, association and assembly. To demonstrate the potential danger, they discuss the example of facial recognition systems that may discourage, or even prevent, people exercising their democratic rights. In addition, AI can be used to manipulate the information that is communicated online, depending on the target audience (for example, it can choose what information to highlight based on demographic factors). Or it can fabricate information that is inaccurate (for example, videos or articles that spread false news) with the aim and result of impeding informed decision making.

At the same time, the positive contribution of AI technologies to the public and private sectors is clear (from AI models for cancer diagnosis[103] to extreme weather phenomena prediction[104]), such that AI will inevitably become an increasingly widespread and integral part of our lives. Accordingly, it will – to some extent – change our society. However, how it does so is not inevitable or predefined, but will be determined by human choices. This suggests that there is an urgent need for the public sector to take strategic decisions and to co-ordinate actions for safeguarding democracy and democratic values while preparing and realising the transition towards new social and technological spaces (Ahn and Chen 2020), thus preparing citizens to live productively with AI.

---

101. The Council of Europe, *Democracy*, www.coe.int/en/web/compass/democracy.
102. www.right-to-education.org/sites/right-to-education.org/files/resource-attachments/A%20Human%20Rights-based%20Approach%20to%20Education%20for%20All_0.pdf.
103. Greenfield (2019), Harvard University blog, *Artificial intelligence in medicine: applications, implications, and limitations*, https://sitn.hms.harvard.edu/flash/2019/artificial-intelligence-in-medicine-applications-implications-and-limitations/.
104. BBC (2021), *AI can predict if it will rain in two hours' time*, www.bbc.com/news/technology-58748934.

3.2.3. Democracy and AI in education

Concerning education, AI is usually communicated as a potential solution for supporting its democratisation through personalisation and adaptation (Corbett et al. 1997) – for example, by making possible one-to-one instruction, an approach that has been contested (e.g. Holmes et al. 2021), or through the delivery of quality content regardless of geographical or language restrictions (Chounta et al. 2021). More than 20 years ago, Aiken and Epstein (2000) proposed a set of ethical guidelines for designing AIED in an attempt to start a conversation on ethics and AIED, a conversation that stalled for the next two decades, pointing towards the need to "respect differences in cultural values" and to "accommodate diversity". Similarly, Blanchard (2015) explored the impact of cultural variations on AIED research and pointed out that international representation both in terms of authorship (that is, who conducts the research) and population sampling is necessary to ensure good quality and generalisable outcomes, as well as to reinforce community involvement. One may argue that these discussions point towards fundamental humanistic values related to democratic ideals, but to date there has been little research in these areas.

However, the use of AI in education especially in relation to democracy and democratic education raises a number of questions regarding the organisation of our education systems, pedagogy and societal aspects, among others. Issues include:

- To promote democracy and democratic values, an AIED system should match the description "from all and for all" supporting the three pedagogic rights deriving from mutuality in education: enhancement, inclusion and participation (Bernstein 2000), pinpointing the interconnection between democracy and human rights. Similarly, how can we support the design and deployment of AIED systems that are community-originated, community-oriented and community-driven (Heimans et al. 2021)? Do educational institutions (schools, universities and so on) have the capacity to act as communities for driving the widespread application of AIED – and should they do so? What are the implications for communities that, due to technological or financial disparities, are not able to follow up with the design and deployment of AIED systems, or for marginalised communities that are typically underrepresented in the state-of-the-art research? Could these disparities lead to a greater divide rather than transforming education for all?
- Democratic education presupposes open access and equity, meaning that everyone has access to the same quality of learning materials, conditions and opportunities. The relationship between democracy and public education is well documented and discussed over time, and one could argue that the clearest example of democratic education in practice is public sector schools (Dewey 1903; Heimans et al. 2021; Sehr 1997; Stitzlein 2017). Accordingly, when we think of AI, how can we ensure that all learners, regardless of cultural background, personal characteristics or financial status will have access to AIED systems and AI-enhanced learning environments, especially taking into account that prominent AI and, specifically, AIED initiatives are led by IT for-profit corporations (Nemitz 2018)?

- Modern AIED systems are mainly based on cognitive and knowledge modelling with the aim of providing personalised instruction and content while AI-enhanced learning targets individual learners rather than learner groups (Holmes et al. 2021; Leaton Gray and Kucirkova 2018). AIED systems, mainly the so-called intelligent tutoring systems, have been criticised for not reinforcing attitudes of partnership, solidarity, respect and sensitivity for the needs of other members of the community but instead promote individuals, potentially at the expense of the collective (Kucirkova and Littleton 2017). On the other hand, AIED research extends to collaborative and group learning contexts, for example aiming to facilitate group formation (Stewart and D'Mello 2018) or to promote co-creative dialogues (Griffith et al. 2021). How can we broaden, expand and communicate relevant research to promote the design and deployment of socially-aware over individually-focused AIED systems? How can we deliver systems that aim to support learners of different abilities and in various learning contexts without creating a divide between the learner population? How can we balance the benefits for the individual learner and the learning group as a whole, leading to classrooms that act as micro-communities of established democratic practice?
- A particular challenge for ML models is that they inevitably represent the world as a function of the past. Accordingly, if the data used for training ML models introduced bias, so will be the resultant models (for a review of algorithmic bias in education, see Baker and Hawn 2021). Similarly, learner-supporting AI systems can only infer and respond to the patterns of engagement of past users of the system. Here, the bias might not be so obvious, but it is still real and has significant consequences (Tuomi 2018). For example, past users of the AIED systems, the early adopters, tend to come from school systems in more privileged countries, as that is where the tools are mostly developed, and schools in those countries are more likely to be able to afford the new technologies (Pinkwart 2016; Schiff 2021). Inevitably, therefore, the resultant ML models may better represent those more privileged learners, with uncertain consequences for less privileged learners. How can we create data sets and models that are balanced and representative for all learner populations and that do not reinforce bias? Alternatively, how can we design methodological approaches that allow us to correct for bias, if that is even possible, and develop systems that safeguard equity?

3.2.4. Critical reflections

Related work has focused and elaborated on the risks that AI poses to practising, establishing and sustaining democracy and democratic procedures, especially in terms of the manipulation and fabrication of information, practices that threaten democratic rights (e.g. surveillance systems) and so on (Hilton 2019; Nemitz 2018). When it comes to the use of AI in education – as a specific application domain – additional concerns come into play that do not necessarily apply or are not taken into account for general-purpose AI systems.

As noted earlier, the "personalisation" of learning has been the driving force of educational technology for around 100 years (Watters 2021), and it is now probably the most widely made argument for the integration of AI in education. This raises multiple concerns. For example, is personalisation possible or even desirable – given that ML works by grouping data? Is it actually more homogenisation than personalisation? Similarly, what potential divides might follow personalisation, and could these have explicit or implicit negative impacts on democracy? For example, who can have or afford access to AIED systems and consequently their potential benefits, and might personalised learning result in uneven learning gains, with some learners benefiting more than others? Similarly, there are implications for AIED on the social aspects of learning. Schools and classrooms do not only disseminate subject knowledge and content, but they also aim to educate individuals regarding democratic values and humanistic principles; in other words, a classroom may act as a preparation stage for the individual becoming a citizen in a democratic society. At this point, it is not clear how AIED systems take up or impact on this role.

It is critical to establish and foster informed public discussions around the design, development and deployment of AI systems for education, regardless of the systems' purpose (either systems that aim to act as learner-supporting or as teacher-supporting AI). These discussions, following the definition of democracy, should primarily be led by the public sector (while AIED is fast becoming the preserve of the commercial sector). They should be open to all stakeholders – teachers, parents, learners, administration, researchers, technology providers – to ensure multivocality and communication on common ground. Further discussions should not focus on technological aspects but explicitly address the potential impact of AI technologies on democracy. Although democracy and democratic values are considered well-known and straightforward topics, related work has pointed out that – even among public sector stakeholders – such terms are either non-uniformly understood, or it is not clear why and how technology could have an impact on them (Barrett et al. 2021). Existing work regarding the challenges around AI and democracy is valuable, but at the same time there is the need for further elaboration on topics that closely relate to AI in education and how to safeguard and promote democratic ideals in the digital era.

3.3. AI, education and the rule of law

3.3.1. What is meant by the rule of law

> The rule of law provides the institutional basis for safeguarding both democratic participation and the protection of fundamental rights and freedoms. An independent and impartial judiciary, which ensures citizens due judicial processes and fair and equal treatment under the law, acts as a guarantor of recourse whenever fundamental rights or freedoms could be breached. (Leslie et al. 2021: 13)

In a comprehensive review of the teaching of AI and the law in the USA, Johnson and Shen write that "sectors as diverse as patent law, criminal law, torts, human rights, climate change, healthcare, finance, and transportation all face imminent and abrupt

changes in light of rapid advances in AI and ML technology" (2021: 25). Interestingly, the education sector is not listed. However, it should be concluded that there is a pressing need for ethical guidance for, and regulation of, AI.

In this section, the application of the rule of law with respect to AI in education is illustrated by relevant legislation and legal frameworks, by work on regulation of AI systems, research on AI in education and law and through examples of interpretations and in reported cases of violations. The section ends with revealed gaps both in research on AI, education and the rule of law, and in regulatory and legal aspects on the application and impact of AI in the educational sector.

3.3.2. International legal frameworks

Leslie et al. (2021) conclude that presently there are no international laws focused specifically on AI. However, a number of existing legal instruments that set out people's fundamental rights (cf. section 3.1) are relevant, including:

- The European Convention on Human Rights
- The European Social Charter (ESC)
- The International Bill of Human Rights (comprising the Universal Declaration of Human Rights, the International Covenant on Economic, Social and Cultural Rights and the International Covenant on Civil and Political Rights and its two Optional Protocols)
- The Charter of Fundamental Rights of the European Union (CFR)
- United Nations Convention on the Rights of the Child (UNCRC)
- The Convention on the Rights of Persons with Disabilities

In particular, the right to non-discrimination and the right to privacy are applicable for AI applications in general, and thus are also relevant for the use of AI in education. Existing legal instruments that protect particular groups (e.g. minorities) are also of relevance.

Leslie et al. (2021) distinguish between soft law (non-binding, voluntary compliance) and hard law (legally binding) and summarise that while current legal mechanisms to some extent protect individual rights, the risks associated with AI are not yet sufficiently addressed. This will require not only legal and regulatory efforts, but also public oversight in the design, development and use of AI systems. This is challenging given the uncertainty and ambiguity of AI systems and a need to balance the benefits of AI innovation and protection of human rights. These issues are certainly relevant for the use of AI in education and are particularly crucial when children and youth are involved. Furthermore, it is recognised that AI systems (and their data flow) often cross multiple jurisdictions, making it more complicated. This arises in the use of AI in education, often raising questions of data rights, learner profiling and cultural impact on educational systems.

In their historical review of the origins and meaning of data protection, Korff and Georges (2020) describe how the EU's GDPR was adopted to meet the challenges posed by new technologies and services such as profiling, algorithmic decision making and AI, where the EU Commission saw "strong, high-level data protection

as an essential condition for gaining trust in the online environment". Used together with national education laws and data regulations, it provides some of the strongest data protection for learners in the world. For those developing AI applications for schools in member states, it is necessary to comply with the requirement of data protection by design and by default as stipulated in Article 10 of Convention 108 or, in addition, the GDPR Article 25. Similarly, in a review of Hildebrandt's (2015) *Smart technologies and the end(s) of law*, Kerr writes that "Hildebrandt instead forewarns that the only thing able to save the Rule of Law as we know it is 'legal protection by design'"[105] (2017: 92) for technology that impacts human behaviour. Legal protection by design "aims to ensure that legal protection is not ruled out by the affordances of the technological environment that determines whether or not we enjoy the substance of fundamental rights" (Hildebrandt 2019: 16). In the GDPR this is addressed by the legal obligation to conduct a Data Protection Impact Assessment (DPIA).[106]

School owners (e.g. municipalities) are required to carry out a DPIA that identifies and evaluates the risks associated with the use of digital tools in schools when the tools engage certain processing operations. Thus, a DPIA is included for all "learning with AI" learner- and teacher-supporting AI systems. This is challenging because it is a complex and time-consuming task, and requires high competence. To aid this process, for example, the Norwegian Data Protection Agency provides a list of operations[107] that always requires a DPIA, including processes meeting two or more criteria (in some cases only one): evaluation or scoring, automated decision making with legal or similar significant effect, systematic monitoring, sensitive data or data of a highly personal nature, data processed on a large scale, matching or combining data sets, and data concerning vulnerable data subjects. Specifically named processes that are relevant for education include: processing of personal data for the purpose of evaluating learning, coping and well-being in schools or kindergartens (at all levels of education), camera surveillance in schools or kindergartens, the processing of personal sensitive or highly personal data on a large scale for the training of algorithms, and the processing of personal data to systematically monitor proficiency, skills, scores, mental health and development.

Regulation of AI

In December 2020, the CAHAI Secretariat published a report "Towards regulation of AI systems"[108] addressing the impact of AI on human rights, democracy and the rule of law, providing guidelines on AI ethics, an analysis of international legally binding

105. Hildebrandt M. (2019), "10. 'Legal by Design' or 'Legal Protection by Design'?" *Law for Computer Scientists*, (see section 10.3), https://lawforcomputerscientists.pubpub.org/pub/gfzd6k0g/release/12.

106. Wolford B. (GDPR EU), *Data Protection Impact Assessment (DPIA)*, https://gdpr.eu/data-protection-impact-assessment-template.

107. Datatilsynet (The Data Protection Supervisory Authority Norway), *Processing operations subject to the requirement of a data protection impact assessment*, www.datatilsynet.no/globalassets/global/dokumenter-pdfer-skjema-ol/regelverk/veiledere/dpia-veileder/dpialist280119.pdf.

108. Council of Europe (2020), CAHAI, "Towards regulation of AI systems: global perspectives on the development of a legal framework on artificial intelligence systems based on the Council of Europe's standards on human rights, democracy and the rule of law", www.coe.int/en/web/artificial-intelligence/-/-toward-regulation-of-ai-systems-.

instruments, and reviewing three national perspectives on AI systems regulation. When defining AI for regulatory purposes they write that "A complicating factor is that legal definitions differ from pure scientific definitions whereas they should meet a number of requirements (such as inclusiveness, preciseness, comprehensiveness, practicability, permanence), some of which are legally binding, and some are considered good regulatory practice" (Ben-Israel et al. 2020: 23). With respect to AI and the rule of law, they make six statements (ibid.: 31-32) about how AI is a double-edged sword with both potentials and dangers related to efficiency, legitimacy and trust, authority in and out of the courts, terms of service versus the rule of law, enforcement of trustworthy AI and threats to the law versus strengthening the law. While none of these are directed in particular at education, all are relevant to the application of AI in many facets of education (e.g. governance, learning, monitoring, assessments), namely in learner-, teacher- and institutional-supporting AI systems. In particular, their strategies for "awareness", "measure for compliance, accountability and redress", "protecting democracy, democratic structures and the rule of law" should be conceptualised within education.

The European Commission, as part of their work on a digital strategy, is concerned with fostering a European approach to AI[109] which includes AI excellence and trustworthiness. This includes a communication that states that "Europe must act as one to harness the many opportunities and address challenges of AI in a future-proof manner,"[110] and a regulatory framework. In April 2021, the European Union proposed the Regulation on Artificial Intelligence, or the Artificial Intelligence Act,[111] (AI Act) which will be the first law on AI by a major regulator anywhere. The AI Act "seeks to lay down harmonised rules for the development, placement on the market and use of AI systems which vary by characteristic and risk [high, limited, minimal]" (Veale and Borgesius 2021: 97). It is a legal framework that promotes the use of AI and addresses the associated potential risks (Schwemer et al. 2021). The draft act[112] recognises that, "The use of AI with its specific characteristics (e.g. opacity, complexity, dependency on data, autonomous behaviour) can adversely affect a number of fundamental rights enshrined in the EU Charter of Fundamental Rights ('the Charter')." Education and training, identified as a critical area, is mentioned with respect to minimising the risk of erroneous or biased AI-assisted decisions, especially related to assessing individuals in, or trying to gain admission to, educational and vocational training institutions, cases which are identified as high risk, and to protecting the vulnerabilities of children. With respect to the values of the Council of Europe, Schwemer,

109. European Commission (2021), Communication on Fostering a European approach to Artificial Intelligence, https://digital-strategy.ec.europa.eu/en/library/communication-fostering-european-approach-artificial-intelligence.

110. European Commission (2021), Coordinated Plan on Artificial Intelligence 2021 Review, https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review.

111. Sioli L. (2021), A summary presentation on the act by the European Commission, www.ceps.eu/wp-content/uploads/2021/04/AI-Presentation-CEPS-Webinar-L.-Sioli-23.4.21.pdf.

112. Regulation of the European Parliament and of the Council, Laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain Union legislative acts, COM(2021) 206 final, (2021 draft), (para 3.5), https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021PC0206&from=EN.

Tomada and Pasini write that:

> it is noteworthy that the proposal does not follow a rights-based approach, which would, for example, introduce new rights for individuals that are subject to decisions made by AI systems. Instead, it focuses on regulating providers and users of AI systems in a product regulation-akin manner. (2021: 6).

3.3.3. Research on AI in education and the rule of law

AI and the rule of law has already been a field for research for some time, with its development following the general trends in AI research over the last decades (Leslie et al. 2021; Surden 2019). Surden (2019) summarises its history[113] as a move from early academic endeavours centred on knowledge and rule-based legal systems in the 1970s, through the development of formal models of legal argument and computational models of legislation and legal rules in the 1980s and 1990s, to a focus from 2000 on machine-learning approaches, with an emergence of legal technology SMEs that aim to make law more efficient or effective.

Surden (2019) also distinguishes between AI in the practice of law (e.g. discovery for litigation or predictive coding and technology-assisted law), AI in the administration of law (e.g. legal decision making or in policing) and AI and "users" of law (e.g. people using legal self-help systems or legal expert chatbots). Furthermore, he identifies contemporary issues including bias in algorithmic decision making, interpretability of AI systems, transparency around how AI systems are making their decisions and deference to automated decision making, in line with recognised challenges for the AI and its application. While describing AI in law in general, each of these contemporary issues are extremely relevant to understanding and evaluating the use of AI in education, in particular in light of the GDPR.

Three examples of research that could be said to have a relation to AI in education and the law are: work on algorithmic decision making for admission to higher education, research on data and algorithmic literacy and research to support law education. With an increasing use of algorithmic decision-making systems in general, "fairness concerns are gaining momentum in academic and public discourses" (Marcinkowski et al. 2020: 122) due to biases in the training data. Interested in perceptions of (un)fairness of the application of algorithmic decision making for admissions in higher education, Marcinkowski and colleagues (2020) carried out a survey of 304 students at a German university to assess their attitudes and perceptions of algorithmic versus human decision making. They found that students rate algorithmic decision making higher than human decision making with respect to procedural and distributive fairness; they are perceived as more objective and fairer. This is interesting when compared to medicine where human decision making is seen as superior to AI.[114]

Work on competence frameworks for data and AI literacies, for citizens in general and for particular professions, often include both the technological dimension and

113. See Bench-Capon et al. (2012), a review of 55 papers presented during the first 25 years of the International Conference on AI and Law.

114. See: www.nature.com/articles/s41562-021-01146-0.

human dimensions of AI literacy such as aspects of data privacy, data protection and personal rights. These literacies have a legal dimension and also are aimed at social responsibility and democracy in the use of data and algorithms (Ben-Israel et al. 2020). One example is from Atenas and colleagues, who include data governance as a key literacy:

> Data governance can be understood as the policies and regulations in place for deploying and presenting data in regards with its accessibility, usability, integrity and security-based data standards, norms and laws. (2020: 8)

Another example is the updated European Digital Competence Framework for Citizens – DigComp 2.2 (Vuorikari et al. 2022), which recognises that every citizen needs to be cognisant in the use of their own, and other data, in the use of algorithms that manipulate this data, being aware of their right to privacy and that laws and regulations are followed.

Another line of research is related to the use of AI in legal education. Practising argumentation (Lynch et al. 2007) or writing analytics in a civil law degree (Knight et al. 2018) are both examples of learning with AI.

3.3.4. Applying the rule of law to AI in educational practice

Most of these examples involve institution-supporting AI (for administration of marks, admission, attendance, fees), while two are focused on learner-supporting AI and the use of adaptive algorithms in school, and the last on input to a new education law that takes into account AI in education.

AI and grade prediction

In 2020, two cases challenging the use of algorithms related to high school student exams were raised. The first, in the UK, was the use of algorithms to estimate A-level results, and the second, in Norway, was a challenge to the International Baccalaureate Organization's use of an awarding algorithm in the calculation of final grades.

Digital rights' organisation Foxglove threatened to take legal action against Ofqual,[115] the government body that regulates qualifications, exams and tests in England, on the grounds that the algorithm being used to determine students' estimated A-level results potentially violated the UK Data Protection Act. The claim argues that (i) the algorithm is not grading students, rather the school, resulting in significant disadvantages for students in poor schools and advantages for small, rich schools, and (ii) this automation of such decision making in a situation with major impact for the individual student potentially violates the GDPR Article 22, and the UK Data Protection Act.

115. Dark (2020), *UK: Legal action threatened over algorithm used to grade teenagers' exams*, www.statewatch.org/news/2020/august/uk-legal-action-threatened-over-algorithm-used-to-grade-teenagers-exams/; and BBC (2020), *A-levels and GCSEs: How did the exam algorithm work?* www.bbc.com/news/explainers-53807730.

In May 2020, Datatilsynet, the Norwegian DPA, requested[116] that the International Baccalaureate Organization (IBO) explain their awarding algorithms that calculated final grades for individual students based on student coursework, teacher-delivered predicted grades, as well as historical prediction data for an individual school.[117] This method was taken into use as the final exams could not be written due to the Covid-19 pandemic. The fear was that the calculation of the individual grades of IB students was based on an automated decision-making process[118] without room for meaningful human assessment. This raised several questions with regard to the processing of personal data pursuant to Article 58(1)(a) of the GDPR and in particular Article 5(1)(a), (c) and (d) and Article 22(2) and (3). The intention was that Datatilsynet would order the rectification of the final IB grades.[119] While the action resulted in changes, and some students received higher grades, it meant that (i) Datatilsynet did not have the competence to challenge them further, and (ii) the IBO main office is in the UK, and at that time, as the UK was still part of the EEA, Datatilsynet could not make a decision against IBO. Thus, the case was closed (see also Cyndecka 2020).

In both cases, the final exam results were estimated based on historical data – not the individual student's previous grades, but previous years' grades at the school. This unfairly benefited students in previously successful schools, typically those in higher socio-economic districts, and penalised students in lower-achieving schools, typically those in more challenged districts. This approach, which is far from the dominant rhetoric of "algorithmic personalisation", had serious consequences for individual learners, impacting negatively on their access to higher education or entry to the world of work.

Biometric data use in schools

Datainspektionen, the Swedish Authority for Privacy Protection (DPA), fined a Swedish school €20 000 for running, albeit with the consent of the students, a facial recognition pilot that kept track of student attendance.[120] The school was found to have unlawfully used sensitive biometric data, failed to carry out an adequate impact assessment, and had not consulted the DPA. Given the clear imbalance between the data subject (the student) and the controller (the school), Datainspektionen ruled that consent was not a valid legal justification.

---

116. Datatilsynet (Data Protection Supervisory Authority Norway), "Order to provide information – International Baccalaureate Organization – Awarding model and grading system", www.datatilsynet.no/contentassets/ea9284bbfcb64f819b2171228bc912a4/ibo---order-to-provide-information-by-24-july-2020.pdf.
117. International Baccalaureate Organization (2020), *Awarding May 2020 results further information*, www.ibo.org/news/news-about-the-ib/awarding-may-2020-results-further-information.
118. www.efta-studies.org/post/a-dystopian-story-about-covid-19-artificial-intelligence-setting-grades-and-the-gdpr.
119. Datatilsynet (2020) *The Norwegian DPA intends to order rectification of IB grades*, www.datatilsynet.no/en/news/2020/the-norwegian-dpa-intends-to-order-rectification-of-ib-grades.
120. European Data Protection Board (2019), *Facial recognition in school renders Sweden's first GDPR fine*, https://edpb.europa.eu/news/national-news/2019/facial-recognition-school-renders-swedens-first-gdpr-fine_sv.

Similarly, the Polish DPA fined a Polish primary school €5 000 for the illegal use of children's biometric data without a legal basis, even though the school obtained the data and processed them on the basis of the written consent of the parents or legal guardians.[121] The school was using a biometric reader at the entrance to the school canteen to identify the children and verify the payment of the meal fee. The Polish DPA concluded that the processing of biometric data was both disproportionate and unnecessary for achieving the goal of identifying a child's entitlement to receive lunch. They also highlighted that other forms of identification could be used.

Both cases highlight the imbalance between the use of an individual's sensitive personal data and the goal of the school (see also King and Persson 2022).

Use of AI systems' data in schools

As part of Datatilsynet, the Norwegian Data Protection Agency, a sandbox for AI has been created.[122] One project examined the use of learning analytics and AI in an adaptive application to be used in schools in Norway. This raised a number of questions concerning the privacy and data protection of learners whose personal data are being processed by algorithms (Sluttrapport – AVT-Project). These were addressed by applying the General Data Protection Regulation and the national law on education. The final report[123] presents a discussion of the legal basis for processing the personal data of learners with the purpose of providing adapted education, which is guaranteed by law, and the development of the said algorithms. The findings of this work will be valuable input in an update of the Norwegian education law.

3.3.5. Critical reflections

Several gaps related to AI, education and law have been identified. First, in their chapter "Landscape of legal instruments" (2021), Leslie and colleagues name several domain-specific legal instruments for cybercrime, biomedicine and aviation – but they do not identify any specific legal instrument for the education sector. This is a weakness and a danger which urgently needs to be addressed.

Second, research on AI and the law in education is scarce, although with the promotion of AI as a game changer for education, there is a need for research (from a legal perspective) on (i) data protection and rights, (ii) legal implications of algorithms and bias, (iii) rights related to transparency and explainability of algorithms and (iv) literacy of stakeholders (from those creating laws and regulations to school owners, teachers, learners, parents and providers of the technologies) with regard to their rights.

---

121. Urząd Ochrony Danych Osobowych (Data Protection Supervisory Authority Poland) (2020), *Fine for processing students' fingerprints imposed on a school*, https://uodo.gov.pl/en/553/1102.
122. www.datatilsynet.no/en/regulations-and-tools/sandbox-for-artificial-intelligence.
123. www.datatilsynet.no/regelverk-og-verktoy/sandkasse-for-kunstig-intelligens/ferdige-prosjekter-og-rapporter/avt-sluttrapport.

Finally, given the growth of and complexity of AI in society, and the legal implications, there is also a pressing need for education lawyers on AI in general (Johnson and Shen 2021), and we would argue that this needs to include the legal issues related to AI in education in particular. For example, Johnson and Shen (2021: 28) provide a comprehensive overview of teaching AI and law in the USA[124] and recommend that "law schools that do not offer a course in Law and AI should do so … and for those schools that already have an introductory course, we suggest that AI issues be more broadly engaged throughout the curriculum through dedicated courses and by revising current course offerings". Of the categories of courses offered in the USA (e.g. AI and healthcare, AI and war/national security, AI and cybersecurity), there are currently no courses being offered about AI and education. The need for strengthening law education is supported by the Shanghai Initiative on Artificial Intelligence and Future Rule of Law,[125] which advocates "broadening the teaching content of AI and other specialties on the basis of law discipline, paying attention to the cross-integration of AI and law education, and cultivating a group of talents with legal literacy and knowledge of AI technology" (Cui 2020: 197).

Open questions

Recommendation CM/Rec(2019)10 on developing and promoting digital citizenship education,[126] adopted by the Committee of Ministers on 21 November 2019, recommended that governments of member states review their legislation, policies and practices, including learning frameworks, to ensure that they are aligned with the recommendations. This is especially urgent in relation to the use of AI in education.

As noted earlier, processing a child's personal data in educational settings has particular complexity due to the non-consensual setting in which children and families are disempowered – which affects the freely given nature of consent. In particular, children cannot (or rarely in member state law) enter into contracts.

The rights bearers are not only children, but also the parents or legal guardians. The purpose of going to school and the reasonable expectations of families of any associated data processing is to exercise and fulfil the child's right to education. As discussed earlier, this comes with associated obligations – to respect the rights and philosophical beliefs of the parent and further legal obligations around the rights of the child with a disability, or minority and indigenous children.

Accordingly, there are three key and challenging questions that need to be addressed.

1. Can children be required to use an AI system that exploits their behaviours (through the data processed from their interactions) in the interests of the institution, any third party, or for commercial product development or

124. Of 197 law schools, only 26% offer at least one law and AI course, and only half of these offer multiple courses.

125. A result from the high-level seminar on artificial intelligence and the rule of law, hosted by the Shanghai Law Society during the World AI Conference 2018.

126. Recommendation CM/Rec (2019)10 of the Committee of Ministers to member States on developing and promoting digital citizenship education, https://search.coe.int/cm/Pages/result_details.aspx?ObjectID=090000168098de08.

enhancement, in particular where the child's personal data are retained as AI-model training data?

2. If other less intrusive methods of performing the task are available and some schools choose to teach children without sending their personal data to an AI company, can AI ever meet the tests of necessity and proportionality and be lawful at all?
3. Must schools respect parents or children's wishes, and where applicable in member state data protection law, the right to object and the right to restrict processing, or can a school lawfully refuse, making the use of certain products compulsory for all learners in practice?

PART IV

Conclusion and a needs analysis

4.1. Conclusion

This report set out to explore the multiple connections between AI and education through the lens of the Council of Europe's mandate to protect human rights, to support democracy and to promote the rule of law. As we did so, while we acknowledged the potential of AI for education, we encountered and discussed much hyperbole, identified many important challenges and raised multiple questions. Most importantly, how do we ensure that AI&ED protects and does not undermine human rights, democracy and the rule of law? To begin with, what is the "right kind" of AI in education?

> Are the AI technologies being introduced in schools and other educational settings addressing the right educational tasks? Are they enhancing learning as an essentially human and social activity, or aiming to make learning "more efficient"? Are they designed to support, or to replace, teachers? Are they personalising learning pathways to prespecified learning content, mainly preparing students for exams, or supporting personalised learning outcomes, enabling students to achieve their individual aims and potential? (Holmes 2020)[127]

In parallel, on the other side of the AI&ED coin, what should be taught about AI, to our children and our citizens, in our schools and universities and in vocational education and lifelong learning? How do we ensure that we move beyond focusing exclusively on the technological dimension of AI to instead give equal attention to the human dimension of AI – issues such as the impact of AI on human rights, autonomy and agency, alongside questions of transparency, fairness, trustworthiness and ethics.

Given the novelty of our perspective on such a fast-growing domain of AI, we do not claim that this report provides definitive answers. Instead, we hope our sometimes deliberately provocative writing prompts more questions than answers, in order to provide a stake in the sand for future related work being undertaken by the Council of Europe and its member states. We conclude the report in the same light, with a provisional and sometimes provocative needs analysis – identifying a diversity of needs that we hope will stimulate further critical discussion about AI&ED through the lens of human rights, democracy and the rule of law.

4.2. A needs analysis

As noted, the key purpose of the following provisional needs analysis is to stimulate and inform further critical debate – between learners, educators, AI researchers, commercial developers, policy makers and all other stakeholders. The identified needs are based on the premise that AI in and of itself is not problematic and recognises that what is instead potentially problematic is how AI is developed, trained and applied in educational contexts, who the AI targets and who are the real beneficiaries.

- We need to identify and act upon linkages across the Council of Europe's work, to increase understanding in and between policy makers of the challenges that AI poses across the directorates and member states.

127. www.nesta.org.uk/blog/right-kind-ai-education

- We need a better understanding of the diversity of connections between AI and education, and not be limited by current approaches (that tend to underemphasise the human dimension of AI).
- We need more evidence (i.e. large-scale independent research, including from non-WEIRD – western, educated, industrialised, rich and democratic – countries) and less hyperbole about the connections between AI and education, which in turn will require more funding.
- We need a better understanding of what counts as evidence. Research must go beyond simple metrics like academic progress to consider the broader impact of an AI tool on learners' cognition, mental health and human rights.
- We need to avoid automating poor pedagogic practices (e.g. instructionism and exam proctoring) and instead focus on using the power of AI to address genuine education "wicked problems"[128] (e.g. inclusion, engagement and assessment).
- We need appropriate, robust regulation, addressing human and child rights, before AI tools are introduced into classrooms (in a process similar to medicine's stepped safety trials), which addresses the technology's full life cycle.
- We need to recognise that there is a qualitative difference between teachers and AI-driven tools that are notionally doing the same thing (the AI tools are outside the system, commercially owned, proprietary and rarely transparent).
- We need to ensure that parents are able to exercise their democratic rights in procurement decisions (e.g. of AI-driven tools) that might affect their child's development and right to education.
- We need school and lifelong-learning curricula that address both the human and technological dimensions of AI, to ensure that everyone better understands both how AI works and its potential impact on all our lives.
- We need to ensure ethics by design (covering issues such as bias, transparency, choice of pedagogy) for all AI-driven tools proposed for use in educational contexts, to facilitate rather than undermine innovation.
- We need to ensure that children are not forced to accept being compulsory research subjects or being compulsorily involved in product development simply by exercising their right to education.
- We need to ensure that data rights and intellectual property rights remain explicitly with the learners (for example, if state-funded schools are being used to develop AI models, the models should at least be open access).
- We need appropriate professional development for teachers (as well as for administrators and policy makers), so that they are able to make informed decisions about which AI tools might be appropriate for their classroom.

128. For a helpful explanation of "wicked problems", see www.stonybrook.edu/commcms/wicked-problem/about/What-is-a-wicked-problem. Wicked problem characteristics include: They do not have a definitive formulation. Their solutions are not true or false, only good or bad. There is no way to test the solution to a wicked problem. Their solutions are irreversible. There is no end to the number of solutions or approaches to a wicked problem. All wicked problems are essentially unique.

- We need multidisciplinary approaches, bringing together educators, learners and parents, learning scientists and philosophers, computer scientists and AI engineers, commercial developers and governments.
- In short, we need the application and teaching of AI in education to prioritise and facilitate human rights, democracy and the rule of law.

References

Access Now (2018), *Human rights in the age of artificial intelligence*, available at www.accessnow.org/cms/assets/uploads/2018/11/AI-and-Human-Rights.pdf, accessed 23 June 2022.

Aguirre A. et al. (2021), *AI loyalty by design: a framework for governance of AI*, Social Science Research Network, SSRN Scholarly Paper ID 3930338, available at https://papers.ssrn.com/abstract=3930338, accessed 23 June 2022.

Ahn M. J. and Chen Y.-C. (2020), *Artificial intelligence in government: potentials, challenges, and the future*, The 21st Annual International Conference on Digital Government Research, pp. 243-52, available at https://doi.org/10.1145/3396956.3398260, accessed 23 June 2022.

Aiken R. M. and Epstein R. G. (2000), "Ethical guidelines for AI in education: starting a conversation", *International Journal of Artificial Intelligence in Education* Vol. 11, pp. 163-76.

Aikman S. and Unterhalter E. (2005), *Beyond access: transforming policy and practice for gender equality in education*, Oxfam GB/Practical Action Publishing, available at https://oxfamilibrary.openrepository.com/handle/10546/115410, accessed 23 June 2022.

Anderson J. R. et al. (1995), "Cognitive tutors: lessons learned", *The Journal of the Learning Sciences* Vol. 4, No. 2, pp. 167-207.

Anuradha J. et al. (2010), "Diagnosis of ADHD using SVM algorithm", *Proceedings of the Third Annual ACM Bangalore Conference*, pp. 1-4, available at https://dl.acm.org/doi/10.1145/1754288.1754317, accessed 23 June 2022.

Aristotle (2009), *The Nicomachean ethics*, Brown L. (ed.), Ross D. (tr.), (rev. edn), Oxford University Press, Oxford.

Arnold K. E. and Pistilli M. D. (2012), "Course signals at Purdue: using learning analytics to increase student success", *LAK12: Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, pp. 267-70, available at https://doi.org/10.1145/2330601.2330666, accessed 23 June 2022.

Arntz M., Gregory T. and Zierahn U. (2016), *The risk of automation for jobs in OECD countries: a comparative analysis*, OECD, available at https://doi.org/10.1787/5jlz9h56dvq7-en, accessed 23 June 2022.

Ashrafi F. and Javadi A. (2020), "Correct characteristics of the newly involved artificial intelligence methods in science and technology using statistical data sets", *International Journal of Modern Engineering Technologies* Vol. 2, No. 2.

Atenas J., Havemann L. and Timmermann C. (2020), "Critical literacies for a datafied society: academic development and curriculum design in higher education", *Research in Learning Technology* Vol. 28, available at https://doi.org/10.25304/rlt.v28.2468, accessed 23 June 2022.

Baker M. J. (2000), "The roles of models in artificial intelligence and education research: a prospective view, *Journal of Artificial Intelligence and Education* Vol. 11, pp. 122-43.

Baker R. S. and Hawn A. (2021), *Algorithmic bias in education*, EdArXiv Preprints, available at https://doi.org/10.35542/osf.io/pbmvz, accessed 23 June 2022.

Baker T., Smith L. and Anissa N. (2019), *Educ-AI-tion rebooted? Exploring the future of artificial intelligence in schools and colleges*, NESTA, available at www.nesta.org.uk/documents/1190/Future_of_AI_and_education_v5_WEB.pdf, accessed 23 June 2022.

Barassi V. (2020), *Child data citizen: how tech companies are profiling us from before birth*, MIT Press, Cambridge, MA.

Barrett B., Dommett K. and Kreiss D. (2021), "The capricious relationship between technology and democracy: analyzing public policy discussions in the UK and US", *Policy & Internet*, available at https://doi.org/10.1002/poi3.266, accessed 23 June 2022.

Barrett M. et al. (2019), "Using artificial intelligence to enhance educational opportunities and student services in higher education", *Inquiry: The Journal of the Virginia Community Colleges* Vol. 22, No. 11, pp. 1-10.

Beal C. R. et al. (2007), "On-line tutoring for math achievement testing: a controlled evaluation", *Journal of Interactive Online Learning* Vol. 6, No. 1, pp. 43-55.

Beal C. R. et al. (2010), "Evaluation of AnimalWatch: an intelligent tutoring system for arithmetic and fractions", *Journal of Interactive Online Learning* Vol. 9, No. 1, pp. 64-77.

Becker B. (2017), "Artificial intelligence in education: what is it, where is it now, where is it going", in Mooney B. (ed.), *Ireland's Yearbook of Education 2017-2018*, pp. 42-48, Education Matters, available at https://irelandseducationyearbook.ie/irelands-yearbook-of-education-2017-2018/, accessed 23 June 2022.

Benaich N. (2020), "AI has disappointed on Covid", *Financial Times*, available at www.ft.com/content/0aafc2de-f46d-4646-acfd-4ed7a7f6feaa, accessed 23 June 2022.

Bench-Capon T. et al. (2012), "A history of AI and law in 50 papers: 25 years of the international conference on AI and law", *Artificial Intelligence and Law* Vol. 20, No. 3, pp. 215-319, available at https://doi.org/10.1007/s10506-012-9131-x, accessed 23 June 2022.

Ben-Israel I. et al. (2020), "Towards regulation of AI systems: global perspectives on the development of a legal framework on artificial intelligence (AI) systems based on the Council of Europe's standards on human rights, democracy and the rule of law", Council of Europe, available at https://rm.coe.int/prems-107320-gbr-2018-compli-cahai-couv-texte-a4-bat-web/1680a0c17a, accessed 23 June 2022.

Berman G. and Albright K. (2017), *Children and the data cycle: rights and ethics in a big data world*, Innocenti Working Papers No. 2017/05, available at https://doi.org/10.18356/7d33bc21-en, accessed 23 June 2022.

Bernstein B. (2000), *Pedagogy, symbolic control, and identity*, Rowman & Littlefield Publishers, Lanham, MD.

Berryhill J. et al. (2019), *Hello, World: artificial intelligence and its use in the public sector*, OECD Working Papers on Public Governance No. 36, OECD, available at https://doi.org/10.1787/726fd39d-en, accessed 23 June 2022.

Bietti E. (2020), "From ethics washing to ethics bashing: a view on tech ethics from within moral philosophy", *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency*, pp. 210-19, available at https://dl.acm.org/doi/abs/10.1145/3351095.3372860, accessed 23 June 2022.

Biggs P. et al. (2018), *The state of broadband 2018: broadband catalyzing sustainable development*, ITU, Geneva.

Binns R. (2021), *Data minimisation and privacy-preserving techniques in AI systems*, available at https://ico.org.uk/about-the-ico/news-and-events/ai-blog-data-minimisation-and-privacy-preserving-techniques-in-ai-systems/, accessed 23 June 2022.

Blanchard E. G. (2015), "Socio-cultural imbalances in AIED research: investigations, implications and opportunities", *International Journal of Artificial Intelligence in Education* Vol. *25*, No. 2, pp. 204-28, available at https://doi.org/10.1007/s40593-014-0027-7, accessed 23 June 2022.

Blanchard E. G. et al. (2009), "Affective artificial intelligence in education: from detection to adaptation", *AIED* Vol. 200, pp. 81-88.

Bloom B. S. (1984), "The 2 sigma problem: the search for methods of group instruction as effective as one-to-one tutoring", *Educational Researcher* Vol. 13, No. 6, pp. 4-16.

Boddington P. (2017), *Towards a code of ethics for artificial intelligence research*, Springer, Berlin/Heidelberg.

Borgesius F. Z. (2018), *Discrimination, artificial intelligence and algorithmic decision-making*, Council of Europe, available at www.coe.int/en/web/european-commission-against-racism-and-intolerance/newsroom/-/asset_publisher/U2IWxeHB054o/content/-discrimination-artificial-intelligence-and-algorithmic-decision-making-, accessed 23 June 2022.

Boulay B. (du) (2016), *Artificial intelligence as an effective classroom assistant*, *IEEE Intelligent Systems* Vol. 31, No. 6, pp. 76-81, available at https://doi.org/10.1109/MIS.2016.93, accessed 23 June 2022.

Boulay B. (du) et al. (2018), "What does the research say about how artificial intelligence and big data can close the achievement gap?", in Luckin R. (ed.), *Enhancing learning and teaching with technology*, pp. 256-85, UCL Institute of Education Press, London.

Brown L. X. Z. (2020), *How automated test proctoring software discriminates against disabled students*, Center for Democracy & Technology, available at https://cdt.org/insights/how-automated-test-proctoring-software-discriminates-against-disabled-students/, accessed 23 June 2022.

Bryant J. et al. (2020), *How artificial intelligence will impact K-12 teachers*, McKinsey, available at www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers, accessed 23 June 2022.

Bughin J., Manyika J. and Woetzel J. (2017), *Jobs lost, jobs gained: workforce transitions in a time of automation*, McKinsey Global Institute, available at https://www.mckinsey.com/~/media/mckinsey/industries/public%20and%20social%20sector/our%20insights/what%20the%20future%20of%20work%20will%20mean%20for%20

jobs%20skills%20and%20wages/mgi-jobs-lost-jobs-gained-executive-summary-december-6-2017.pdf, accessed 23 June 2022.

Buolamwini J. and Gebru T. (2018), "Gender shades: intersectional accuracy disparities in commercial gender classification", *Conference on Fairness, Accountability, and Transparency*, pp. 77-91, available at https://proceedings.mlr.press/v81/buolamwini18a/buolamwini18a.pdf, accessed 23 June 2022.

Byrne R. et al. (2010), "eGrader, a software application that automatically scores student essays: with a postscript on ethical complexities", *Undefined*, available at www.semanticscholar.org/paper/eGrader%2C-a-software-application-that-automatically-Byrne-Tang/6a800257bbb62df104e8595cea4dc73ccf4d2b54, accessed 23 June 2022.

Canto M. (2019), *Brazil – We don't need no observation: the use and regulation of facial recognition in Brazilian public schools*, Global Information Society Watch, available at https://giswatch.org/node/6159, accessed 23 June 2022.

Carrel A. (2018), "Legal intelligence through artificial intelligence requires emotional intelligence: a new competency model for the 21st century legal professional", *Georgia State University Law Review* Vol. 35, No. 4, p. 1153-83.

Centre for Data Ethics and Innovation (2020), *Review into bias in algorithmic decision-making*, p. 151, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957259/Review_into_bias_in_algorithmic_decision-making.pdf, accessed 23 June 2022.

Chander S. and Jakubowska E. (2020), *Attention EU regulators: we need more than AI "ethics" to keep us safe*, Access Now, available at www.accessnow.org/eu-regulations-ai-ethics/, accessed 23 June 2022.

Chassignol M. et al. (2018), "Artificial intelligence trends in education: a narrative overview", *Procedia Computer Science* Vol.136, pp. 16-24.

Chounta I.-A. et al. (2021), "Exploring teachers' perceptions of artificial intelligence as a tool to support their practice in Estonian K-12 education", *International Journal of Artificial Intelligence in Education*, pp. 1-31, available at https://doi.org/10.1007/s40593-021-00243-5, accessed 23 June 2022.

Chrysafiadi K. and Virvou M. (2013), "Student modeling approaches: a literature review for the last decade", *Expert Systems with Applications* Vol. 40, No. 11, pp. 4715-29, available at https://doi.org/10.1016/j.eswa.2013.02.007, accessed 23 June 2022.

Clegg J. and Afitska O. (2011), "Teaching and learning in two languages in African classrooms", *Comparative Education* Vol. 47, No. 1, pp. 61-77, available at https://doi.org/10.1080/03050068.2011.541677, accessed 23 June 2022.

Collinson J. and Persson J. (2021), *A reflection on the UNCRC Best Interests of the Child principle in the context of The Age Appropriate Design Code*, defenddigitalme, available at https://defenddigitalme.org/wp-content/uploads/2021/10/A-Reflection-on-the-Best-Interests-of-the-Child-in-the-context-of-the-Age-Appropriate-Design-Code-05102021-v2.0.pdf, accessed 23 June 2022.

Conati C., Porayska-Pomsta K. and Mavrikis M. (2018), *AI in education needs interpretable machine learning: lessons from open learner modelling*, ArXiv:1807.00154 [Cs], available at http://arxiv.org/abs/1807.00154, accessed 23 June 2022.

Conijn R. et al. (2022), "The fear of big brother: the potential negative side-effects of proctored exams", *Journal of Computer Assisted Learning*, pp. 1-14, available at https://doi.org/10.1111/jcal.12651, accessed 23 June 2022.

Connolly R. (2020), "Why computing belongs within the social sciences", *Communications of the ACM* Vol. 63, No. 8, pp. 54-59, available at https://doi.org/10.1145/3383444, accessed 23 June 2022.

Corbett A. T. et al. (1997), "Intelligent tutoring systems", in *Handbook of human-computer interaction* (2nd edn), pp. 849-74, Elsevier, Amsterdam.

Cotterell R. et al. (2020), *Are all languages equally hard to language-model?*, ArXiv:1806.03743 [Cs], available at http://arxiv.org/abs/1806.03743, accessed 23 June 2022.

Council of Europe (2010), Charter on Education for Democratic Citizenship and Human Rights Education: Recommendation CM/Rec(2010)7 adopted by the Committee of Ministers of the Council of Europe on 11 May 2010 and explanatory memorandum, Council of Europe, Strasbourg.

Council of Europe Commissioner for Human Rights (2019), *Unboxing artificial intelligence: 10 steps to protect human rights*, available at https://rm.coe.int/unboxing-artificial-intelligence-10-steps-to-protect-human-rights-reco/1680946e64, accessed 23 June 2022.

Crawford K. (2021), *Atlas of AI: power, politics, and the planetary costs of artificial intelligence*, Yale University Press, New Haven, CT.

Cui Y. (2020), "The high-level seminar on AI and rule of law yields fruitful theoretical results, leading the direction of development", in *Artificial intelligence and judicial modernization*, pp. 193-99, Springer Singapore, available at https://doi.org/10.1007/978-981-32-9880-4_15, accessed 23 June 2022.

Cyndecka M. A. (2020), *A dystopian story about Covid-19, artificial intelligence setting grades and the GDPR*, EFTA-Studies, available at www.efta-studies.org/post/a-dystopian-story-about-covid-19-artificial-intelligence-setting-grades-and-the-gdpr, accessed 23 June 2022.

Dalipi F., Imran A. S. and Kastrati Z. (2018), *MOOC dropout prediction using machine learning techniques: review and research challenges*, 2018 IEEE Global Engineering Education Conference (EDUCON), pp. 1007-14, available at https://doi.org/10.1109/EDUCON.2018.8363340, accessed 23 June 2022.

Davies H. C., Eynon R. and Salveson C. (2020), "The mobilisation of AI in education: a Bourdieusean field analysis", *Sociology*, available at https://doi.org/10.1177/0038038520967888, accessed 23 June 2022.

defend digital me (2020), *The state of data report 2020: mapping a child's digital footprint in the state education landscape in England*, available at https://defenddigitalme.org/research/the-state-of-data-2020/report/, accessed 23 June 2022.

Dennis M. J. (2018), "Artificial intelligence and recruitment, admission, progression, and retention", *Enrollment Management Report* Vol. 22, No. 9, pp. 1-3, available at https://doi.org/10.1002/emt.30479, accessed 23 June 2022.

Dewey J. (1903), "Democracy in education", *The Elementary School Teacher* Vol. 4, No. 4, pp. 193-204.

Diamond L. (2019), "The road to digital unfreedom: the threat of postmodern totalitarianism", *Journal of Democracy* Vol. 30, No. 1, pp. 20-24.

Drigas A. S. and Ioannidou R.-E. (2013), "A review on artificial intelligence in special education", in Lytras D. M. et al. (eds), *Information systems, e-learning, and knowledge management research* Vol. 278, pp. 385-91, Springer, Berlin/Heidelberg, available at https://doi.org/10.1007/978-3-642-35879-1_46, accessed 23 June 2022.

Egelandsdal K. et al. (2019), *Adaptiv læring i matematikk: empirisk rapport om Multi Smart Øving i grunnskolen* [*Adaptive learning in mathematics: empirical report on the Multi Smart intervention in primary schools*], Centre for the Science of Learning & Technology (SLATE), University of Bergen, available at https://bora.uib.no/bora-xmlui/handle/1956/21354, accessed 23 June 2022.

Elliot M. et al. (2018), "Functional anonymisation: personal data and the data environment", *Computer Law & Security Review* Vol. 34, No. 2, pp. 204-21, available at https://doi.org/10.1016/j.clsr.2018.02.001, accessed 23 June 2022.

Entwistle N. (2000), *Promoting deep learning through teaching and assessment – Conceptual frameworks and educational contexts*, TLRP Conference, Leicester, available at www.etl.tla.ed.ac.uk/docs/entwistle2000.pdf, accessed 23 June 2022.

Everett C. (2020), *UK A-level algorithm fiasco a global example of what not to do – What went wrong and why*, Diginomica, available at http://diginomica.com/uk-level-algorithm-fiasco-global-example-what-not-do-what-went-wrong-and-why, accessed 23 June 2022.

Evgeniou T., Hardoon D. R. and Ovchinnikov A. (2020), "What happens when AI is used to set grades?", *Harvard Business Review*, 13 August, available at https://hbr.org/2020/08/what-happens-when-ai-is-used-to-set-grades, accessed 23 June 2022.

Eynon R. and Young E. (2021), "Methodology, legend, and rhetoric: the constructions of AI by academia, industry, and policy groups for lifelong learning", *Science, Technology, & Human Values* Vol. 46, No. 1, pp. 166-91, available at https://doi.org/10.1177/0162243920906475, accessed 23 June 2022.

Feng W., Tang J. and Liu T. X. (2019), "Understanding dropouts in MOOCs", *Proceedings of the AAAI Conference on Artificial Intelligence* Vol. 33, No. 01, pp. 517-24, available at https://doi.org/10.1609/aaai.v33i01.3301517, accessed 23 June 2022.

Ferguson R. et al. (2016), *Research evidence on the use of learning analytics: implications for education policy*, JRC Science for Policy report, European Commission, Luxembourg.

Frey C. B. and Osborne M. A. (2013), *The future of employment: how susceptible are jobs to computerisation?* Machines and employment workshop, Oxford University, Oxford.

Gagné R. M. and Brown L. T. (1963), "Some factors in the programming of conceptual learning", *Journal of Experimental Psychology* Vol. 62, No. 4, pp. 313-21, available at https://doi.org/10.1037/h0049210, accessed 23 June 2022.

Gent E. (2019), *The "ghost work" powering tech magic*, BBC – Worklife 101, available at www.bbc.com/worklife/article/20190829-the-ghost-work-powering-tech-magic, accessed 23 June 2022.

Gobert J. D. et al. (2013), "From log files to assessment metrics: measuring students' science inquiry skills using educational data mining", *Journal of the Learning Sciences* Vol. 22, No. 4, pp. 521-63.

Gobert J. D. et al. (2018), "Real-time scaffolding of students' online data interpretation during inquiry with Inq-ITS using educational data mining", in Auer M. E. et al. (eds), *Cyber-physical laboratories in engineering and science education* (pp. 191-217), Springer International.

Goel Y. and Goyal R. (2020), "On the effectiveness of self-training in MOOC dropout prediction", *Open Computer Science* Vol. 10, No. 1, pp. 246-58, available at https://doi.org/10.1515/comp-2020-0153, accessed 23 June 2022.

Gottschalk F. (2019), *Impacts of technology use on children – Exploring literature on the brain, cognition and well-being*, OECD Education Working Papers No. 195, OECD, available at https://doi.org/10.1787/8296464e-en, accessed 23 June 2022.

Gray J. (2017), "University of Buckingham to monitor students' social media accounts to tackle depression and suicide", *HuffPost UK*, available at www.huffingtonpost.co.uk/entry/university-of-buckingham-students-social-media-accounts-depression-suicide_uk_588b5196e4b02f223a01a178, accessed 23 June 2022.

Griffith A. E. et al. (2021), "Discovering co-creative dialogue states during collaborative learning", *International Conference on Artificial Intelligence in Education*, pp. 165-177.

Hager G. D. et al. (2019), *Artificial intelligence for social good*, ArXiv:1901.05406 [Cs], available at https://doi.org/10.48550/arXiv.1901.05406, accessed 23 June 2022.

Heaven W. D. (2019), "Why deep-learning AIs are so easy to fool", *Nature* Vol. 574, No. 7777, pp. 163-66, available at https://doi.org/10.1038/d41586-019-03013-5, accessed 23 June 2022.

Heaven W. D. (2021), "Hundreds of AI tools have been built to catch covid. None of them helped", *MIT Technology Review*, available at www.technologyreview.com/2021/07/30/1030329/machine-learning-ai-failed-covid-hospital-diagnosis-pandemic/, accessed 23 June 2022.

Heimans S., Singh P. and Kwok H. (2021), "Pedagogic rights, public education and democracy", *European Educational Research Journal*, available at https://doi.org/10.1177/14749041211011920, accessed 23 June 2022.

Hendry J. (2018), "Govts dump NAPLAN robo marking plans", *ITnews*, available at www.itnews.com.au/news/govts-dump-naplan-robo-marking-plans-482044, accessed 23 June 2022.

Hickey S. and Hossain N. (2019), *The politics of education in developing countries: from schooling to learning*, OUP Oxford, available at https://books.google.co.uk/books?id=gMKKDwAAQBAJ, accessed 23 June 2022.

Hildebrandt M. (2015), *Smart technologies and the end(s) of law: novel entanglements of law and technology*, available at https://doi.org/10.4337/9781849808774, accessed 23 June 2022.

Hildebrandt M. (2019), "10. 'Legal by Design' or 'Legal Protection by Design'?", *Law for Computer Scientists*, available at https://lawforcomputerscientists.pubpub.org/pub/gfzd6k0g/release/12, accessed 23 June 2022.

Hilton A. D. (2019), "Artificial intelligence: the societal responsibility to inform, educate, and regulate", *AI Matters* Vol. 5, No. 3, pp. 70-76, available at https://doi.org/10.1145/3362077.3362088, accessed 23 June 2022.

Holmes W. (2020), *The right kind of AI in education*, Nesta, available at www.nesta.org.uk/blog/right-kind-ai-education/, accessed 23 June 2022.

Holmes W. and Porayska-Pomsta K. (eds) (2022), *The ethics of artificial intelligence in education: practices, challenges, and debates*, Routledge, New York.

Holmes W. et al. (2018), *Technology-enhanced personalised learning: untangling the evidence*, Robert Bosch Stiftung, available at www.bosch-stiftung.de/sites/default/files/publications/pdf/2018-08/Study_Technology-enhanced%20Personalised%20Learning.pdf, accessed 23 June 2022.

Holmes W., Bialik M. and Fadel C. (2019), *Artificial intelligence in education: promises and implications for teaching and learning*, Center for Curriculum Redesign, available at https://drive.google.com/file/d/1lmzlbhKvYyRB6J0USCndqXitmVgsfTbI/view, accessed 23 June 2022.

Holmes W. et al. (2021), "Ethics of AI in education: towards a community-wide framework", *International Journal of Artificial Intelligence in Education*, available at https://link.springer.com/article/10.1007/s40593-021-00239-1, accessed 23 June 2022.

Holstein K. et al. (2018), "The classroom as a dashboard: co-designing wearable cognitive augmentation for K-12 teachers", *Proceedings of the 8th International Conference on Learning Analytics and Knowledge*, pp. 79-88, available at https://dl.acm.org/doi/10.1145/3170358.3170377, accessed 23 June 2022.

Holstein K., McLaren B. M. and Aleven V. (2017), "Intelligent tutors as teachers' aides: exploring teacher needs for real-time analytics in blended classrooms", *Proceedings of the 7th International Conference on Learning Analytics and Knowledge*, pp. 257-66, available at https://doi.org/10.1145/3027385.3027451, accessed 23 June 2022.

Hutson M. (2021), "Robo-writers: the rise and risks of language-generating AI", *Nature* Vol. 591, No. 7848, pp. 22-5, available at https://doi.org/10.1038/d41586-021-00530-0, accessed 23 June 2022.

Hwang G.-J. et al. (2020), *Vision, challenges, roles and research issues of artificial intelligence in education*, Elsevier, Amsterdam.

ITU (2020), *United Nations activities on artificial intelligence (AI) 2020*, ITU Publications, Geneva.

Jarrell A. et al. (2015), "Examining the relationship between performance feedback and emotions in diagnostic reasoning: toward a predictive framework for emotional support", in Conati C. et al. (eds), *Artificial Intelligence in Education* Vol. 9112, pp. 650-53, Springer International Publishing, available at https://doi.org/10.1007/978-3-319-19773-9_83, accessed 23 June 2022.

Järvelä S. et al. (2021), "What multimodal data can tell us about the students' regulation of their learning process?", *Learning and Instruction* Vol. 72, 101203, available at https://doi.org/10.1016/j.learninstruc.2019.04.004, accessed 23 June 2022.

Jivet I. et al. (2017), "Awareness is not enough: pitfalls of learning analytics dashboards in the educational practice", in Lavoué É. et al. (eds), *Data driven approaches in digital education*, pp. 82-96, Springer International Publishing, available at https://doi.org/10.1007/978-3-319-66610-5_7, accessed 23 June 2022.

Jobin A., Ienca M. and Vayena E. (2019), "Artificial intelligence: the global landscape of ethics guidelines", *Nature Machine Intelligence* Vol. 1, No. 9, 389-99, available at https://doi.org/10.1038/s42256-019-0088-2, accessed 23 June 2022.

Johnson B. and Shen F. X. (2021), "Teaching law and artificial intelligence", *Minnesota Journal of Law, Science & Technology* Vol. 22, No. 2, pp. 23-42.

Kapur M. (2008), "Productive failure", *Cognition and Instruction* Vol. 26, No. 3, pp. 379-424, available at https://doi.org/10.1080/07370000802212669, accessed 23 June 2022.

Karr V. (2009), *It's about ability: learning guide on the Convention on the Rights of Persons with Disabilities*, UNICEF, available at www.unicef.org/media/85751/file/Its_About_Ability_Learning_Guide_EN.pdf, accessed 23 June 2022.

Kerr I. R. (2017), *The devil is in the defaults*, Social Science Research Network, SSRN Scholarly Paper ID 3395383, available at https://papers.ssrn.com/abstract=3395383, accessed 23 June 2022.

King P. and Persson J. (2022), *The state of biometrics 2022: a review of policy and practice around biometric data in UK education*, defenddigitalme, available at https://defenddigitalme.org/research/state-biometrics-2022, accessed 23 June 2022.

Knight S. et al. (2018), "Designing academic writing analytics for civil law student self-assessment", *International Journal of Artificial Intelligence in Education* Vol. 28, No. 1, pp. 1-28, available at https://doi.org/10.1007/s40593-016-0121-0, accessed 25 June 2022.

Knox J. (2020), "Artificial intelligence and education in China", *Learning, Media and Technology* Vol. 45, No. 3, pp. 298-311.

Kohli M. and Prasad T. V. (2010), "Identifying dyslexic students by using artificial neural networks", *Proceedings of the World Congress on Engineering* Vol. 1, No. 1, pp. 1-4.

Kokotsaki D., Menzies V. and Wiggins A. (2016), "Project-based learning: a review of the literature", *Improving Schools* Vol. 19, No. 3, pp. 267-77, available at https://doi.org/10.1177/1365480216659733, accessed 25 June 2022.

Komljenovic J. (2021), "The rise of education rentiers: digital platforms, digital data and rents", *Learning, Media and Technology* Vol. 46, No. 3, pp. 320-32, available at https://doi.org/10.1080/17439884.2021.1891422, accessed 25 June 2022.

Korff D. and Georges M. (2020), "The origins and meaning of data protection", *SSRN Electronic Journal*, available at https://doi.org/10.2139/ssrn.3518386, accessed 25 June 2022.

Kosmyna N. and Maes P. (2019), "Attentivu: an EEG-based closed-loop biofeedback system for real-time monitoring and improvement of engagement for personalized learning", *Sensors* Vol. 19, No. 23, p. 5200.

Kucirkova N. and Littleton K. (2017), "Developing personalised education for personal mobile technologies with the pluralisation agenda", *Oxford Review of Education* Vol. 43, No. 3, pp. 276-88.

Kurzweil R. (2006), *The Singularity is near: when humans transcend biology*, Duckworth, London.

Kynigos C. (2019), *Adaptive learning in mathematics: situating Multi Smart Øving in the landscape of digital technologies for mathematics education*, Centre for the Science of Learning & Technology (SLATE), University of Bergen, available at https://bora.uib.no/bora-xmlui/handle/1956/21352, accessed 25 June 2022.

Leaton Gray S. H. and Kucirkova N. (2018), "A united and thriving Europe? A sociology of the European Schools" and "If personalised education and artificial intelligence are a democratic problem, could pluralisation be the democratic solution?" British Educational Research Association conference, Newcastle, 11-13 September.

Ledford H. (2019), "Millions of black people affected by racial bias in health-care algorithms", *Nature* Vol. 574, No. 7780, pp. 608-9, available at https://doi.org/10.1038/d41586-019-03228-6, accessed 25 June 2022.

Leslie D. et al. (2021), *Artificial intelligence, human rights, democracy, and the rule of law: a primer*, Council of Europe, available at www.ssrn.com/abstract=3817999, accessed 25 June 2022.

Lovato S. B., Piper A. M. and Wartella E. A. (2019), "Hey Google, do unicorns exist?": conversational agents as a path to answers to children's questions", *Proceedings of the 18th ACM International Conference on Interaction Design and Children, IDC 2019*, pp. 301-13, available at https://doi.org/10.1145/3311927.3323150, accessed 25 June 2022.

Lundy L. (2021), *Human rights law – The speckled bird of educational research?* European Educational Research Association, available at https://blog.eera-ecer.de/human-rights-in-educational-research, accessed 25 June 2022.

Lundy L. et al. (2019), *Two clicks forward and one click back: report on children with disabilities in the digital environment*, Council of Europe, available at https://rm.coe.int/two-clicks-forward-and-one-click-back-report-on-children-with-disabili/168098bd0f, accessed 25 June 2022.

Lupton D. and Williamson B. (2017), "The datafied child: the dataveillance of children and implications for their rights", *New Media & Society* Vol. 19, No. 5, pp. 780-94, available at https://doi.org/10.1177/1461444816686328, accessed 25 June 2022.

Lynch C. et al. (2007), "Argument diagramming as focusing device: does it scaffold reading", *Proceedings of the AIED Workshop on Applications for Ill-Defined Domains*, pp. 51-60.

Ma W. et al. (2014), "Intelligent tutoring systems and learning outcomes: a meta-analysis", *Journal of Educational Psychology* Vol. 106, No. 4, 901-18.

Macfarlane B. (2003), *Teaching with integrity: the ethics of higher education practice*, Routledge, Abingdon, Oxon/New York, NY.

McLaren B. M. and Scheuer O. (2010), "Supporting collaborative learning and e-discussions using artificial intelligence techniques", *International Journal of Artificial Intelligence in Education* Vol. 20, No. 1, pp. 1-46.

McMorrow R. et al. (2021), "China's education sector crackdown hits foreign investors", *Financial Times*, 26 July, available at www.ft.com/content/dfae3282-e14e-4fea-aa5f-c2e914444fb8, accessed 25 June 2022.

Majumdar B. et al. (2018), "Technology: artificial intelligence", *British Dental Journal*, Vol. 224, No. 12, p. 916.

Marcinkowski F. et al. (2020), "Implications of AI (un-)fairness in higher education admissions: the effects of perceived AI (un-)fairness on exit, voice and organizational reputation", *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency*, pp. 122-30, available at https://doi.org/10.1145/3351095.3372867, accessed 25 June 2022.

Marcus G. (2020), *The next decade in AI: four steps towards robust artificial intelligence*, ArXiv:2002.06177 [Cs], available at http://arxiv.org/abs/2002.06177, accessed 25 June 2022.

Marcus G. and Davis E. (2020), "GPT-3, Bloviator: OpenAI's language generator has no idea what it's talking about", *MIT Technology Review*, available at www.technologyreview.com/2020/08/22/1007539/gpt3-openai-language-generator-artificial-intelligence-ai-opinion/, accessed 25 June 2022.

Markauskaite L. et al. (2022), "Rethinking the entwinement between artificial intelligence and human learning: what capabilities do learners need for a world with AI?", *Computers and Education: Artificial Intelligence* Vol. 3, 100056. https://doi.org/10.1016/j.caeai.2022.100056, accessed 25 June 2022.

Martinez-Maldonado R. et al. (2021), "Moodoo the tracker: spatial classroom analytics for characterising teachers' pedagogical approaches", *International Journal of Artificial Intelligence in Education*", available at https://doi.org/10.1007/s40593-021-00276-w, accessed 25 June 2022.

Matsushita K. (2018), "An invitation to deep active learning", in Matsushita K. (ed.), *Deep active learning: toward greater depth in university education*, pp. 15-33, Springer, available at https://doi.org/10.1007/978-981-10-5660-4_2, accessed 25 June 2022.

Mendicino M., Razzaq L. M. and Heffernan N. (2009), "A comparison of traditional homework to computer-supported homework", *Journal of Research on Technology in Education* Vol. 41, No. 3, pp. 331-59, available at https://doi.org/10.1080/15391523.2009.10782534, accessed 25 June 2022.

Miao F. and Holmes W. (2021a), *AI and education: guidance for policy-makers*, UNESCO, available at https://unesdoc.unesco.org/ark:/48223/pf0000376709, accessed 25 June 2022.

Miao F. and Holmes W. (2021b), *Beyond disruption: technology enabled learning futures; 2020 edition of Mobile Learning Week*, UNESCO, available at https://unesdoc.unesco.org/ark:/48223/pf0000377753, accessed 25 June 2022.

Miao F. and Holmes W. (2022), *International Forum on AI and Education – Ensuring AI as a common good to transform education, 7-8 December 2021; synthesis report*. UNESCO, available at https://unesdoc.unesco.org/ark:/48223/pf0000381226, accessed 25 June 2022.

Miao F. et al. (2019), *Guidelines on the development of open educational resources policies*, UNESCO and Commonwealth of Learning, available at https://unesdoc.unesco.org/ark:/48223/pf0000371129, accessed 25 June 2022.

Miao F. and Shiohira K. (2022), *K-12 AI curricula: a mapping of government-endorsed AI curricula*, UNESCO.

Molenaar I., Horvers A. and Baker R. S. (2021), "What can moment-by-moment learning curves tell about students' self-regulated learning?", *Learning and Instruction* Vol. 72, 101206, https://doi.org/10.1016/j.learninstruc.2019.05.003, accessed 25 June 2022.

Morozov E. (2014), *To save everything, click here: technology, solutionism, and the urge to fix problems that don't exist*, Penguin, London.

Naismith B. and Juffs A. (2021), "Finding the sweet spot: learners' productive knowledge of mid-frequency lexical items", *Language Teaching Research*, available at https://doi.org/10.1177/13621688211020412, accessed 25 June 2022.

Nazaretsky T., Cukurova M. and Alexandron G. (2021), "An instrument for measuring teachers' trust in AI-based educational technology", *LAK22: 12th International Learning Analytics and Knowledge Conference*, pp. 56-66.

Nemitz P. (2018), "Constitutional democracy and technology in the age of artificial intelligence", *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* Vol. 376, No. 2133, available at https://doi.org/10.1098/rsta.2018.0089, accessed 25 June 2022.

Nemorin S. (2017), "Affective capture in digital school spaces and the modulation of student subjectivities", *Emotion, Space and Society* Vol. 24, pp. 11-18.

OECD (2021), *OECD Digital Education Outlook 2021: pushing the frontiers with artificial intelligence, blockchain and robots*, OECD, available at https://doi.org/10.1787/589b283f-en, accessed 25 June 2022.

Olney A. M. et al. (2017), "Assessing the dialogic properties of classroom discourse: proportion models for imbalanced classes", in Hu X et al. (eds), *Proceedings of the 10th International Conference on Educational Data Mining*, pp. 162-67.

O'Neil C. (2017), *Weapons of math destruction: how big data increases inequality and threatens democracy* (01 edition), Penguin, London.

Page L. C. and Gehlbach H. (2017), "How an artificially intelligent virtual assistant helps students navigate the road to college", *AERA Open* Vol. 3, No. 4, available at https://doi.org/10.1177/2332858417749220, accessed 25 June 2022.

Pane J. F. et al. (2010), "An experiment to evaluate the efficacy of cognitive tutor geometry", *Journal of Research on Educational Effectiveness* Vol. 3, No. 3, pp. 254-81.

Pardo A. et al. (2019), "Using learning analytics to scale the provision of personalised feedback", *British Journal of Educational Technology* Vol. 50, No. 1, pp. 128-38.

Parson E. et al. (2019), *Artificial intelligence in strategic context: an introduction*, UCLA: The Program on Understanding Law, Science, and Evidence (PULSE), available at https://escholarship.org/uc/item/9c8651s6, accessed 25 June 2022.

Pekrun R. (2014), "Emotions and learning", *Educational Practices Series* Vol. 24, No. 1, pp. 1-31.

Pérez-Ortiz M. et al. (2020), *An AI-based learning companion promoting lifelong learning opportunities for all* (Opinion Series Report), International Research Centre on Artificial Intelligence under the auspices of UNESCO, available at https://ircai.org/project/ai-based-learning-companion-promoting-lifelong-learning/, accessed 25 June 2022.

Peters R. S. (1970), *Ethics and education*, Allen & Unwin, London.

Pinkwart N. (2016), "Another 25 years of AIED? Challenges and opportunities for intelligent educational technologies of the future", *International Journal of Artificial Intelligence in Education* Vol. 26, No. 2, pp. 771-83.

Popenici S. A. D. and Kerr S. (2017), "Exploring the impact of artificial intelligence on teaching and learning in higher education", *Research and Practice in Technology Enhanced Learning* Vol. 12, No. 22, available at https://doi.org/10.1186/s41039-017-0062-8, accessed 25 June 2022.

Porayska-Pomsta K. et al. (2018), "Blending human and artificial intelligence to support autistic children's social communication skills", *ACM Transactions on Computer-Human Interaction (TOCHI)* Vol. 25, No. 6, pp. 1-35.

Powles J. (2018), "The seductive diversion of 'solving' bias in artificial intelligence", *OneZero*, available at https://onezero.medium.com/the-seductive-diversion-of-solving-bias-in-artificial-intelligence-890df5e5ef53, accessed 25 June 2022.

Prates M. O. R., Avelar P. H. C. and Lamb L. (2019), *Assessing gender bias in machine translation – A case study with Google Translate*, ArXiv:1809.02208 [Cs], available at http://arxiv.org/abs/1809.02208, accessed 25 June 2022.

Raval N. (2019), *Artificial intelligence: human rights, social justice and development*, Global Information Society Watch 2019, Association for Progressive Communications.

Rehak R. (2021), "The language labyrinth: constructive critique on the terminology used in the AI discourse", in Verdegem P. (ed.), *AI for everyone?*, University of Westminster Press, London, available at https://doi.org/10.16997/book55.f, accessed 25 June 2022.

Reynaert D., Bouverne-de-Bie M. and Vandevelde S. (2009), "A review of children's rights literature since the adoption of the United Nations Convention on the Rights of the Child", *Childhood* Vol. 16, No. 4, pp. 518-34, available at https://doi.org/10.1177/0907568209344270, accessed 25 June 2022.

Roberts M. et al. (2021), "Common pitfalls and recommendations for using machine learning to detect and prognosticate for Covid-19 using chest radiographs and CT scans", *Nature Machine Intelligence* Vol. 3, No. 3, pp. 199-217, available at https://doi.org/10.1038/s42256-021-00307-0, accessed 25 June 2022.

Romero A. (2021), "Understanding GPT-3 in 5 minutes", *Medium*, available at https://towardsdatascience.com/understanding-gpt-3-in-5-minutes-7fe35c3a1e52, accessed 25 June 2022.

Roschelle J. et al. (2017), *How big is that? Reporting the effect, size and cost of ASSISTments in the Maine Homework Efficacy Study*, SRI International, Menlo Park, CA.

Rudin C. (2019), "Stop explaining black box machine learning models for high stakes decisions and use interpretable models instead", *Nature Machine Intelligence* Vol. 1, No. 5, pp. 206-15, available at https://doi.org/10.1038/s42256-019-0048-x, accessed 25 June 2022.

Rust R. (2021), "Code the code: surveillance capitalism, education, and the critical theory of technology", West Chester University doctoral dissertation, available at https://digitalcommons.wcupa.edu/all_doctoral/99, accessed 25 June 2022.

Samuel J. et al. (2018), *Beyond STEM, how can women engage big data, analytics, robotics and artificial intelligence? – An exploratory analysis of confidence and educational factors in the emerging technology waves influencing the role of and impact upon women*, SSRN Electronic Journal, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3735279, accessed 25 June 2022.

Sapci A. H. and Sapci H. A. (2020), "Artificial intelligence education and tools for medical and health informatics students: systematic review", *JMIR Medical Education* Vol. 6, No. 1, available at www.ncbi.nlm.nih.gov/pmc/articles/PMC7367541/, accessed 25 June 2022.

Sapiezynski P., Kassarnig V. and Wilson C. (2017), *Academic performance prediction in a gender-imbalanced environment* (Data set), Boise State University, ID, available at https://doi.org/10.18122/B20Q5R, accessed 25 June 2022.

Sayed Y. and Ahmed R. (2011), "Education quality in post-apartheid South African policy: balancing equity, diversity, rights and participation", *Comparative Education* Vol. 47, No. 1, pp. 103-18, available at https://doi.org/10.1080/03050068.2011.541680, accessed 25 June 2022.

Schiff D. (2021), "Out of the laboratory and into the classroom: the future of artificial intelligence in education", *AI & Society* Vol. 36, pp. 331-48, available at https://doi.org/10.1007/s00146-020-01033-8, accessed 25 June 2022.

Schwemer S. F., Tomada L. and Pasini T. (2021), "Legal AI systems in the EU's proposed Artificial Intelligence Act", *Proceedings of the Second International Workshop on AI and Intelligent Assistance for Legal Professionals in the Digital Workplace (LegalAIIA 2021),* held in conjunction with ICAIL.

Sclater N. (2016), *Learning analytics in higher education: a review of UK and international practice – Data analytics*, JISC, available at https://analytics.jiscinvolve.org/wp/2016/04/19/learning-analytics-in-higher-education-a-review-of-uk-and-international-practice/, accessed 25 June 2022.

Sehr D. T. (1997), *Education for public democracy*, Suny Press, Albany, NY.

Seldon A. and Abidoye O. (2018), *The fourth education revolution: will artificial intelligence liberate or infantilise humanity?* The University of Buckingham Press, London.

Silapachote P. and Srisuphab A. (2016), "Teaching and learning computational thinking through solving problems in artificial intelligence: on designing introductory engineering and computing courses", *2016 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, pp. 50-54.

Stevens E. et al. (2019), "Identification and analysis of behavioral phenotypes in autism spectrum disorder via unsupervised machine learning", *International Journal of Medical Informatics* Vol. 129, pp. 29-36, available at https://doi.org/10.1016/j.ijmedinf.2019.05.006, accessed 25 June 2022.

Stewart A. and D'Mello S. K. (2018), "Connecting the dots towards collaborative AIED: linking group makeup to process to learning", *International Conference on Artificial Intelligence in Education*, pp. 545-56.

Stitzlein S. M. (2017), *American public education and the responsibility of its citizens: supporting democracy in the age of accountability*, Oxford University Press, Oxford.

Sujon Z. (2019), "Disruptive play or platform colonialism? The contradictory dynamics of Google expeditions and educational virtual reality", *Digital Culture & Education* Vol. 11(1), available at https://www.digitalcultureandeducation.com/volume-11-papers/disruptive-play-or-platform-colonialism-the-contradictory-dynamics-of-google-expeditions-and-educational-virtual-reality, accessed 25 June 2022.

Surden H. (2019), "Artificial intelligence and law: an overview", *Georgia State University Law Review* Vol. 35, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3411869#, accessed 25 June 2022.

Suresh H. and Guttag J. V. (2019), "A framework for understanding unintended consequences of machine learning", *ArXiv Preprint*, *ArXiv:1901.10002*, available at https://arxiv.org/abs/1901.10002, accessed 25 June 2022.

Susskind R. and Susskind D. (2015), *The future of the professions: how technology will transform the work of human experts* (1st edn), Oxford University Press, Oxford.

Thompson G. and Cook I. (2017), "The logic of data-sense: thinking through learning personalisation", *Discourse: studies in the cultural politics of education* Vol. 38, No. 5, pp. 740-54, available at https://doi.org/10.1080/01596306.2016.1148833, accessed 25 June 2022.

Tuomi I. (2018), *The impact of artificial intelligence on learning, teaching, and education*, Publications Office of the European Union, Luxembourg, available at https://publications.jrc.ec.europa.eu/repository/bitstream/JRC113226/jrc113226_jrcb4_the_impact_of_artificial_intelligence_on_learning_final_2.pdf, accessed 25 June 2022.

UNDP (2020), *The next frontier: human development and the Anthropocene*, United Nations Development Programme.

UNICEF (2021), *Policy guidance on AI for children*, available at www.unicef.org/globalinsight/media/2356/file/UNICEF-Global-Insight-policy-guidance-AI-children-2.0-2021.pdf.pdf, accessed 25 June 2022.

UNICEF and UNESCO (2007), *A human rights-based approach to education for all*, UNICEF.

United Nations (1992), *Declaration on the Rights of Persons Belonging to National or Ethnic, Religious and Linguistic Minorities*, available at www.ohchr.org/en/

instruments-mechanisms/instruments/declaration-rights-persons-belonging-national-or-ethnic, accessed 25 June 2022.

United Nations (2011), *Guiding Principles on Business and Human Rights – Implementing the United Nations "Protect, Respect and Remedy" Framework*, available at www.ohchr.org/documents/publications/guidingprinciplesbusinesshr_en.pdf, accessed 25 June 2022.

Van Der Hof S. et al. (2020), "The child's right to protection against economic exploitation in the digital world", *International Journal of Children's Rights* Vol. 28, No. 4, pp. 833-59.

VanLehn K. et al. (2005), "The Andes physics tutoring system: lessons learned", *International Journal of Artificial Intelligence in Education* Vol. 15, No. 3, pp. 147-204.

Veale M. and Borgesius F. Z. (2021), *Demystifying the Draft EU Artificial Intelligence Act*, ArXiv:2107.03721 [Cs], available at https://doi.org/10.9785/cri-2021-220402, accessed 25 June 2022.

Vuorikari R. and Holmes W. (2022), "DigComp 2.2. Annex 2. Citizens Interacting with AI systems", in Vuorikari R., Kluzer S. and Punie Y. (eds), *DigComp 2.2, The Digital Competence Framework for Citizens: with new examples of knowledge, skills and attitudes* (pp. 72-82), Publications Office of the European Union, available at https://data.europa.eu/doi/10.2760/115376, accessed 25 June 2022.

Vuorikari R., Kluzer S. and Punie Y. (2022), *DigComp 2.2: The Digital Competence Framework for Citizens: with new examples of knowledge, skills and attitudes* (EUR 31006 EN), EU Joint Research Centre, available at https://publications.jrc.ec.europa.eu/repository/handle/JRC128415, accessed 25 June 2022.

Walleser E. (2021), "When the world needed it most, artificial intelligence failed: how Covid-19 poked holes in AI", *Towards Data Science*, available at https://towardsdatascience.com/when-the-world-needed-it-most-artificial-intelligence-failed-how-covid-19-poked-holes-in-ai-38b742ddc222, accessed 25 June 2022.

Wasson B. (1997), "Advanced educational technologies: the learning environment", *Computers in Human Behavior* Vol. 13, No. 4, pp. 571-94, available at https://doi.org/10.1016/S0747-5632(97)00027-7, accessed 25 June 2022.

Waters A. and Miikkulainen R. (2014), "GRADE: machine learning support for graduate admissions", *AI Magazine* Vol. 35, No. 1, p. 64, available at https://doi.org/10.1609/aimag.v35i1.2504, accessed 25 June 2022.

Watters A. (2021), *Teaching machines*, MIT Press, Cambridge, MA.

West S. M., Whittaker M. and Crawford K. (2019), *Discriminating systems: gender, race and power in AI*, AI Now Institute, available at https://ainowinstitute.org/discriminatingsystems.pdf, accessed 25 June 2022.

Whittaker M. et al. (2018), *AI Now Report 2018*, AI Now Institute, New York University, NY.

Williamson B. (2019), "Datafication of education: a critical approach to emerging analytics technologies and practices", in Beetham H. and Sharpe R. (eds), *Rethinking pedagogy for a digital age*, pp. 212-26, available at https://doi.org/10.4324/9781351252805-14, accessed 25 June 2022.

Williamson B. (2020), "New digital laboratories of experimental knowledge production: artificial intelligence and education research", *London Review of Education* Vol. 18, No. 2, pp. 209-20.

Williamson B. and Eynon R. (2020), "Historical threads, missing links, and future directions in AI in education", *Learning, Media and Technology* Vol. 45, No. 3, pp. 223-35, available at https://www.tandfonline.com/doi/full/10.1080/17439884.2020.1798995, accessed 25 June 2022.

Winfield A. F. T. and Jirotka M. (2018), "Ethical governance is essential to building trust in robotics and artificial intelligence systems", *Philosophical Transactions of the Royal Society A* Vol. 376, No. 2133, available at https://doi.org/10.1098/rsta.2018.0085, accessed 25 June 2022.

Wollny S. et al. (2021), "Are we there yet? A systematic literature review on chatbots in education", *Frontiers in Artificial Intelligence* Vol. 4, available at www.frontiersin.org/article/10.3389/frai.2021.654924, accessed 25 June 2022.

Woolf B. P. (2010), *Building intelligent interactive tutors: student-centered strategies for revolutionizing e-learning*, Morgan Kaufmann, Burlington, MA.

World Economic Forum (2015), *New vision for education: unlocking the potential of technology*, World Economic Forum, available at www3.weforum.org/docs/WEFUSA_NewVisionforEducation_Report2015.pdf, accessed 25 June 2022.

Yeung K. (2020), "Recommendation of the council on artificial intelligence (OECD)", *International Legal Materials* Vol. 59, No. 1, pp. 27-34.

Zanzotto F. M. (2019), "Human-in-the-loop artificial intelligence", *Journal of Artificial Intelligence Research* Vol. 64, pp. 243-52.

Zawacki-Richter O. et al. (2019), "Systematic review of research on artificial intelligence applications in higher education – Where are the educators?", *International Journal of Educational Technology in Higher Education* Vol. 16, No. 39, available at https://doi.org/10.1186/s41239-019-0171-0, accessed 25 June 2022.

Zeide E. (2019), *Artificial intelligence in higher education: applications, promise and perils, and ethical questions*, Educause, available at https://er.educause.edu/articles/2019/8/artificial-intelligence-in-higher-education-applications-promise-and-perils-and-ethical-questions, accessed 25 June 2022.

Appendix I

Definitions of AI

The following examples are given here to illustrate the range of available definitions of AI.

John McCarthy (who is credited with coining the term artificial intelligence), 1955[129]

> The artificial intelligence problem is taken to be that of making a machine behave in ways that would be called intelligent if a human were so behaving.

Oxford English Dictionary, 2006

> The capacity of computers or other machines to exhibit or simulate intelligent behaviour.

Stanford University, 2016[130]

> A branch of computer science that studies the properties of intelligence by synthesizing intelligence.

OECD, 2019[131]

> An AI system is a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy.

Council of Europe, 2021[132]

> A set of sciences, theories and techniques whose purpose is to reproduce by a machine the cognitive abilities of a human being. Current developments aim, for instance, to be able to entrust a machine with complex tasks previously delegated to a human.

European Union, 2021[133]

> Software that is developed with one or more of the techniques and approaches listed in Annex I and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with.

129. http://www-formal.stanford.edu/jmc/history/dartmouth/dartmouth.html.
130. https://ai100.stanford.edu/2016-report.
131. https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449.
132. www.coe.int/en/web/artificial-intelligence/glossary.
133. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0206.

ANNEX I

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

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

(c) Statistical approaches, Bayesian estimation, search and optimization methods.

Parliamentary Assembly of the Council of Europe, 2021[134]

> Computer-based systems that can perceive and derive data from their environment, and then use statistical algorithms to process that data in order to produce results intended to achieve pre-determined goals. The algorithms consist of rules that may be established by human input, or set by the computer itself, which "trains" the algorithm by analysing massive data sets and continues to refine the rules as new data is received.

UNICEF, 2021[135]

> Machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations, or decisions that influence real or virtual environments. AI systems interact with us and act on our environment, either directly or indirectly. Often, they appear to operate autonomously, and can adapt their behaviour by learning about the context.

UNESCO, 2021[136]

> AI systems are information-processing technologies that integrate models and algorithms that produce a capacity to learn and to perform cognitive tasks leading to outcomes such as prediction and decision-making in material and virtual environments. AI systems are designed to operate with varying degrees of autonomy by means of knowledge modelling and representation and by exploiting data and calculating correlations.

134. https://pace.coe.int/en/pages/artificial-intelligence.
135. www.unicef.org/globalinsight/reports/policy-guidance-ai-children.
136. https://unesdoc.unesco.org/ark:/48223/pf0000381137.

Appendix II

Recent related Council of Europe reports

Artificial intelligence, human rights, democracy, and the rule of law: a primer

Explores AI and the core Council of Europe values – human rights, democracy and the rule of law. Education is not included.

Leslie D., Burr C., Aitken M., Cowls J., Katell M. and Briggs M. (2021), "Artificial intelligence, human rights, democracy, and the rule of law: a primer", Council of Europe, www.turing.ac.uk/research/publications/ai-human-rights-democracy-and-rule-law-primer-prepared-council-europe

Convention 108+ – Convention for the Protection of Individuals with regard to the Processing of Personal Data

Outlines data protection guidelines, but does not directly refer to AI. Some of the issues raised in this report relate to Convention 108.

Council of Europe (2018), Convention 108+ – Convention for the Protection of Individuals with regard to the Processing of Personal Data, https://rm.coe.int/convention-108-convention-for-the-protection-of-individuals-with-regar/16808b36f1

Digital Citizenship Guidelines for school-industry partnerships

Outlines guidelines for school-industry partnership. AI is briefly mentioned and the guidelines can be further expanded to address broader aspects discussed in this report.

Council of Europe, DCE Expert Group (2019), "Digital Citizenship Guidelines for school-industry partnerships", www.ictcoalition.eu/medias/uploads/source/Forum%2002072019/CoE%20digital%20citizenship%20guidelines%20June%202019%20%20-%20%20Read-Only.pdf

Handbook on European data protection law

Data protection law is referred to in this report.

European Union Agency for Fundamental Rights and Council of Europe (2018), *Handbook on European data protection law*, www.echr.coe.int/Documents/Handbook_data_protection_ENG.pdf

Higher education's response to the Covid-19 pandemic – Building a more sustainable and democratic future

Indicates the importance of digital education, democracy and inclusion with a focus on higher education.

Bergan S., Gallagher T., Harkavy I., Munck R. and Hilligje van't Land (eds) (2021), *Higher education's response to the Covid-19 pandemic – Building a more sustainable and democratic future*, Council of Europe Publishing, Higher Education Series No. 25, https://rm.coe.int/prems-006821-eng-2508-higher-education-series-no-25/1680a19fe2

Higher education for diversity, social inclusion and community – A democratic imperative

Does not explicitly refer to AI but some of the issues raised in this report refer to the democratic imperative.

Bergan S. and Harkavy I. (eds) (2018), *Higher education for diversity, social inclusion and community – A democratic imperative*, Council of Europe Publishing, Higher Education Series No. 22, https://rm.coe.int/higher-education-for-diversity-16x24-web/16808e4a7a

Internet Governance – Council of Europe Strategy 2016-2019. Democracy, human rights and the rule of law in the digital world

There is no reference to AI, but the internet governance is relevant to issues discussed in this report.

Council of Europe (2016), "Internet Governance – Council of Europe Strategy 2016-2019. Democracy, human rights and the rule of law in the digital world", https://rm.coe.int/internet-governance-strategy-2016-2019-updated-version-06-mar-2018/1680790ebe

The Reference Framework of Competences for Democratic Culture in brief

AI is referenced in this report when referring to competences.

Council of Europe (2021), *The Reference Framework of Competences for Democratic Culture in brief,* https://rm.coe.int/prems-004721-the-reference-framework-of-competences-for-democratic-cul/1680a27f24

Unboxing artificial intelligence: 10 steps to protect human rights

This report makes several references to AI literacy, including both the technological and human dimensions, but does not address the application of AI in education.

Council of Europe Commissioner for Human Rights (2019), "Unboxing artificial intelligence: 10 steps to protect human rights", https://rm.coe.int/unboxing-artificial-intelligence-10-steps-to-protect-human-rights-reco/1680946e64

Appendix III

Recent related reports from other institutions

The impact of artificial intelligence on learning, teaching, and education (European Commission)

Offers a broad focus on what AI in education involves, rather than considering adoption or offering a critical view from the lenses of human rights, democracy and rule of law.

Tuomi I., Punie Y., Vuorikari R. and Cabrera M. (eds) (2018), *The impact of artificial intelligence on learning, teaching, and education*, European Commission, Joint Research Centre, https://op.europa.eu/en/publication-detail/-/publication/5cb8eee3-e888-11e8-b690-01aa75ed71a1

Ethics guidelines for trustworthy AI (European Commission)

Provides guidelines for trustworthy AI, some of which are elaborated in this report in the context of AI and education.

Directorate-General for Communications Networks, Content and Technology (2019), *Ethics guidelines for trustworthy AI*, European Commission, https://op.europa.eu/en/publication-detail/-/publication/d3988569-0434-11ea-8c1f-01aa75ed71a1

OECD Digital Education Outlook 2021: pushing the frontiers with artificial intelligence, blockchain and robots (OECD)

Discusses research perspectives, while this report focuses on adoption and a critical view through the lens of human rights, democracy and the rule of law.

OECD (2021), *OECD Digital Education Outlook 2021: pushing the frontiers with artificial intelligence, blockchain and robots*, OECD Publishing, www.oecd.org/education/oecd-digital-education-outlook-7fbfff45-en.htm

Trustworthy artificial intelligence (AI) in education: promises and challenges (OECD)

This paper was written to support the G20 artificial intelligence dialogue but there is no explicit discussion with regard to human rights, democracy and the rule of law. Also, this report offers a broader perspective of AI and education with a focus on adoption.

Vincent-Lancrin S. and van der Vlies R. (2020), *Trustworthy artificial intelligence (AI) in education: promises and challenges,* OECD Education Working Paper No. 218, www.oecd.org/education/trustworthy-artificial-intelligence-ai-in-education-a6c90fa9-en.htm

Beijing Consensus on Artificial Intelligence and Education (UNESCO)

Outcome document of the International Conference on Artificial Intelligence and Education "Planning education in the AI era: Lead the leap".

UNESCO (2021), *Beijing Consensus on Artificial Intelligence and Education,* https://unesdoc.unesco.org/ark:/48223/pf0000368303

AI and education: guidance for policy-makers (UNESCO)

Uses similar historic references but does not offer a critical view, especially with regard to human rights, democracy and rule of law.

Miao F. and Holmes W. (2021), *AI and education: guidance for policy-makers*, UNESCO, https://unesdoc.unesco.org/ark:/48223/pf0000376709

Intergovernmental Meeting of Experts (Category II) related to a Draft Recommendation on the Ethics of Artificial Intelligence (UNESCO)

Discusses AI and ethics issues, some of which are elaborated in this report in the context of AI and education.

UNESCO (2021), *Intergovernmental Meeting of Experts (Category II) related to a Draft Recommendation on the Ethics of Artificial Intelligence,* https://unesdoc.unesco.org/ark:/48223/pf0000377897

K-12 AI curricula: a mapping of government-endorsed AI curricula (UNESCO)

Touches on AI literacy, but this report offers a deeper discussion.

Miao F. and Shiohira K. (2022), *K-12 AI curricula: a mapping of government-endorsed AI curricula,* UNESCO's Unit for Technology and Artificial Intelligence in Education, https://unesdoc.unesco.org/ark:/48223/pf0000380602

Policy guidance on AI for children (UNICEF)

Considers the range of ways in which AI systems impact children today, which are illustrated by use cases or examples that highlight the key opportunities, risks and concerns.

UNICEF (2021), *Policy guidance on AI for children,* www.unicef.org/globalinsight/media/2356/file/UNICEF-Global-Insight-policy-guidance-AI-children-2.0-2021.pdf.pdf

Artificial intelligence for children – Toolkit (World Economic Forum)

Designed to help companies, designers, parents, guardians, children and youth ensure that AI respects the rights of children and has a positive impact in their lives.

World Economic Forum (2022), *Artificial intelligence for children – Toolkit,* https://www3.weforum.org/docs/WEF_Artificial_Intelligence_for_Children_2022.pdf

Appendix IV

Reviews of AIED research

Aleven V., McLaren B. M., Sewall J., van Velsen M., Popescu O., Demi S., Ringenberg M. and Koedinger K. R. (2016), "Example-tracing tutors: intelligent tutor development for non-programmers", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 224-69, https://link.springer.com/article/10.1007/s40593-015-0088-2.

Aleven V., McLaughlin E. A., Glenn R. A. and Koedinger K. R. (2017), "Instruction based on adaptive learning technologies", in Mayer R. E. and Alexander P. (eds), *Handbook of research on learning and instruction* (2nd edn), pp. 522-60, Routledge, New York, www.cs.cmu.edu/afs/.cs.cmu.edu/Web/People/aleven/Papers/2016/Aleven_etal_Handbook2016_AdaptiveLearningTechnologies_Prepub.pdf.

Aleven V., Roll I., McLaren B. M. and Koedinger K. R. (2016), "Help helps, but only so much: research on help seeking with intelligent tutoring systems", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 205-23, https://link.springer.com/article/10.1007/s40593-015-0089-1.

Baker R. S. (2016), "Stupid tutoring systems, intelligent humans", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 600-14, https://link.springer.com/article/10.1007/s40593-016-0105-0.

Boulay B. (du) (2016), "Artificial intelligence as an effective classroom assistant", *IEEE Intelligent Systems* Vol. 31, No. 6, pp. 76-81, www.doi.org/10.1109/MIS.2016.93.

Boulay B. (du), Mitrovic T. and Yacef K. (eds) (in preparation), *Handbook of artificial intelligence in education*, Edward Elgar Publishing, Cheltenham, Glos.

Bull S. and Kay J. (2016), "SMILI☺: a framework for interfaces to learning data in open learner models, learning analytics and related fields", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 293-331, https://link.springer.com/article/10.1007/s40593-015-0090-8.

Charitopoulos A., Rangoussi M. and Koulouriotis D. (2020), "On the use of soft computing methods in educational data mining and learning analytics research: a review of years 2010-2018", *International Journal of Artificial Intelligence in Education* Vol. 30, pp. 371-430, https://link.springer.com/article/10.1007/s40593-020-00200-8.

Cukurova M., Luckin R. and Kent C. (2020), "Impact of an artificial intelligence research frame on the perceived credibility of educational research evidence", *International Journal of Artificial Intelligence in Education* Vol. 30, pp. 205-35, https://link.springer.com/article/10.1007/s40593-019-00188-w.

D'Mello S. K. (2016), "Giving eyesight to the blind: towards attention-aware AIED", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 645-59, https://link.springer.com/article/10.1007/s40593-016-0104-1.

Dermeval D., Paiva R., Bittencourt I., Vassileva J. and Borges D. (2018), "Authoring tools for designing intelligent tutoring systems: a systematic review of the literature", *International Journal of Artificial Intelligence in Education* Vol. 28, pp. 336-84, https://link.springer.com/article/10.1007/s40593-017-0157-9.

Dillenbourg P.(2016), "The evolution of research on digital education", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 544-60, https://link.springer.com/article/10.1007/s40593-016-0106-z.

Harley J. M., Lajoie S. P., Frasson C. and Hal N. C. (2017), "Developing emotion-aware, advanced learning technologies: a taxonomy of approaches and features", *International Journal of Artificial Intelligence in Education* Vol. 27, pp. 268-97, https://link.springer.com/article/10.1007/s40593-016-0126-8.

Holmes W. (2020), "Artificial intelligence in education", in Tatnall A. (ed.), *Encyclopedia of education and information technologies*, pp. 88-103, Springer International Publishing, https://doi.org/10.1007/978-3-030-10576-1_107.

Holmes W., Bialik M. and Fadel C. (2019), *Artificial intelligence in education: promises and implications for teaching and learning*, Center for Curriculum Redesign, Boston, MA.

Holmes W., Porayska-Pomsta K., Holstein K., Sutherland E., Baker T., Shum S., Santos O., Rodrigo M., Cukurova M., Bittencourt I. and Koedinger K. (2021), "Ethics of AI in education: towards a community-wide framework", *International Journal of Artificial Intelligence in Education*, https://link.springer.com/article/10.1007/s40593-021-00239-1.

Kim Y. and Baylor A. L. (2016), "Research-based design of pedagogical agent roles: a review, progress, and recommendations", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 160-69, https://link.springer.com/article/10.1007/s40593-015-0055-y.

Kurdi G., Leo J., Parsia B., Sattler U. and Al-Emari S. (2020), "A systematic review of automatic question generation for educational purposes", *International Journal of Artificial Intelligence in Education* Vol. 30, pp. 121-204, https://link.springer.com/article/10.1007/s40593-019-00186-y.

Luckin R., George K. and Cukurova M. (2022), *AI for school teachers*, CRC Press, Boca Raton, FL, https://doi.org/10.1201/9781003193173.

Luckin R. and Holmes W. (2016), *Intelligence unleashed: an argument for AI in education*, UCL Knowledge Lab, London.

Markauskaite L., Marrone R., Poquet O., Knight S., Martinez-Maldonado R., Howard S., Tondeur J., De Laat M., Buckingham Shum S., Gašević D. and Siemens G. (2022), "Rethinking the entwinement between artificial intelligence and human learning: what capabilities do learners need for a world with AI?", *Computers and Education: Artificial Intelligence* Vol. 3, www.sciencedirect.com/science/article/pii/S2666920X2200011X.

Pinkwart N. (2016), "Another 25 years of AIED? Challenges and opportunities for intelligent educational technologies of the future", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 771-83, https://link.springer.com/article/10.1007/s40593-016-0099-7.

Rummel N., Walker E. and Aleven V. (2016), "Different futures of adaptive collaborative learning support", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 784-95, https://link.springer.com/article/10.1007/s40593-016-0102-3.

Santos O. (2016), "Training the body: the potential of AIED to support personalized motor skills learning", *International Journal of Artificial Intelligence in Education* Vol. 26, pp. 730-55, https://link.springer.com/article/10.1007/s40593-016-0103-2.

Sottilare R. A., Burke S., Salas E., Sinatra A. M., Johnston J. H. and Gilbert S. B. (2018), "Designing adaptive instruction for teams: a meta-analysis", *International Journal of Artificial Intelligence in Education* Vol. 28, pp. 225-64, https://link.springer.com/article/10.1007/s40593-017-0146-z.

Appendix V

Some examples of student-supporting AIED tools

The following examples of student-supporting AIED tools is given here only to illustrate just how many such tools already exist, many of which are multi-million-dollar-funded, and many of which are being widely implemented by national governments.

Please note that the inclusion of any particular tool in the following list does not constitute a recommendation of that tool by either the authors of this report or by the Council of Europe. NB All links were accessible in July 2022.

Alef (https://www.alefeducation.com)

ALEKS (www.aleks.com)

Alta (www.knewton.com)

AmritaCREATE (www.amritacreate.org)

Area9 (https://area9learning.com)

ASSISTments (https://new.assistments.org)

Better Marks (https://bettermarks.com)

Byjus (https://byjus.com)

CogBooks (www.cogbooks.com)

Cognii (www.cognii.com)

Domoscio (https://domoscio.com/en/domoscio-spark-2)

Dreambox (www.dreambox.com)

EnLearn (www.enlearn.org)

Inq-ITS (www.inqits.com)

iReady (www.curriculumassociates.com/Products/i-Ready)

Laix (www.liulishuo.com)

Mathia (www.carnegielearning.com)

Qubena (https://qubena.com)

RealizeIt (http://realizeitlearning.com)

Querium (http://querium.com)

Smart Sparrow (www.smartsparrow.com)

Snappet (https://nl.snappet.org)

Soffos (https://soffos.ai)

Squirrel AI (http://squirrelai.com)

Summit Learning (www.summitlearning.org)

Thinkster Math (https://hellothinkster.co.uk)

Toppr (www.toppr.com)

About the authors

Wayne Holmes (PhD, University of Oxford) is an Associate Professor (learning sciences and innovation) at University College London, and is a researcher on AI and education (AI&ED) for IRCAI (the International Research Centre on artificial intelligence under the auspices of UNESCO), UNESCO's Technology and Artificial Intelligence in Education Unit and the Council of Europe. Having been involved in education throughout his life, Wayne brings a critical studies perspective to the connections between AI and education, and their social and ethical implications. His recent publications include *Artificial intelligence in education: promises and implications for teaching and learning* (2019), *Ethics of AI in education: towards a community-wide framework* (2021), *The ethics of AI in education: practices, challenges and debates* (2022) and, for UNESCO, *AI and education: guidance for policy-makers* (2021). Wayne also co-authored the EU's DigComp 2.2. Annex 2. *Citizens interacting with AI systems* (2022) and has given invited talks on AI&ED in Brazil, China, Croatia, Denmark, Germany, Greece, India, Japan, Oman, Portugal, Slovenia, Spain and the USA (and online to audiences in many other countries around the world). ORCID: 0000-0002-8352-1594.

Jen Persson is Director of defend digital me. This not-for-profit organisation is a call to action to protect children's rights in the digital environment in education. It was founded in 2016 by teachers and parents who campaign for safe, fair and transparent data processing in England and beyond. Jen supported the Council of Europe Consultative Committee of the Convention for the Protection of Individuals with Regard to Processing of Personal Data (Convention 108) in the development of Guidelines on Children's Data Protection in an Education setting adopted in 2020.

Irene-Angelica Chounta is a Junior Professor (tenure-track) in Computational Methods in Modelling and Analysis of Learning Processes at the Department of Computer Science and Applied Cognitive Science, University of Duisburg-Essen in Germany. Her research focuses on computational learning analytics (LA) for technology-enhanced learning (TEL), AI in education (AIED) and educational technologies. Her main research interest is to model learners' behaviour in order to provide evidence-based, adaptive and personalised feedback, in a variety of contexts: from intelligent tutoring systems and computer-supported collaborative learning environments to hackathons and makerspaces. In 2019, she was awarded a four-year start-up grant from the Estonian Research Council for her research on "Combining machine learning and learning analytics to provide personalised scaffolding for computer-supported learning activities". Irene was born and raised in Athens, Greece, and studied at the University of Patras. She has lived and worked in Germany (University of Duisburg-Essen), USA (Carnegie Mellon University) and Estonia (University of Tartu). Currently, she serves as a Communications Co-Chair for the International Society of the Learning Sciences (ISLS), and she is an active member of the International Artificial Intelligence in Education Society (IAIED) and the Society for Learning Analytics Research (SoLAR). ORCID: 0000-0001-9159-0664.

Barbara Wasson is a full Professor of Information Science at the Department of Information Science and Media Studies, University of Bergen, Norway, and Director of the Centre for the Science of Learning & Technology (SLATE), the national competence centre for learning analytics funded by the Norwegian Ministry of Education. Her research work in the field of technology-enhanced learning (TEL) has ranged from AI in education, computer-supported collaborative learning, mobile learning, learning games, learning analytics and data literacy. Wasson was a co-founder of Kaleidoscope, the European Network of Excellence, served on the executive board and led the Computer-supported Collaborative Learning Special Interest Group (CSCL Sig) with 400 members. She was programme co-chair of Quantitative Ethnography 2021 and is programme co-chair for the Society of Learning Analytics conference LAK24. She is on the editorial board of *Designs for Learning*, the *Italian Journal of Educational Technology* and the *Nordic Journal of Digital Literacy*. Currently Wasson is on the steering board of UiB AI (University of Bergen) and a member of the UiB rector's expert group EU Forum, in addition to her work for the Council of Europe, she is a member of the Norwegian Government's expert group on learning analytics, which is looking at the technical, pedagogical, legal and ethical aspects of the implementation of learning analytics in the Norwegian educational sector. ORCID: 0000-0003-4897-1394.

Vania Dimitrova is a full Professor (Chair) of Human-Centred Artificial Intelligence at the School of Computing, University of Leeds, UK. Her research focuses on building systems that help people make sense of data, take decisions in complex settings, expand their knowledge and learn from experience. She explores the use of data and knowledge models to get insights into user-generated content, understand users and influence behaviour, capture knowledge and support information exploration. She is currently President of the International AI in Education Society and Co-Director of the UKRI Centre for Doctoral Training in AI for Medical Diagnosis and Care. She was Co-Director of the Leeds Research Centre in Digital Learning and was Director of Technology Enhanced Learning Strategy at the Leeds Institute of Medical Education. She is associate editor of both the *International Journal of AI in Education* and *Frontiers of AI: AI for Human Learning and Behavior Change*. She was associate editor of *IEEE Transactions on Learning Technologies* (IEEE-TLT), a member of the editorial boards for the personalisation journal *UMUAI* and chaired several international conferences in intelligent learning environments (AIED, ECTEL, ICCE). She co-ordinated the ImREAL EU project which developed AI technologies to aid cultural awareness training. ORCID: 0000-0002-7001-0891.

Sales agents for publications of the Council of Europe
Agents de vente des publications du Conseil de l'Europe

BELGIUM/BELGIQUE
La Librairie Européenne -
The European Bookshop
Rue de l'Orme, 1
BE-1040 BRUXELLES
Tel.: + 32 (0)2 231 04 35
Fax: + 32 (0)2 735 08 60
E-mail: info@libeurop.eu
http://www.libeurop.be

Jean De Lannoy/DL Services
c/o Michot Warehouses
Bergense steenweg 77
Chaussée de Mons
BE-1600 SINT PIETERS LEEUW
Fax: + 32 (0)2 706 52 27
E-mail: jean.de.lannoy@dl-servi.com
http://www.jean-de-lannoy.be

CANADA
Renouf Publishing Co. Ltd.
22-1010 Polytek Street
CDN-OTTAWA, ONT K1J 9J1
Tel.: + 1 613 745 2665
Fax: + 1 613 745 7660
Toll-Free Tel.: (866) 767-6766
E-mail: order.dept@renoufbooks.com
http://www.renoufbooks.com

CROATIA/CROATIE
Robert's Plus d.o.o.
Marasoviçeva 67
HR-21000 SPLIT
Tel.: + 385 21 315 800, 801, 802, 803
Fax: + 385 21 315 804
E-mail: robertsplus@robertsplus.hr

CZECH REPUBLIC/
RÉPUBLIQUE TCHÈQUE
Suweco CZ, s.r.o.
Klecakova 347
CZ-180 21 PRAHA 9
Tel.: + 420 2 424 59 204
Fax: + 420 2 848 21 646
E-mail: import@suweco.cz
http://www.suweco.cz

DENMARK/DANEMARK
GAD
Vimmelskaftet 32
DK-1161 KØBENHAVN K
Tel.: + 45 77 66 60 00
Fax: + 45 77 66 60 01
E-mail: reception@gad.dk
http://www.gad.dk

FINLAND/FINLANDE
Akateeminen Kirjakauppa
PO Box 128
Keskuskatu 1
FI-00100 HELSINKI
Tel.: + 358 (0)9 121 4430
Fax: + 358 (0)9 121 4242
E-mail: akatilaus@akateeminen.com
http://www.akateeminen.com

FRANCE
Please contact directly /
Merci de contacter directement
Council of Europe Publishing
Éditions du Conseil de l'Europe
F-67075 STRASBOURG Cedex
Tel.: + 33 (0)3 88 41 25 81
Fax: + 33 (0)3 88 41 39 10
E-mail: publishing@coe.int
http://book.coe.int

Librairie Kléber
1, rue des Francs-Bourgeois
F-67000 STRASBOURG
Tel.: + 33 (0)3 88 15 78 88
Fax: + 33 (0)3 88 15 78 80
E-mail: librairie-kleber@coe.int
http://www.librairie-kleber.com

NORWAY/NORVÈGE
Akademika
Postboks 84 Blindern
NO-0314 OSLO
Tel.: + 47 2 218 8100
Fax: + 47 2 218 8103
E-mail: support@akademika.no
http://www.akademika.no

POLAND/POLOGNE
Ars Polona JSC
25 Obroncow Street
PL-03-933 WARSZAWA
Tel.: + 48 (0)22 509 86 00
Fax: + 48 (0)22 509 86 10
E-mail: arspolona@arspolona.com.pl
http://www.arspolona.com.pl

PORTUGAL
Marka Lda
Rua dos Correeiros 61-3
PT-1100-162 LISBOA
Tel: 351 21 3224040
Fax: 351 21 3224044
E mail: apoio.clientes@marka.pt
www.marka.pt

RUSSIAN FEDERATION/
FÉDÉRATION DE RUSSIE
Ves Mir
17b, Butlerova ul. - Office 338
RU-117342 MOSCOW
Tel.: + 7 495 739 0971
Fax: + 7 495 739 0971
E-mail: orders@vesmirbooks.ru
http://www.vesmirbooks.ru

SWITZERLAND/SUISSE
Planetis Sàrl
16, chemin des Pins
CH-1273 ARZIER
Tel.: + 41 22 366 51 77
Fax: + 41 22 366 51 78
E-mail: info@planetis.ch

TAIWAN
Tycoon Information Inc.
5th Floor, No. 500, Chang-Chun Road
Taipei, Taiwan
Tel.: 886-2-8712 8886
Fax: 886-2-8712 4747, 8712 4777
E-mail: info@tycoon-info.com.tw
orders@tycoon-info.com.tw

UNITED KINGDOM/ROYAUME-UNI
The Stationery Office Ltd
PO Box 29
GB-NORWICH NR3 1GN
Tel.: + 44 (0)870 600 5522
Fax: + 44 (0)870 600 5533
E-mail: book.enquiries@tso.co.uk
http://www.tsoshop.co.uk

UNITED STATES and CANADA/
ÉTATS-UNIS et CANADA
Manhattan Publishing Co
670 White Plains Road
USA-10583 SCARSDALE, NY
Tel: + 1 914 472 4650
Fax: + 1 914 472 4316
E-mail: coe@manhattanpublishing.com
http://www.manhattanpublishing.com

Council of Europe Publishing/Éditions du Conseil de l'Europe
F-67075 STRASBOURG Cedex
Tel.: + 33 (0)3 88 41 25 81 – Fax: + 33 (0)3 88 41 39 10 – E-mail: publishing@coe.int – Website: http://book.coe.int

Artificial intelligence (AI) is increasingly having an impact on education, bringing opportunities as well as numerous challenges. These observations were noted by the Council of Europe's Committee of Ministers in 2019 and led to the commissioning of this report, which sets out to examine the connections between AI and education (AI&ED). In particular, the report presents an overview of AI&ED seen through the lens of the Council of Europe values of human rights, democracy and the rule of law; and it provides a critical analysis of the academic evidence and the myths and hype.

The Covid-19 pandemic school shutdowns triggered a rushed adoption of educational technology, which increasingly includes AI-assisted classrooms tools (AIED). This AIED, which by definition is designed to influence child development, also impacts on critical issues such as privacy, agency and human dignity – all of which are yet to be fully explored and addressed. But AI&ED is not only about teaching and learning with AI, but also teaching and learning about AI (AI literacy), addressing both the technological dimension and the often-forgotten human dimension of AI.

The report concludes with a provisional needs analysis – the aim being to stimulate further critical debate by the Council of Europe's member states and other stakeholders and to ensure that education systems respond both proactively and effectively to the numerous opportunities and challenges introduced by AI&ED.

PREMS 092922

ENG

www.coe.int

The Council of Europe is the continent's leading human rights organisation. It comprises 46 member states, including all members of the European Union. All Council of Europe member states have signed up to the European Convention on Human Rights, a treaty designed to protect human rights, democracy and the rule of law. The European Court of Human Rights oversees the implementation of the Convention in the member states.

http://book.coe.int
ISBN 978-92-871-9236-3
€49/US$98

COUNCIL OF EUROPE

CONSEIL DE L'EUROPE