Building an understanding of AI in education

Issues Paper: HPST II | Australia workstream

Australian Government
Department of Education

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It is designed as an input to HPST II and as such is not for publication or distribution outside the project team.

Contents

Background

The High Performing Systems for Tomorrow (HPST) Project was established in 2018 as a collaboration between the OECD and selected countries with outstanding results in the Programme for International Student Assessment (PISA)[1] designed to explore shared education policy challenges and shape future directions in education. Phase I involved comparative research on learning systems and policy dialogues on the implications of artificial intelligence (AI) for the future of education. Project outcomes were captured in a series of OECD papers and include new thinking on the purposes of education. Broadly, countries concluded that education in the 21st Century should support the concept of human flourishing.

In the second phase of the project (HPST II), participating countries[2] will examine how learning, teaching and assessments can be re-shaped for evolving education systems and how PISA survey data and the OECD education evidence base can be used to inform policy development, strategies and practices to support education for human flourishing. The aim is to create a robust conceptual framework that informs policy development in secondary education for interested countries and steers the long-term direction of PISA.

Purpose of this paper

This paper has been produced by the Australian Government Department of Education as part of a larger contribution to HPST II. There are nine workstreams contributing to HPST II (see Appendix 1). Australia is leading the workstream: *'Deepening understanding of what AI means for societies, economies and individuals'* ('the AI workstream'), with Germany providing comment and advice as our reactive partner.

As the initial deliverable for the AI workstream, the intent of this Issues Paper is to examine emerging digital technologies, with a focus on AI. It aims to build a comprehensive picture of current and future developments in AI and related technologies, analysing the challenges and opportunities they create for individuals, societies and economies. The paper also poses potential questions for discussion. These questions will inform Phase II of the AI workstream, which will examine the implications for education goals and competencies.

[1] Canada (British Columbia); Estonia; Finland; Hong Kong; Singapore. About - PISA (oecd.org)

[2] Continuing jurisdictions from Phase I are: British Columbia (Canada); Estonia; Finland; and Singapore. Countries joining Phase II are: Germany; the United Kingdom; and Australia. Germany is Australia's 'reactive partner' on the AI workstream. About - PISA (oecd.org)

Introduction

Future generations will require new skills and capabilities to flourish in an AI-enabled world. The permeation of AI and emerging technology in all aspects of our daily lives is already changing the way we live, learn, work and play. Currently AI has applications in a range of sectors, including early disease detection in medicine, approving home loans in banking, and invasive species recognition in the environmental field. This will have flow on effects to education that we must consider as policymakers and educators.

Education supports us as we grow and develop through all stages of life, from early childhood to further education and beyond. In a broader context, education prepares us for the future, creating the prospective workforce and shaping the society that we want to live in. This paper explores the current and emerging impact of AI on us as individuals, on societies and economies, to lay the groundwork for understanding the role of education in ensuring that we are well equipped for a profoundly different future.

AI is a broad, and often misunderstood, term used to describe a field of computer science that looks to create machines that imitate human intelligence. Many people think of AI as a technology that is capable of speaking and moving like a person. While this is something that's currently only in the realms of science fiction, AI is already being used in exciting ways in industries such as healthcare, finance, transportation and entertainment.

This paper will begin by establishing a definition of AI, and reviewing some of its existing capabilities and applications. We will then look to the future and examine the positive and negative impacts we expect AI to have on individuals, societies and economies. AI could improve quality of life, streamline processes, enhance productivity and foster innovation. However, it also poses challenges ranging from job displacement, privacy, ethics, and concentration of power.

The paper then begins a discussion on how we can prepare individuals societies and economies to effectively harness the opportunities and mitigate the risks of AI and related technologies, posing questions about how to navigate an AI-enabled future. These questions address issues around privacy and child protection, what we should teach, and how students will learn. This section will serve as a jumping-off point for the second phase of the AI workstream, where we will address the implications of AI and emerging technologies for education goals and competencies.

What is AI?

Artificial Intelligence (AI) is an interdisciplinary field of computer science that aims to develop intelligence systems capable of performing tasks that would typically require human intelligence. It includes a range of technologies that can recognise different inputs such as text, image, and sound and analyse them to produce an output such as performing commands, diagnosing problems, and suggesting solutions. To do this, AI relies on algorithms and computation models to process vast amounts of data to extract meaningful patterns and insights.

There are three categories of AI: narrow AI, general AI and artificial superintelligence. Narrow or weak AI is trained to perform a single or narrow task, often much faster than a human can. These systems are tailored for particular domains, such as speech recognition, face detection, image classification, or recommendation systems.[3] They excel in their specific area but lack complex cognition. Current examples of narrow AI include machine learning, deep learning, and natural language processing[4], as can be seen in the recent ground breaking technology ChatGPT.[5]

Existing Narrow AI falls short on critical thinking, as it is not yet capable of interpreting context cues or may not have appropriate background knowledge or lived experience to perform such a skill. In addition, the predefined parameters of AI do not question the assumptions it has been programmed with. Unlike human intelligence, AI has some of the following limitations:

- unable to challenge its own thinking or change its perspective;
- lacks true creativity;
- unable to think outside of the box;
- cannot imagine new possibilities; and
- is unable to form innovative ideas that has not been presented to it before.[6]

These kinds of advanced capabilities are described as General or Strong AI. They are commonly depicted in science fiction, with characters such as C-3PO and the Terminator and describes a multifaceted machine or robot with the ability to complete almost any human task – both cognitive and physical. However, the development of Strong AI remains a theoretical concept, and achieving it is a complex and ongoing research challenge.

Artificial superintelligence is a hypothetical level of AI that exceeds human intelligence and abilities. There is conflicting expert opinion about when we can expect to see this technology. The future may bring advances that allow AI to mimic complex human reasoning and critical thinking more closely, but these capabilities are likely to remain a uniquely human strength in the foreseeable future.

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[3] Z Larkin, 'General AI vs Narrow AI', *Levity,* 16 November 2022, accessed 25 May 2023. General AI vs Narrow AI (levity.ai)

[4] H Sarker, 'AI-Based Modelling: Techniques, Applications and Research Issues Towards Automation, Intelligent and Smart Systems', *SN COMPUT. SCI,* 2022, accessed 14 April 2023.

[5] I Lavery, 'ChatGPT: Everything to know about the viral groundbreaking AI bot', *Global News, 10 December 2022, accessed 24 May 2023.* ChatGPT: Everything to know about the viral, 'groundbreaking' AI bot - National | Globalnews.ca

[6] S Sultan, 'Limitations of Artificial Intelligence', *Rochester Institute of Technology,* 18 May 2021, accessed 25 May 2023. Limitations Of Artificial Intelligence (rit.edu)

Current Applications of AI

Despite its name, Narrow AI has advanced significantly with current applications across all aspects of society. For **individuals**, AI embedded domestic appliances have been enhancing convenience, efficiency, and productivity in our daily lives. Some appliances clearly advertise the use of AI, like robotic vacuum cleaners that clean our homes autonomously or smart refrigerators that can keep track of the food items inside, their expiry dates, and even suggest recipes based on the available ingredients. In other cases it may not be clear to individuals that a product uses AI, particularly where products have become embedded in day to day life. For example, personalised entertainment in streaming services like Netflix or Spotify use AI to analyse personal interests and habits to tailor content recommendation and advertising.

In the realm of personal health, AI-enabled wearable devices monitor various health metrics like heart rate, sleep patterns, and physical activity. This data provides valuable insights to help users maintain a healthy lifestyle and can be easily forwarded to doctors to aid in early disease detection. This technology can also provide people with greater independence in their daily lives. Home assistants like Alexa or Siri can help vision impaired people to access internet content. Barriers to communication are being lifted using speech-to-text software, automated signing avatars, and eye-tracking.[7] Chatbots can provide therapy and companionship to children who struggle with social interactions or communication.[8] AI-powered robotics also exist that can help with some manual tasks such as walking or lifting, although these remain expensive.

For **societies**, AI is helping governments respond in more agile and targeted ways than previously possible, improving community management and delivery of social services. Public service chatbots and document analysis programs have reduced the administrative burden placed on public servants in many countries, making government services more efficient and higher quality, and raising job satisfaction of government employees.[9] For example, in Australia the Commonwealth Scientific and Industrial Research Organisation (CSIRO) recently developed a program called SPARK which can be used to predict the spread of bushfires and flooding.[10] This program not only aids in emergency management but supports infrastructure planning, estimating ecological impacts and firefighting resource allocation.

Adoption of facial recognition technology has strengthened security within government organisations and improved border security and immigration processes. United State Customs and Border Protection implemented facial recognition technology for identity checks across 32 airports in July 2022. The use of this technology has been found to increase security and save time for customs officials, allowing them to focus on other tasks.[11] However, there remain concerns about privacy and embedded bias in facial

[7] United Nations Office of the Human Rights Commissioner, 'Artificial intelligence and the rights of persons with disabilities - Report of the Special Rapporteur on the rights of persons with disabilities', 28 December 2021, accessed 12 April 2023. https://www.ohchr.org/en/documents/thematic-reports/ahrc4952-artificial-intelligence-and-rights-persons-disabilities-report

[8] CSIRO, 'Chatbot apps for communication and social interaction therapy', 8 November 2021, accessed 11 April 2023. https://www.csiro.au/en/research/technology-space/ai/chatbots-for-therapy

[9] Deloitte AI Institute, 'The Government and Public Services AI Dossier', 2021, accessed 24 May 2023. AI Use Cases in Government | Deloitte US

[10] CSIRO, 'SPARK: Predicting Bushfire Spread', 8 December 2022, accessed 19 May 2023. Spark: Predicting bushfire spread - CSIRO

[11] U.S. Government Accountability Office, 'Facial Recognition Technology: CBP Traveller Identity Verification and Efforts

recognition technology that has stalled implementation in some countries and sectors, including education.[12] [13]

In contrast to these positive societal impacts, the development, production and maintenance of AI systems is already having some negative implications. At present, generative AI models are trained using "supervised learning" approaches. Human labour is currently an essential component of this process as low-cost labour makes it cost effective for firms to use unskilled labourers to identify and classify training tasks. Firms using AI already outsource labelling to workers in the Global South, and the resulting power-imbalance could lead to greater exploitation of vulnerable workers in "digital sweatshops".[14] In other cases, supervised learning depends on activities that could put humans at risk of harm without their informed consent. One example is the gathering of data by vehicle manufacturers to improve autonomous vehicle systems by operating them on public roads. Whether passengers of such vehicles have provided informed consent to the risks of riding in still-developing technology is arguable, but in general other road users and pedestrians have not consented to those risks.[15]

Within the **economy**, many businesses are already using AI technologies to improve their productivity and to augment or substitute human labour. Examples include mining companies using autonomous vehicles to transport materials, and hospitals using AI systems to scan medical images for evidence of illnesses and injuries. Recent advances in generative AI are likely to significantly increase productivity in some industries in ways which are only just beginning to be explored. AI is also being used as a management tool, particularly by companies like Amazon.[16] This can improve productivity through better allocation and management of human resources. Within the finance industry, fraud detection algorithms are commonly used to detect fraudulent or illegal banking activities. The algorithms can identify patterns and anomalies in the behaviour of account holders and flag potential suspect accounts or transactions.

As we have seen, AI has a large range of existing capabilities and applications. The evolution of AI technologies is only expected to quicken, and both the positive and negative impacts on humans will only grow.

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to Address Privacy Issues', 27 July 2022, accessed 24 May 2023. Facial Recognition Technology: CBP Traveler Identity Verification and Efforts to Address Privacy Issues | U.S. GAO

[12] Josh Taylor, 'Victoria police distances itself from controversial facial recognition firm Clearview AI', *The Guardian*, 19 June 2020, accessed 24 May 2023. Victoria police distances itself from controversial facial recognition firm Clearview AI | Victoria | The Guardian

[13]Henrietta Cook, 'Tough new rules for 'Big Brother' face-reading technology in schools', *The Age*, 5 February 2019, accessed 24 May 2023. Facial recognition: Tough new rules for 'Big Brother" face-reading technology in schools (theage.com.au)

[14] C Metz, 'AI is learning from humans. Many humans', *The New York Times,* 16 August 2019, accessed 5 April 2023. https://www.nytimes.com/2019/08/16/technology/ai-humans.html

[15] C Blackett, 'The Ethics of AI in Autonomous Transport.', *Research Publishing,* August 2022, accessed 6 April 2023. (PDF) The Ethics of AI in Autonomous Transport (researchgate.net)

[16] Anil Rana, 'How Amazon Uses Artificial Intelligence?', *SEASIA*, 3 January 2023, accessed 24 May 2023. How Amazon Uses Artificial Intelligence? - Seasia Infotech

Harnessing the potential of AI

Individuals, societies and economies will need to be prepared to harness the opportunities of AI and emerging technologies as they arise. This will mean developing new skills to use technology fairly and effectively, and having strong foresight capabilities in-built in businesses and governments to support early adoption and appropriate regulation. Education will be essential to building these capabilities in the next generation and supporting current citizens through professional development and adult education.

Individual

With AI and emerging technologies becoming more prevalent, people will need to have the skills to engage with these technologies in a responsible, effective, and safe manner. These technologies are becoming embedded in everything that we do, from transport to entertainment. This means it will be essential for people to have basic digital skills and understanding to ensure that they can engage with their community and be able to perform what will become basic tasks. The education curriculum will need to reflect these new 'basic' skills as well as focus on building skills that AI cannot emulate. Inherently human traits such as teamwork, critical thinking, and managing conflict are just some of the essential skills humans will need to flourish in an AI-enabled world.

Society

Education has a key role in the way that AI will drive societal change, from improving wellbeing and benefits from assistive technology to increasing inequality, discrimination, and exploitation of workers. From childhood to adult education, the education system will need to instil in students an understanding of how AI and other emerging technologies work and how to use and develop them in an ethical manner. With the increasing prevalence of these technologies, students will need to have the skills to recognise potential risks including systemic bias and data privacy concerns embedded in technology.

Economy

Quality education primarily contributes to economic prosperity by providing the next generation of workers with the skills that will be in demand by future employers. Ensuring that the delivery of education remains dynamic and current will maximise AI supported productivity gains in the economy. When future workers are equipped with the skills demanded by future employers, future labour and skills shortages will be minimised. Adult education and the continuation of lifelong learning will also play a vital role in ensuring that workers displaced by the broader use of AI and emerging technologies will be able to reskill and find alternative employment.

The Future of AI – opportunities and challenges

AI is expected to have an impact on everything we do. As discussed, AI has already driven significant changes to our world. As AI technology becomes further embedded the impacts on different sectors and areas of our lives will shift and grow. Innovation will likely result in a more prosperous society, with higher productivity both for businesses and in the domestic sphere. However, the risks and challenges associated with adoption of this technology may have impacts that governments, businesses and individuals are not able to foresee.

Impacts of AI and related technologies on individuals

Benefits of domestic application of AI

As AI capabilities continue to advance, individuals are likely to delegate an increasing share of daily tasks to AI systems. Initially this is likely to include administrative tasks, including collecting information, summarising information, planning and communication tasks, as these processes are cheaper and easier to automate. As the technology advances and components, such as robotics, become less costly, individuals will more commonly delegate a range of menial or low-value tasks to AI systems, such as vacuuming. By automating more daily tasks, individuals should have more personal time which may be used for leisure, further education, paid labour, or volunteer work.

Box 1. Personalised learning

Some educators are exploring the use of personalised learning platforms, including to support students with disability. These AI-enabled platforms deliver students personalised on-demand support to supplement person-to-person teaching. They may also provide educators information about learning and progress of each student in real time. There is some early evidence that some of these platforms may be effective, the evidence remains mixed for many. However, new tools are being developed and studied as AI continues to advance.

As discussed before, perhaps the most impactful domestic applications of AI are those that assist people with disability or who require assistance with certain tasks for other reasons. Future advances in AI are likely to deliver further quality of life improvements for people living with disability. Carers are also likely to benefit, as AI becomes available that can assist with caring tasks. However, cost may remain a barrier to some people living with disability accessing some AI-powered assistance, especially where it depends on expensive components like robotics.

Emerging technologies could improve mobility for some and safety for everybody. For example, cities composed of entirely self-driving cars could prevent traffic and road accidents. This technology has become available to some, however it still has significant

limitations that do not have simple answers.[17] [18] Opportunities that self-driving cars present, such as smoother traffic flow, will not be fully realised until most or all people are using the technology, as self-driving cars need to connect with their environment, including traffic lights and other cars.[19]

Cognitive and psychological impacts

It is possible that living in an AI-rich environment will have impacts on individual cognitive abilities and psychology. In the short-term for instance there may be a shift in human capabilities in response to the shift in AI capabilities. On the one hand, humans may become less capable in skills that are frequently automated. For example, some commentators worry that greater reliance on generative AI in creative fields may inhibit human creativity by reducing opportunities for people to practice creative endeavours.[20] Other experts have worried that people may uncritically accept information that AI systems deliver in confident natural language, thereby making people less practiced at assessing information for accuracy and reliability.[21] Some commentators worry that people may increasingly rely on AI for companionship and intimacy, which could "inhibit deep human connections, leaving our relationships with one another less reciprocal, or shallower, or more narcissistic".[22]

More positively additional free time may allow people to improve other capabilities, or preserve capabilities with fewer direct uses that are still valued for enjoyment or other benefits. This may be true for complex skills such as critical thinking, but also for basic or fundamental skills. For example, many people continue to use handwriting as it improves comprehension and recall.[23] Similarly, people might spend their additional free time investing in their interpersonal relationships, which would increase not just their own wellbeing, but also the wellbeing of others. These complicating factors make it difficult to predict skill shifts in specific areas, with different impacts likely to result in a diverse range of outcomes for different individuals.

The long-term impacts of living in an AI-rich environment are even more difficult to predict. It is possible that growing up in an AI-rich environment will have psychological or cognitive impacts that may take many years to manifest. For instance, the impacts of social media on emotional well-being and memory performance took years to establish and

[17] Alex Davies and Aarian Marshall, 'The WIRED guide to self-driving cars', 9 September 2021, accessed 25 May 2023. Self-Driving Cars: The Complete Guide | WIRED

[18] Laurie Clarke, 'How self-driving cars got stuck in the slow lane', 28 March 2022, accessed 25 May 2023. How self-driving cars got stuck in the slow lane | Self-driving cars | The Guardian

[19] John McDermid, 'Autonomous cars: five reasons they still aren't on our roads', 30 July 2020, accessed 25 May 2023. Autonomous cars: five reasons they still aren't on our roads (theconversation.com)

[20] G Duttweiler, 'How can AI support human creativity? Here's what a new study found', *World Economic Forum,* 20 February 2023, accessed 4 April 2023. https://www.weforum.org/agenda/2023/02/ai-can-catalyze-and-inhibit-your-creativity-here-is-how/

[21] T Hsu & S Thompson, 'Disinformation Researchers Raise Alarms About AI Chatbots', *The New York Times,* 13 February 2023, accessed 3 April 2023. https://www.nytimes.com/2023/02/08/technology/ai-chatbots-disinformation.html

[22] N Christakis, 'How AI will rewire us', *The Atlantic,* April 2019, accessed 3 April 2023. https://www.theatlantic.com/magazine/archive/2019/04/robots-human-relationships/583204/

[23] Umejima, Keita, et al, 'Paper notebooks vs. mobile devices: brain activation differences during memory retrieval.', *Frontiers in Behavioral Neuroscience,* 2021, accessed 10 April 2023.

the precise mechanisms are still being studied.[24] Potential risks include exposure of adults or children to disturbing, harmful or exploitative content due to difficulties in controlling AI outputs. Where AI is used for companionship or therapy, routine processes like software updates could cause emotional distress amongst users that believe that the personality of their AI companion has changed.[25] On a broader scale, it is unclear what effect a further encroachment of AI into activities that were previously the exclusive domain of humans will have on perceptions of self-worth, identity and meaning.[26] The causal role of AI in some changes to individual psychology or cognitive abilities may be extremely difficult to establish, as any changes will occur in an environment with frequent and significant environmental changes layered on top of each other, many of which may interact with or confound each other.

Impacts of AI and related technologies on societies

Public good

In many jurisdictions, a larger economy may boost government revenues, which could enable greater spending on government priorities. Governments may be able to deliver more or higher quality services per dollar of spending due to AI-driven productivity and efficiency gains. For example, AI assistants might be able to provide advice to citizens on government programs and policies, alleviating waiting lists for such advice and weaving together information from policies or programs across government, rather than just one sector. AI-systems may also improve the effectiveness of government policy. For instance, compliance rates may improve if AI-systems can identify a greater share of non-compliant entities against whom enforcement action can be taken. Policy advice may also identify more efficient and effective government policies if AI becomes capable of assisting policymakers to undertake more sophisticated or reliable analyses of the economic, social, and distributional effects of policy. AI assisted linking of large data sets is one example where AI tools could deliver a significant benefit to the policymaking process. Finally, it may become easier to deliver quality services and support to vulnerable or underserviced communities. For example, AI powered systems could be used to scan imagery for early indications of floods or fires, improving warning times and saving lives and property.[33]

Improvements in the quality or quantity of government services like those discussed above could deliver significant benefits to lower-income individuals and other vulnerable groups. This could in turn help to reduce inequality and improve social mobility. However, the power of AI systems to address inequity depends at least in part on the ability of governments to harness the benefits of AI and take action to ensure the benefits are distributed fairly. There are also risks that AI-systems may exacerbate existing disparities or create new inequalities.

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[24] Sharifian, Neika, and L B Zahodne, 'Daily associations between social media use and memory failures: The mediating role of negative affect', *The Journal of general psychology,* 2021, accessed 13 April 2023.

[25] Brooks, Rob, 'I tried the Replika AI companion and can see why users are falling hard. The app raises serious ethical questions' *The Conversation*, 23 February 2023, accessed 20 April 2023. https://theconversation.com/i-tried-the-replika-ai-companion-and-can-see-why-users-are-falling-hard-the-app-raises-serious-ethical-questions-200257

[26] Brougham, David, and Jarrod Haar. 'Smart technology, artificial intelligence, robotics, and algorithms (STARA): Employees perceptions of our future workplace', *Journal of Management & Organization,* 2018, accessed 13 April 2023.

Appropriate regulation will be essential for ethical and safe use of new technologies. Aspects of using AI systems could be highly dangerous or have potential for misuse. At other times, new technologies may need guidelines that support people and businesses to use them effectively. For example, delegating some decision-making to AI systems could pose significant risks. The opaque nature of the decision-making process used by machine-learning algorithms means that consequences can be challenging to predict in advance, and difficult to explain once identified. AI is already being used to make decisions in areas that have enormous impacts on people's lives, such as hiring decisions, in criminal law, and in healthcare.

It is well documented that AI has the potential to create or perpetuate biases. Such biases may stem from the way the system is designed both in the learning and output stages, the way data is gathered or entered, or the way the output is used by humans or other technology. Many prominent examples of bias in AI decision-making are affected by a combination of these issues. For example, predictive policing algorithms are used in some jurisdictions to predict crime outbreaks or even to inform sentencing decisions. Some of these algorithms predict the likelihood of reoffending while others predict the likelihood of crime in a particular area. They are intended to increase safety in communities and reduce the workload of the police force through data driven decision-making and early prevention. However, AI technology, such as predictive policing algorithms, is trained using historical data. Historical biases can therefore be replicated in their outputs. Research across many predictive policing algorithms has confirmed that their use can lead to greater racial bias in arrests and sentencing. Since the underlying decision-making processes in many of these AI systems are difficult or impossible to explain or analyse, it can be difficult to identify or prove the existence of such biases. [27]

In comparison to AI, skilled and experienced humans can respond effectively and appropriately to unknown inputs using traits such as common sense, intuition, creativity, extrapolation and morality. Humans are also intuitively capable of explaining their decision-making, which is essential for determining accountability and culpability when mistakes are made. Computer scientists are working towards recreating some of these traits in AI, but they remain challenging to replicate for a variety of reasons. Morality and fairness are particularly difficult to build into algorithmic decision-making, as they can vary across cultures and between individuals.[28] For these reasons, researchers recommend that humans be involved in decision-making that involves ethical considerations or has potentially significant impacts.[29]

Misuse of emerging technologies

Institutions with control or influence over AI and related technologies may be able to exert an increasing degree of power over individuals and societies. Which risks eventuate may depend on the kinds of institutions that hold this power. For example, private companies may exploit their power for profit while some governments or political parties may prefer

[27] R Richardson, J M Schultz and K Crawford, 'Dirty data, bad predictions: civil rights violation impact police data, predictive policing systems, and justice', *New York University Law Review*, 13 February 2019, accessed 5 April 2023. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3333423

[28] S Tolmeijer, M Christen, S Kandul, M Kneer, and A Bernstein, 'Capable but Amoral? Comparing AI and Human Expert Collaboration in Ethical Decision Making', *CHI Conference on Human Factors in Computing Systems (CHI '22)*, 2022, accessed 5 April 2023. https://doi.org/10.1145/3491102.3517732

[29] S Tolmeijer, M Christen, S Kandul, M Kneer, and A Bernstein, 'Capable but Amoral? Comparing AI and Human Expert Collaboration in Ethical Decision Making', *CHI Conference on Human Factors in Computing Systems (CHI '22)*, 2022, accessed 5 April 2023. https://doi.org/10.1145/3491102.3517732

using AI for surveillance or political influence.[30] Other groups including organised crime and for-profit organisations may use or design AI-enabled technology to support nefarious or manipulative activities for financial gain. This includes cyber-attacks, surveillance, or illegal data collection. Information gained in this way could be used for fraud, theft, extortion, money laundering, evading law enforcement, and other criminal activities.

The pace at which AI and emerging technologies are advancing makes it challenging for governments and other regulating bodies to develop and implement policies that are appropriate for current technology. In this constant changing environment, it is difficult to pin down the current and upcoming capabilities of technology and identify the opportunities and risks they pose. By the time governments can implement legislation addressing key issues, policy settings may already be obsolete or superseded by subsequent advances.[31]

In the absence of legislative and regulatory clarity, AI could also make it harder to hold individuals or institutions to account for negligent or reckless behaviour. For example, legal liability may be unclear when partially or even fully automated vehicles crash, with drivers arguing that the manufacturer is responsible where an AI control system was operating the vehicle, but the manufacturer claiming that the driver is ultimately responsible for taking back control of the vehicle in dangerous conditions.[32]

Threats to privacy and unethical uses of personal information have been identified as a significant risk arising from advances in AI and related technologies. Some AI systems can gather and analyse data much faster than previously possible. Personal data including browsing, search and purchase histories are already collected in most online settings in a manner that exceeds many people's expectations of privacy. AI systems are beginning to facilitate the collection of similar data in the real world, for instance the use of facial recognition to deny service to selected individuals.[33] Future advances in AI may support even greater collection of personal data and may allow data about an individual to be linked across multiple sources. In many cases, individuals may be unaware that the data has been collected or will not have consented to the ways in which it is eventually used. This may occur because terms and conditions provide companies with extremely broad powers to collect and use data in ways that are not clear to the consumer, because data is sold to third parties, or because data is collected secretly or illegally.

Experts also worry that AI may make it easier to produce misleading or false information and to distribute it to a large audience. Current systems can already be used to make false information appear credible by producing it in a format that is persuasive, such as an essay, or appears credible, such as a news article.[34] AI can also be used to create fake imagery,

[30] K Johnson, 'AI ethics is all about power', *VentureBeat*, 11 November 2019, accessed 30 March 2023. https://venturebeat.com/ai/ai-ethics-is-all-about-power/

[31] D Malan, 'Technology is changing faster than regulators can keep up - here's how to close the gap', *World Economic Forum*, 21 June 2018, accessed 5 April 2023. https://www.weforum.org/agenda/2018/06/law-too-slow-for-new-tech-how-keep-up/

[32] Abraham, S Kenneth and R L Rabin, 'Automated vehicles and manufacturer responsibility for accidents', *Virginia Law Review* 105, 2019, accessed 14 April 2023.

[33] Hill, Kashmir and Kilgannon, Corey, 'Madison Square Garden Uses Facial Recognition to Ban Its Owner's Enemies', *The New York Times*, 22 December 2022, accessed 16 April 2023. https://www.nytimes.com/2022/12/22/nyregion/madison-square-garden-facial-recognition.html

[34] T Hsu & S Thompson, 'Disinformation Researchers Raise Alarms About AI Chatbots', *The New York Times,* 13 February 2023, accessed 3 April 2023. https://www.nytimes.com/2023/02/08/technology/ai-chatbots-disinformation.html

video content, or audio. AI-generated disinformation might be used for the purposes of harassing or blackmailing individuals, influencing political outcomes, spreading propaganda, or causing civil unrest. Harassment using fake or illegally obtained data may affect anyone, however, women may be at a particularly high risk, for instance via stalking or sexual harassment. As access to this kind of technology grows and the quality improves this will become a larger concern for governments, businesses and individuals.

Box 2. Deepfakes

Deepfakes enable the creation of fake videos of real people that appear realistic. The technology is powered by neural networks analysing large data sets of existing video footage to mimic a human being, including their physical appearance, mannerisms, voice, body language, and expressions. This technology presents a major security risk for governments, public figures, and even individuals, with the potential possibility that realistic videos could simulate anyone saying or doing anything. Deepfakes could be used to blackmail, discredit or embarrass individuals, and examples have already been created of Donald Trump , Barack Obama , Vladimir Putin , and others.

The rise of individuals using social media as a news source increases the likelihood of people coming in to contact with and spreading political deepfakes as real news. The online, viral spread of disinformation also makes it harder to regulate the creation, publication and sharing of deepfakes.

Deepfakes are also being used to scam. In 2022 thousands of Americans were scammed by deepfake technology impersonating their loved ones and asking for money. The simulated voice could respond to prompts and questions, and the call even appeared to be coming from the imitated person's phone number. The program only needed a short 10 second clip of someone's voice to accurately replicate it.

Impacts of AI and related technologies on the economy

Impacts on productivity and the consumption of resources

Businesses are likely to become more productive as AI and related technologies become more advanced and more widely available. This is because AI systems are usually developed to assist humans to undertake certain tasks or to complete tasks on behalf of humans. These systems will therefore often be used to complement human labour (produce more output with the same labour) or used as a substitute for human labour (produce the same output or more with less labour). In some industries, AI may also be used to make more efficient use of other inputs such as machinery or energy.

Box 3. Office productivity tools

Many companies are in the process of incorporating the latest generation of generative AI models into office tools like word processors, spreadsheets and presentation programs. One such example is Copilot, an upcoming service announced by Microsoft which combines large language models (LLMs) with personal and public data stored in Microsoft Graph and the Microsoft 365 (M365) applications. According to Microsoft, Copilot will impact the way users work in three main ways:

1. Creativity – Copilot will allow users to jumpstart the creative process as it can generate the first draft of reports, presentations and data visualisation dashboards.

2. Productivity - From quickly drafting suggested replies in Outlook, to summarizing key discussion points from meeting transcript in Teams, Copilot will allow users to focus on work that is productive rather than low-value tasks like drafting meeting minutes.

3. Uplevel skills – Copilot will allow users to utilise M365 functions and programs that they have not yet mastered. Powered by GPT-4, users will be able to use relatively simple prompts to generate outcomes that they previously could not. For example, using the Power Platform to automate a repetitive process or to create a chatbot which would have previously required the involvement of an Azure Specialist.

Within the education sector, teachers are using AI to reduce the administrative burden of their roles and increase their productivity. According to a recent news article[35], ChatGPT is already being used by some teachers to draft unit outlines and lesson plans which allows them to dedicate more time to engaging with students.

As the technology continues to advance, AI is expected to drive further improvements in productivity. However, the timing, magnitude and precise nature of these impacts depend on complex interactions between research activities, technological interdependencies, and sporadic discoveries. This makes it difficult to forecast the impact of AI over any specific timeframe. For example, the development of fully autonomous vehicles would have a substantial influence on the productivity of industries including commercial passenger transport, logistics, mining and many others. However, many predictions of when autonomous vehicles would become widely commercially available have proven inaccurate.[36]

It is even more difficult to predict whether AI will have an impact on the pace of productivity enhancing innovation, and how strong and persistent this effect may be. Some commentators have argued that AI will accelerate the pace of technological change, for example through AI systems that self-improve or generate their own discoveries. AI is already being used in some scientific fields to run experiments, find solutions and even come up with new research questions.[37] However, many commentators are sceptical that

[35] K Roose, 'Don't ban ChatGPT in Schools. Teach with it.', *The New York Times, 12* January 2023, accessed 13 April 2023. Don't Ban ChatGPT in Schools. Teach With It. - The New York Times (nytimes.com)

[36] L Clarke, 'How self-driving cars got stuck in the slow lane', *The Guardian,* 28 March 2022, accessed 25 May 2023. How self-driving cars got stuck in the slow lane | Self-driving cars | The Guardian

[37] Bianchini, Stefano, Moritz Müller, and Pierre Pelletier. 'Artificial intelligence in science: An emerging general method of invention', *Research Policy* 51, 2022, accessed 14 April 2023.

higher productivity growth would be sustainable in the long-run, and argue that a continuation of existing productivity trends is more likely.[38]

In the long run, the increase in productivity delivered by AI could benefit many workers through higher wages and all consumers through lower prices. This is because higher productivity enables businesses to produce more goods and services. Where there is sufficient competition, this leads to lower consumer prices which in turn enables consumers to afford a higher standard of living. An important exception is where businesses can exploit market power to capture the benefits of higher productivity in the form of profits. For example, if a business had a monopoly on a productivity-enhancing AI technology, it could capture most of the benefits in the form of higher profits directed to capital owners, and consumers in general may not benefit from lower prices.

AI-powered efficiency gains could also deliver broader societal benefits, such as environmental benefits resulting from AI systems that identify or enable more efficient use of resources. For example, precision agriculture uses AI powered drones to manage areas of pest infestation and target the application of pesticides. The future use of these drones may help reduce the use of pesticide, cutting the cost of food production as well as mitigating the environmental impacts of agriculture by reducing chemical run off.[39] On the other hand, the high computing and processing demands currently required to train generative AI models, such as GPT4, has negative environmental impacts. Such impacts relate not just to energy and water consumption, but also to disposing of e-waste and the impacts of mining resources for processor components.[40]

Impacts on markets for products and services

Emerging AI systems are likely to enable businesses to develop new products and services that were previously impractical or impossible to offer or provide. It is difficult to predict innovative developments in advance, but historical precedents illustrate how AI can underpin the creation of entirely new products and services. Examples include:

- Image recognition apps that identify artworks, plants and animals
- Subscription-based AI companions using AI-powered chat functions
- Live-translation of text and turn-based translation of conversations.

Markets for other goods and services may shrink or vanish as they are replaced by new markets or become less attractive to consumers than AI-assisted products and services. For example, the introduction of self-driving cars would not only represent a significant change to the product offering of the automotive industry but also radically reshape the courier and taxi services industries.

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[38] Damioli, Giacomo, Vincent Van Roy, and D Vertesy. 'The impact of artificial intelligence on labor productivity', *Eurasian Business Review* 11, 2021, accessed 13 April 2023. The impact of artificial intelligence on labor productivity | SpringerLink

[39] 'Drone and mapping tech', *Queensland Government Department of Agriculture and Fisheries*, 8 February 2023, accessed 6 April 2023. Drone and mapping tech | AgTech (daf.qld.gov.au)

[40] Rohde, Friederike, Maike Gossen, Josephin Wagner, and Tilman Santarius. 'Sustainability challenges of Artificial Intelligence and Policy Implications.' *Ökologisches Wirtschaften - Fachzeitschrift* 36–40, 2021, accessed 6 April 2023.

Box 4. AI Travel Agents

Expedia recently announced a ChatGPT powered chatbot , which can construct bespoke holiday plans and make recommendations on anything from accommodation to transportation and local attractions. Other travel booking companies have already flagged that they will be launching ChatGPT plugins to their websites and mobile phone apps. According to Forbes , travel agents are likely to retain their job security in the short term by drawing on personal experience and access exclusive travel offerings. However, as AI-powered services continue to improve, particularly in their ability to process real-time data, they may become increasingly capable of competing with intermediary services such as travel agents.

There is a possibility that AI discoveries could lead to or exacerbate market failures, for instance if firms are able to gain monopoly control over productivity-enhancing AI technologies and use their market power to set excessive prices. However, it is also possible that some AI systems could facilitate greater competition and more efficient outcomes. For example, the adoption of credit decision algorithms may allow firms with smaller workforces to compete with larger operators, including by offering online-only loans that leverage the resulting lower cost bases to offer lower interest rates or fees.

Impacts on employment

In some fields it is likely that AI will enable the automation of tasks that were previously performed by humans. As a result, demand for workers with those skills may fall, which could be realised through job losses, reduced hours or a change in role for some workers. The impacts of task automation on employment are likely to vary widely across industries and time frames, and any workforce reductions are likely to be distributed unevenly. However, research suggests that automation is likely to affect workers at all income levels, with some middle and high-income roles exposed to automation due to generative AI.[41]

Affected workers who lack the skills demanded in the new economy may experience periods of unemployment or reduced wages. Some displaced workers will be able to retrain, but others may struggle to develop new skills and may therefore experience worsened employment outcomes on an ongoing basis. It is also possible that in some industries the threat of AI-powered automation may be enough to depress wage growth, for instance where automation becomes possible but remains more expensive than human labour so long as wages remain sufficiently low.[42] [43]

[41] T Eloundou T, S Manning, P Mishkin & D Rock, 'GPTs are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models', 27 March 2023, accessed 14 April 2023. [2303.10130] GPTs are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models (arxiv.org)

[42] Leduc, Sylvain, and Zheng Liu. 'Automation, Bargaining Power, and Labor Market Fluctuations', *Federal Reserve Bank of San Francisco,* Working Paper 2019-17, 2019, accessed 14 April 2023.

[43] Lordan, Grace, and David Neumark. 'People versus machines: The impact of minimum wages on automatable jobs', Labour Economics 52, 2018, accessed 13 April 2023.

In many fields, AI may complement human workers by augmenting human capabilities and decision-making skills.[44] [45] The resulting value added to products and services may increase employment in these industries. Productivity gains for workers with skills in high demand are likely to lead to increases in their wages. For these workers, higher living standards would be realised through either higher incomes or the ability to earn a similar income from fewer hours. The effect of AI on wages is therefore unclear but likely to vary significantly by industry. Some experts are concerned this uneven impact of AI on wages could exacerbate income polarisation between countries and within countries.[46]

There is also no clear consensus on the net effect of AI on overall employment. For example, the World Economic Forum's *2020 Future of Jobs* Report predicts that emerging technologies including AI will create more jobs than they destroy, but notes that job creation was slower than job destruction in the most recent year of data.[47] While it is impossible to accurately predict the long run impact of AI on employment, analogous historical periods of technological change have not led to permanent increases in the unemployment rate. However, a period of structural adjustment is possible where job seekers take longer to find appropriate jobs because the skills of the workforce do not match the skills demanded by employers. Over time it is likely that the skill profile of the labour market will adjust towards highly demanded skills as new or reskilled workers replace retiring workers with skills that are no longer in high demand. It is important to recognise however that this adjustment period may last until the end of the working lives of some individuals, and the risk of this outcome could exacerbate existing vulnerabilities or create new vulnerable cohorts.

[44] A Agrawal, J Gans & A Goldfarb. 'Power and Prediction: The Disruptive Economics of Artificial Intelligence', *Harvard Business Review Press*, 15 November 2022, accessed 14 April 2023.

[45] P Aghion, C Antonin, S Bunel & X Jaravel, 'The Effects of Automation on Labor Demand: A Survey of the Recent Literature', *CEPR Discussion Paper* No. DP16868, 8 January 2022, accessed 14 April 2023. DP16868.pdf (cepr.org)

[46] Acemoglu, Daron, and Pascual Restrepo. 'Robots and jobs: Evidence from US labor markets', *Journal of political economy* 128, 2020, accessed 14 April 2023.

[47] World Economic Forum, 'The Future of Jobs Report 2020', 20 October 2020, accessed 13 April 2023. https://www.weforum.org/reports/the-future-of-jobs-report-2020

Preparing for an AI-rich world

AI is changing rapidly and there are concerns that government, businesses, and individuals will not be able to keep up with the pace of change. As discussed, we are already seeing swift evolution of emerging technologies, as exemplified by the trajectory of programs like ChatGPT. The pace of new developments is difficult to forecast. Expert predictions on the date of Artificial General Intelligence vary from as early as 2032[48] or as far as 2059.[49] It is clear that despite uncertainty around when new capabilities will emerge, we must be prepared to appropriately handle them. Currently there are significant limitations to AI, however we should acknowledge that future developments may lead to technology outpacing human ability in many areas. Having a strong understanding of the function, abilities and limitations of AI will assist jurisdictions in determining the best way to employ and regulate the technology.

In this section we will revisit the impacts identified earlier in the paper and analyse some of the ways individuals, economies and societies will need to prepare, touching on the new skills, regulations, and foresight capabilities that will enable us to play an active role in shaping the future.

Private individuals

To realise the potential benefits of AI in their daily-lives, individuals will need to be capable of safely and effectively engaging with AI. Providing clear and unambiguous instructions in a format easy for an AI system to interpret will help ensure it generates the desired output. Individuals may also benefit from a high-level understanding of the capabilities, strengths and weaknesses of different AI systems. This should help ensure that individuals engage with AI critically and help mitigate the risk of using AI in inappropriate ways.

The potential misuse (intended or unintended) of AI means that individuals will need to have the skills to safeguard their privacy and protect themselves from undue influence. Digital literacy and awareness of good privacy practices will be essential. Individuals will also need to be capable of thinking critically and verifying information through research to avoid being tricked or manipulated.

Investing in certain fundamental skills, traits or capabilities may help individuals to protect themselves against any negative psychological or cognitive effects. This may include investing time into certain activities that have positive cognitive side-effects, such as those involving deep thinking, critical reasoning or creativity. It may also be necessary for individuals to learn skills or put in place techniques that ensure reasonable limits are put on the use of AI and related technologies, especially where there is the potential for addictive or otherwise unhealthy engagement.

Already vulnerable individuals may have particularly acute need for certain skills, or the need for other skills in addition to those identified above. For instance, children may be at particularly high risk of harm from scams, misinformation or inappropriate content. As a result, it is likely to be crucial that they develop protective habits and skills early in life.

[48] Metaculus, 'When will the first general AI system be devised, tested, and publicly announced?', n.d., accessed 19 May 2023.

[49] AI Impacts, '2022 Expert Survey on Progress in AI', 3 August 2022, accessed 19 May 2023. 2022 Expert Survey on Progress in AI – AI Impacts

Businesses and other non-government institutions

To fully realise the benefits of AI, businesses and other non-government institutions will need to make changes to their executive leadership, workforce capability and infrastructure. Executives will need to provide leadership on how AI should be implemented and used in the workplace. This will involve engaging in future-focussed thinking to follow and predict advances in AI, and encouraging the use of new and innovative technology and techniques where AI will work alongside human workers.[50] For the reasons outlined above, businesses will need to invest in training and ongoing professional development for workers as well as employing experts with technical skills to support the effective and safe implementation and use of AI.[51] Given public concern around the potential risks of AI and nascent regulatory activity from government, businesses may also need to build additional capability in communications, stakeholder management and government relations. Finally, due to the rapidly changing nature of emerging technologies, businesses must be prepared to invest in infrastructure including up-to-date IT systems and supporting technology.[52]

Businesses and other institutions will need to put in place risk management approaches that are adapted to risks of a different nature and scope to those they are used to managing. New risk management approaches will need to be developed that address technical risks such as privacy breaches or bias, social risks such as human rights violations and inequality, and systemic risks such as civil unrest or interference in democratic processes. These risks will be greater where important decisions are delegated to AI, where AI systems are made available to non-expert users, or where institutions are developing very advanced AI systems with a range of competencies. Institutions that fail to adequately manage risks could experience reputational harm, find themselves at a competitive disadvantage or even lose the social licence to operate.

All institutions will need to continue investing heavily in privacy and data protection while also building capability to identify and counter malicious attacks by AI systems. Combining technical expertise with foresight capabilities is likely to be crucial for identifying and mitigating the risk of unintended consequences of AI usage. Firms that offer AI-powered services may also need to allocate significant resources to monitoring and moderation to prevent their systems from producing inappropriate or harmful content, and to prevent the use of their systems in inappropriate or harmful ways.

Governments and regulatory agencies

Governments that use AI to develop policy or deliver services will have to manage similar risks to those outlined above for businesses and other non-government institutions. Due to the broad responsibilities of government, these risks may involve greater potential for harm or be more diverse in scope. As a result, governments will need to invest in many of the same capabilities as businesses and other non-government institutions. This will include privacy and data protection, ethical design, IT security, monitoring third-party use, and moderation of outputs.

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[50] 'AI in the workplace: What should CEOs really be thinking about?', *BusinessThink*, 5 July 2022, accessed 17 April 2023. AI in the workplace: what should CEOs really be thinking about? - UNSW BusinessThink

[51] 'AI in the workplace: What should CEOs really be thinking about?', *BusinessThink*, 5 July 2022, accessed 17 April 2023. AI in the workplace: what should CEOs really be thinking about? - UNSW BusinessThink

[52] Deloitte, 'Is your organisation ready to harness the potential of AI?', *Harvard Business Review*, 29 March 2019, accessed 17 April 2023. Is Your Organization Ready to Harness the Potential of AI? - SPONSOR CONTENT FROM DELOITTE (hbr.org)

One of the most important responsibilities of governments will be to provide the frameworks that help businesses and individuals realise the benefits of AI, while also adequately mitigating risks and protecting vulnerable individuals and communities. Jurisdictions are currently experimenting with different approaches to regulating AI, with different countries or regions deciding to prioritise addressing different regulatory problems. At this stage there is no common consensus on regulatory best practice.

Governments will also play a role in driving innovation of AI and other emerging technology. Many governments have already put in place funding to support AI innovation or built regulation that enables innovation.[53] In the past, governments have been responsible for major technological revolutions, such as the invention of the internet via a U.S. government research project and the invention of wireless local area network (WiFi) by the Australian Government agency CSIRO.[54] [55] In the future, we can expect that governments may continue to drive and fund innovation into priority areas, such as AI.

The pace of technological change will mean policy makers will need to think flexibly and react quickly. Analytical capabilities such as data science and technical expertise in AI are also likely to be of increasing importance to policy development and monitoring. The diverse ways in which AI might be used in different sectors means that policymakers will need to bring together expertise from across numerous disciplines to understand new and emerging capabilities and determine how best to respond. For AI regulation to be effective policy makers will also need to collaborate effectively with businesses and non-government institutions. Government will also need to be able to engage closely with the public to understand the impacts of AI and to build social licence for beneficial policies.

Box 5. The European Union's AI Act

A major example of an attempt at large-scale regulation is the European Union's (EU) AI Act, which is expected to come in to effect in 2023. The Act is primarily focussed on data quality, accountability, transparency, ethics and human oversight.

The Act proposes 3 risk categories: unacceptable risk will be completely banned (e.g. technology that involves social scoring), high-risk systems will be heavily regulated (e.g. résumé ranking tools), and other systems will be largely unregulated. While this system does not regulate all AI technologies, it is designed to ensure that enough resources are dedicated to regulating programs with the highest risk to ensure regulation is effective.

The release of ChatGPT has stalled the progression of the Act as it does not fall neatly within the risk categories. As a result, the EU is reconsidering how technologies will be categorised, especially when the range of tasks they can perform grows. This highlights the need for regulation to be flexible to account for unexpected changes in technological capabilities and in the ways people and businesses use the technology.

[53] OECD AI Policy Observatory, 'Policies, data and analysis for trustworthy artificial intelligence', n.d., accessed 25 May 2023. The OECD Artificial Intelligence Policy Observatory - OECD.AI

[54] Robert E. Kahn, 'The role of government in the evolution of the internet', in *Revolution in the U.S. Information Infrastructure*, 1995, pp. 13-24.

[55] CSIRO, 'Bringing WiFi to the world', n.d. accessed 25 May 2023. Bringing WiFi to the world - CSIRO

Workforces

Advances in the capability of AI will change the demand for different skills and reshape the structure of the current workforce. Some experts predict that the overall share of jobs that require lower skill levels will continue to fall and the share of jobs that require higher skill levels will increase, a continuation of historical trends.[56] Others predict that low-skill and high-skill workers may remain in demand while demand for middle-skilled jobs will fall, creating a large income disparity between two large groups of workers.[57] On the other hand, in some fields AI may reduce the technical skills required for entry, for instance workers might be able to prompt AI systems to produce some types of code instead of having to learn to code themselves. In this scenario the skill level required for some positions may become lower. The impacts of these trends will vary from industry to industry. For example, generative AI is already being used to replace labour in some creative industries, while non-routine manual tasks, like cleaning, are still mostly performed by human labour.

At least in the short-term demand is expected to grow for digital skills like software automation, AI and data analysis, and new skills like prompt engineering. Skills where AI capabilities remain poor, or where human capabilities complement AI capabilities, will remain in demand. In the short to medium term this is likely to include complex reasoning, critical thinking and other "transversal skills" such as common sense, intuition, creativity, extrapolation and morality. The emergence of new AI technologies is also likely to result in the development of entirely new skills requirements. For example, to skilfully extract high quality outputs from AI systems users may require training in prompt engineering.

Some specific skills, like driving, may eventually become mostly redundant in the workforce, although predicting when this might occur is challenging. As a result, at times in the next few decades large numbers of displaced workers may need to retrain in new skills to avoid economic hardship. Other basic skills may no longer be used directly but may still have indirect effects that make it beneficial for workers to maintain. For example, handwriting skills became less economically relevant with the introduction of digital technology into most workplaces but might remain useful as a comprehension and memorisation tool.

[56] A Heath, 'Skills, Technology and the Future of Work', Reserve Bank of Australia (RBA), 16 March 2020, accessed 11 April 2023. https://www.rba.gov.au/speeches/2020/sp-so-2020-03-16.html

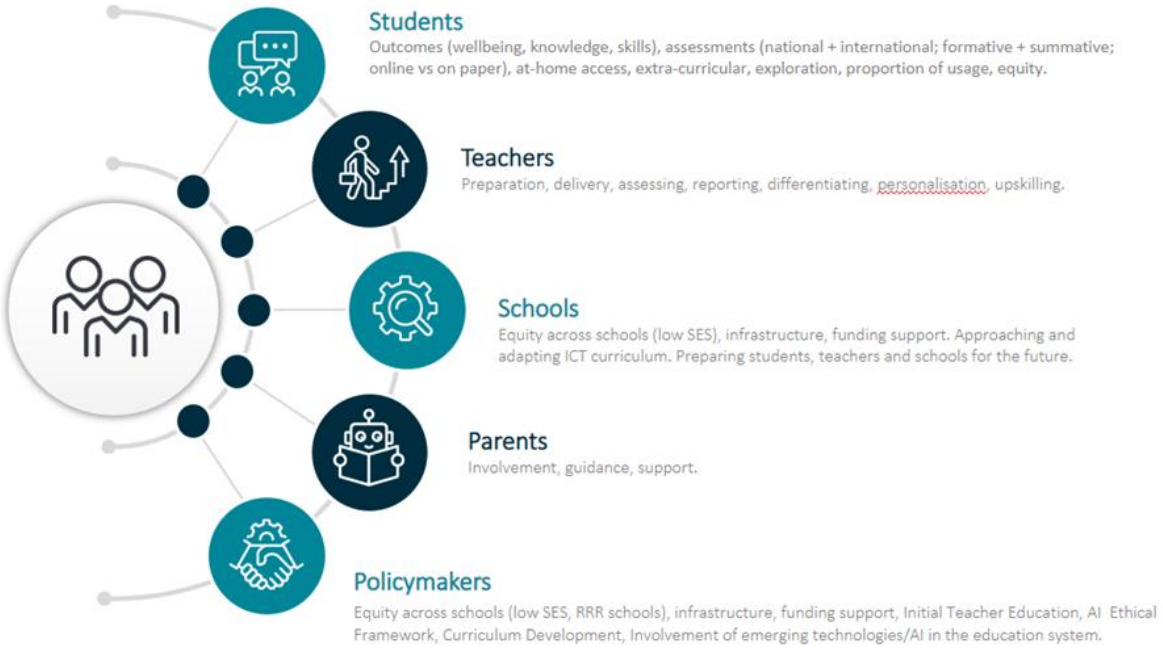
[57] Munro, Mark, Jacob Whiton, and Robert Maxim. 'What jobs are affected by AI?', 2019, accessed 13 April 2023.

How should education systems respond to AI and other emerging technology?

Based on the above discussion, we have developed questions for discussion and consideration. The questions focus on the impact of AI technologies on several key agents within the education system. We will be seeking feedback from HSPT II countries on these questions during phase two of the HPST II project.

The questions below have been drafted to guide the work that will be undertaken during Phase 2 and 3 of this HPST II workstream. The questions focus on the impact of AI on key actors within the education system.

Figure 1. Key Actors



Questions for consideration in Phase 2 and 3

Your feedback on the questions we should consider in Phase 2 and 3 is requested.

Students

1. How might AI and emerging technology change the knowledge and skills students will need from their education?
2. How might AI and emerging technology be utilised by students for in-classroom learning to allow student-centred, differentiated and personalised learning?
3. How might AI and emerging technology be utilised by students for out of classroom learning, including extra-curricular activities/homework?
4. What skills might students need in order to maximise the benefits of AI in the future?
5. How might using AI and emerging technology affect student wellbeing and self-regulation skills?

6. At what age/year level would it be appropriate to introduce students to AI and emerging technologies?
7. How will at-home and recreational use of emerging technologies affect students in the classroom?
8. How will the individual use of education devices effect students in the classroom? (e.g. laptops and other devices used for school work in the classroom)

Teachers

9. How might the advancement of AI and emerging technology change what knowledge and skills teachers should be equipped with?
10. How might teachers' delivery of lessons in classes progress and change while AI and emerging technologies are increasingly adopted?
11. How might teachers' planning and preparation for classes change in response to AI capabilities?
12. How might teachers use AI to complete, or assist with their administrative tasks?
13. How might teachers engage students in outside of class learning using AI?
14. How might the ways in which teachers assess students need to change in response to AI capabilities?
15. How might AI change teachers'/schools' approach in the monitoring of student wellbeing?
16. What things would teachers need to do to protect against digital harms to students, themselves or to the school's reputation?

Schools and School Systems

17. How should equity be ensured within schools (e.g., low SES)?
18. How should schools prepare students for the jobs and society of the future?
19. How might curriculum implementation change? Will the nature of subjects offered at schools need to change in response to possible skillset shift?
20. How should we prepare our teachers and school systems for the future?
21. What technology, tools or equipment might teachers and students need access to?
22. How will schools manage changing cost implications associated with increasing adoption of technology?
23. How might AI change the measurement and tracking of each student's progress across subjects?
24. How might AI change the ways schools monitor the wellbeing of their students?
25. How might schools protect against digital harm to students, teachers or the school?
26. Will schools be able to employ teachers to run possible new niche subjects in the future given existing workforce shortage?
27. Will AI technology be able to address some aspects of teacher workforce shortages?

Parents

28. Will there be frameworks or advice placed for parents' involvement in AI and emerging technologies?
29. How would parents best support students in using emerging technologies/AI in their learning?
30. What would the role be for education-related emerging technologies/AI usage in the home? (e.g. homework tasks involving personalised learning pathways, etc.)
31. What resources are there/would there be for parents to understand the impact of emerging technologies/AI on children's learning and development?

Policy makers

32. How might policy makers ensure equity across schools (low SES, RRR schools)?
33. What changes will be needed to Initial Teacher Education to support future teacher candidates?
34. How will AI Ethical Framework be developed?
35. How might Curriculum development and implementation keep pace with the continued evolution of AI and emerging technologies?
36. Where should EdTech be utilised in the education system?
37. What goals should the education system be striving for?
38. How should the aggregate outcomes of AI use within education be measured and evaluated?
39. How can governments support schools to select suitable EdTech products?
40. How can governments contribute to safeguarding students and teachers?
41. How can governments best support in-service teachers to use EdTech safely and effectively?
42. How can governments promote the study of AI and emerging technologies and ensure our students have the skills they need for the future?
43. Will AI and emerging technology be able to address some educational challenges such as teacher shortages; disadvantaged students, etc.?

Appendix 1

Table 1. HPST II workstreams

	Phase One Task (Jan 23 – Dec 23)			Phase Two Task (Jan 24 – Dec 25)		
Workstream	**Task description**	**Lead**	**Support**	**Task description**	**Lead**	**Support**
Develop a deeper set of perspectives on human flourishing	Explore and reconcile Western and non-Western beliefs and discourses relating to human flourishing	Kristjan Kristjansson (International Expert)				
Update and enrich our understanding of AI's impact on societies, economies and individuals; and the implications for education	Build a comprehensive picture of current and future developments in AI and related technologies, analysing the challenges and opportunities they create for societies, economies and individuals	Vanessa Lapthorne (Australia)	Stuart Elliott	While continuing to update this picture, tease out its implications for education goals and competencies	Vanessa Lapthorne (Australia)	
Strengthen our perspective on the orientation of education for human flourishing	Develop the argument that through the learning process we each discover how we wish to shape the future for the better	Otto Scharmer (International Expert)	Finland, British Columbia	Propose a new approach to equity in education: enabling everyone, irrespective of background, to discover how we wish to shape the future for the better	Otto Scharmer (International Expert)	Finland, British Columbia
Validate and develop the competencies associated with education for human flourishing (adaptive problem-solving, ethical decision-making and aesthetic perception)	Rigorously test proposed competencies. In what ways do they support human flourishing? To what extent are they human and not robot competencies? Analyse PISA 2018 data. What can we infer about current student performance in these competencies?	Michael Stevenson	NCEE	For each competency, develop a framework, an assessment methodology and perspectives on related subjects and curricula. Analyse PISA 2022 Creative Thinking data: what can we infer about current student performance in these competencies?	Mario Piacentini	Estonia and Finland
		Lucia Chauvet and Miyako Ikeda			NCEE	Estonia and Finland
					Stéphan Vincent-Lancrin	Estonia and Finland
Deepen our understanding of how the learning environment can support education for human flourishing	Drawing on the OECD innovative learning environment project, create a framework and underpinning principles	Singapore and Christine Goh (International Expert)	Estonia and Germany	Consider how best to combine guided, active and experiential pedagogies to nurture the suite of competencies associated with education for human flourishing	Singapore and Christine Goh	
					Estonia and Stéphan Vincent-Lancrin	

				Consider the role of digital technology in facilitating education for human flourishing, including the potential to generate real-time student data for multiple purposes	Estonia	
Equip teachers and leaders to drive forward education for human flourishing	Develop a framework and underpinning principles for future teachers and leaders	Valerie Hannon (International Expert)	Lucia C, Sophie F, IB	Derive, design and prototype strategies for developing future teachers and leaders	International Baccalaureate	Sophie Fenton
Consider the implications of education for human flourishing for education systems	Develop perspectives on what education for human flourishing means for each phase of education	NCEE Christina Hinton (International Expert)		Analyse how different system models might optimise education for human flourishing outcomes	NCEE	
Develop an approach to education for human flourishing metrics	Create a metrics framework linking education to human flourishing	Tyler VanderWeele (International Expert)	Stuart Elliott and British Columbia	Derive, design and prototype education for human flourishing metrics, at student and system level	British Columbia	Stuart Elliott
Consider the implications for OECD surveys of education for human flourishing	Analyse the potential to include the competencies associated with education for human flourishing in future PISA cycles			Suggest what education for human flourishing means for the long-term PISA roadmap and other OECD education surveys	Michael Stevenson and Lucia Chauvet	