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On the impact and potential of AI in education

Fang Ou, December 2019 (with updates in May 2020)

This report provides a background of key literature and international policy documents that will facilitate discussion on integrating artificial intelligence (AI) into the education system of Aotearoa New Zealand. It aims to address the broad questions – what does AI mean for the future of learning and teaching? What will this mean for future teachers? We anticipate the extent to which AI may impact the education sector so that informed and appropriate policy decisions can be made.

1. Motivation

1.1 AI is a technology that will transform societies around the world. The pace of technological change fuelled by AI is expected to be very fast. Like electricity, the impact of AI will be significant and far-reaching, transforming lifestyles, social norms, work, policies and education.[1] This rapid pace and large scale create pressure to transform educational practices, institutions and policies. There is a need to monitor how political interest in AI technologies is translated into policy agenda worldwide and assess how these policies might be relevant in the Aotearoa New Zealand context.

1.2 Education is a crucial foundation of a nation's wellbeing, economic productivity and competitiveness, and our next generation needs to be appropriately prepared for the future of work. Recent developments in AI and machine learning will have wide-reaching effects on future job markets and capability requirements. AI could amplify skill differences and make some jobs

obsolete while emphasising others, which will have a profound impact on some individuals whose occupations may be made 'technologically redundant'. It is therefore important that the education system is future-oriented and adapts to the workforce needs of the 'AI era'.

1.3 **AI will change why we teach.** The current education environment was designed primarily for the needs of an industrial society. AI will change the context where learning occurs, and why it is required, hence, it will be necessary to reconsider both the content and the functions of education in this new AI-driven society.[1]

1.4 **AI will change how we teach**. AI technologies have demonstrated the potential to enable new ways of teaching and learning. While 'AI-augmented' education has the potential to equalise opportunities for learning, it may also amplify inequalities, spread biases and routinise old institutional practises. AI technologies may reorganise classrooms or even redefine the role of the teacher. Thus, a strategy is required to enable systematic and effective nationwide implementation of AI technologies for education.

1.5 **Opportunities of harnessing AI for education in Aotearoa New Zealand.** This report highlights four opportunities of leveraging AI technologies for our national education system:

(i) assisting teachers via AI-augmented teaching

(ii) expansion of adaptive, equitable and inclusive learning

(iii) the option to rethink the aims of education, and

(iv) transform education planning and management.

In the following section, we describe related international education and policy developments and outline a set of potential risks and benefits for each of these four opportunities.

2. Brief background of AI

2.1 **The concept of AI is not new**, and the first fundamental theories were described in the early 1930s.[1] The recent AI boom arose from the availability of cost-effective computer processing power and the abundance of vast amounts of data. Generally, there are two types of AI:

- **Artificial narrow intelligence** (ANI) is the type of AI capable of outperforming humans in a narrowly defined task. Typically, the creation of narrow AI requires large amounts of human-labelled data from which a model or pattern is learnt.[2] ANI represents the most advanced AI systems available today and will be the focus of this report.

- **Artificial general intelligence** (AGI) is the concept of machines having human-like general intelligence, for example, learning across different situations and reacting to the unexpected in complex environments.[2] It is expected that the arrival of AGI is still several decades away.

3. AI-augmented teaching and learning

The opportunity

3.1 AI technologies can free teachers from routine tasks. Currently, teachers spend a significant amount of time on routine tasks such as marking assignments and addressing students' commonly asked questions.[3] Such tasks, which have clearly defined, explicit cause and effect outcomes, are well suited to automation by AI programs. Freed from repetitive tasks, teachers will have more time for higher-level tasks such as the design and improvement of teaching methodologies, student guidance and in-person talk and discussion.

3.2 AI-based programs for grading assignments have been developed and implemented in selected institutions worldwide. In addition to reducing the amount of time teachers spend on grading assignments, these programs can reduce inconsistencies caused by human errors and biases and speed up students' learning by providing detailed and immediate feedback. Conventional applications for automated grading are limited to either relatively unambiguous domains, such as maths and physics, or for fixed template assignments, such as multiple-choice quizzes. With the advancement of AI methods such as natural language processing for understanding text and image recognition for interpreting handwriting, automatic grading of worksheets, exams and even essays are now possible.

The *Criterion*® Online Writing Evaluation Service (USA)

- *Criterion*® is a web-based, teacher-led evaluation tool that provides students with immediate feedback about their writing.[4]
- It uses a proprietary *e-rater*® scoring engine which provides both annotated diagnostic feedback and holistic scoring based on level-specific models built from essays scored by trained readers. The engine offers feedback on the structural features of writing, such as grammar, style and organisation. The algorithm-generated holistic score reflects the overall quality of the writing and is said to be in close agreement with human scores.

Source: https://www.ets.org/criterion/about/

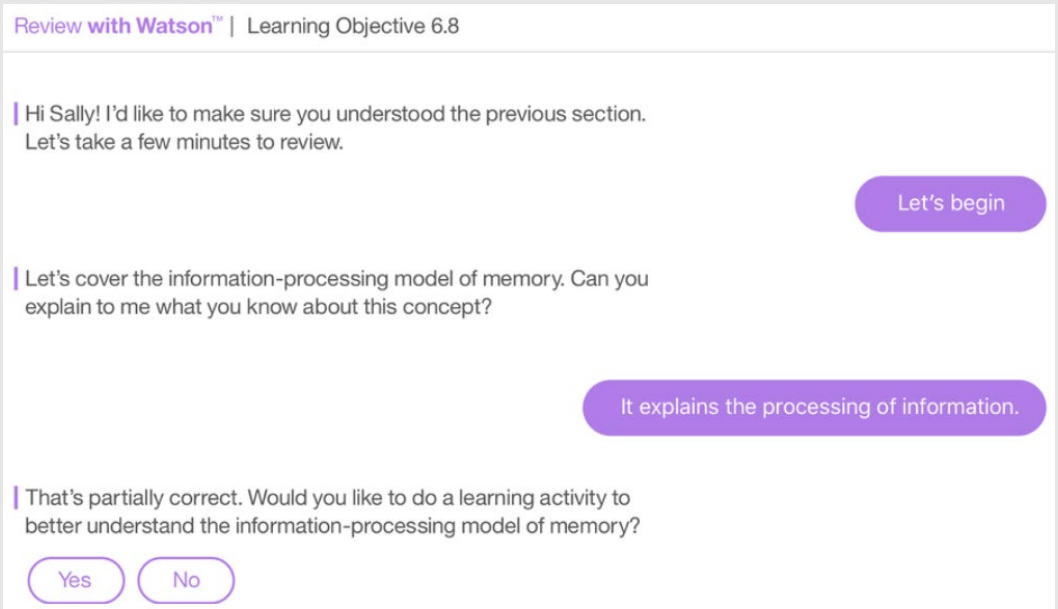
- The writing evaluation program helps students improve by providing real-time scores and instant diagnostic feedback on writing submissions. However, it does not grade the content of the writing and thus cannot take the place of teachers' comments and feedback. Nonetheless, the Criterion tool helps to maximise the teachers' time for assessing the content and style of students' writing.
- Criterion is currently being used globally by schools, universities and institutions.

3.3 AI-based technologies such as intelligent tutoring systems (ITS) can assist students' learning. An ITS is a computer system that aims to simulate and provide the benefits of a one-to-one tutoring experience. ITS typically consists of a *student model* representing the current state of student's knowledge, a *domain model* representing the knowledge to be learned, and a *pedagogical model* that makes instructional decisions.[1] As a result of the student's interaction with the system, ITS can provide automated diagnostic data to the students so that they can reflect and re-evaluate their approaches.

3.4 ITS provides insights which can be used to enhance teaching. After collecting enough user data, an ITS can generate sophisticated student models and learn patterns of interaction from which insights can be derived. Analysis results from the ITS help teachers understand common ways in which students think and identify areas of weak understanding that require additional support. Thus, in addition to assisting with learning, ITS provides an efficient way of monitoring students' learning processes which helps guide teachers in adapting the content and methodology of their teaching. Some ITS are even beginning to use AI to characterise student attention, emotion and conversation dynamics, which is used to recommend optimal groups for collaborative learning in the physical or virtual classroom.[1]

IBM (USA) and Pearson's (UK) Cognitive Tutor ITS

- The IBM-Pearson tutor is an integration of IBM's AI technology, Watson, into Pearson's courseware.[5]
- The cognitive tutor is a digital resource that contains detailed knowledge of the course content and understands students in their natural language. It can provide students with explanations, ask them questions to check their understanding and assess the student's responses and offer feedback. Thus, students can work at their own pace and get specific help in real-time.
- The cognitive tutor helps teachers manage their class by providing insights about how well the students are learning, highlighting areas of common misconceptions and identifying students who require additional help.



Source: http://www.aaronsickler.com/higher-education-tutoring

Implications for teachers

3.5 Understanding the limitations of AI and the importance of the teacher. The teacher's role remains pivotal in institutional education, despite the possibilities of using AI to automate specific routine tasks. Firstly, there is extensive evidence on the importance of having human guidance in the learning process. There are also the creative and socio-emotional aspects of this relationship that go beyond knowledge transmission.[6] Secondly, AI's ability to imitate routine tasks such as grading assessments and answering FAQs remains limited. It currently requires oversight and moderation from the teacher. Current AI-based educational technologies are built using enormous amounts of historical data, which may present ethical and pedagogical implications. In the case of fully automated assessments, the AI system would assess new submissions based on the criteria learnt from past essays and their corresponding grades given by humans. Depending on the amount and variety of essays used in its development, the AI system will be susceptible to bias of many kinds – such as cultural variation in language use – and may struggle when encountering unexpectedly creative and innovative work.[1] Thus, generally, recommendations from AI systems should be taken critically, and the final decisions remain that of the teacher.

3.6 Teachers need new competencies to take advantage of new emerging technologies. Use of AI technologies in the classroom has the potential to help develop students' critical knowledge of AI from a young age. However, to effectively integrate emerging technology tools to enhance education, it is not enough for teachers to know how to use ICT tools that have AI capabilities. Teachers also need to structure the learning environment in new ways, to understand the limitations of these new tools and merge their use with pedagogy approaches. Collaborative skills are enshrined in the Aotearoa New Zealand curriculum and form core features in te ao Māori / Te Marautanga o Aotearoa (the Māori curriculum statement). Aotearoa New Zealand is currently one of the top OECD countries in collaborative problem solving by 15-year-olds, and there is an opportunity for us to add value and lead international practices in this area. With the acceleration of new digital tools adoption, design skills and developer expertise are required to develop professional practices that help students learn collaboration, problem-solving and creative use of technologies with AI-capabilities. Therefore, training and ongoing professional development of teachers should include advanced digital and technology skills and knowledge of AI and its various applications.

3.7 Developers of AI products must engage with teachers. Dialogue between AI developers, policymakers, education researchers and teaching professionals, both Māori and non-Māori, should inform the design and creation of new AI tools for the classroom. Teachers have professional knowledge about what works in the classroom environment. For widespread uptake of new technology, it is important that teachers are involved in the conversation from the beginning and that their needs, wants and concerns are heard and taken onboard. Perspectives from te ao Māori are fundamental to this process.

Selected international developments in teacher training:

UNESCO ICT Competency Framework for Teachers (ICT-CFT)

- UNESCO and its partners CISCO, Intel ISTE and Microsoft developed an updated technology competency framework for teachers (ICT-CFT)[7] in 2011, which identified the competencies that teachers should develop to use technology effectively in the classroom. The ICT-CFT is aimed at helping countries to develop comprehensive national teacher technology competency standards in an era of rapid scientific developments.
- The ICT-CFT proposes that teaching methods need to adapt to evolving knowledge societies. Students need to be enabled not only to gain in-depth knowledge of their school subjects but also to understand how they themselves can create new knowledge using the new available technologies.
- The framework is organised into three approaches that connect education policy with economic development:
  - i) 'Technology literacy approach' – incorporation of technology skills into the school curriculum, to increase the extent to which emerging technology is used by students and the workforce.
  - ii) 'Knowledge deepening approach' – increase the ability of students and the workforce to use knowledge to solve complex, real-world problems and create value for society.
  - iii) 'Knowledge creation approach' – increase the ability of students and the workforce to innovate, create new knowledge and benefit from this knowledge.
  - iv) The Beijing Consensus recommended that AI skills should be integrated into ICT competency frameworks for teachers.[9]

Teacher training – a part of the UK's national AI strategy

- In May 2019, the UK government released its national AI strategy,[8] which contains plans to work with schools, universities and industry to ensure a highly-skilled workforce. They will invest £406 million in skills, specifically maths, digital and technical education. This figure includes funding to upskill 8,000 computer science schoolteachers.

Implications for learners

3.8 AI-augmentation of the classroom may bring new interface technologies for interacting with digital tools. In its current state, AI technology can only be as good as the training data that is used to build its models. Naturally, technology creators will be interested in increasing the variety and amount of training data to ensure the reliability and superior performance of their AI. User interface technology collects real-time input from learners as well as their historical data, which can be used by the AI to model the individual. Thus, commentators anticipate that in the coming years, there will be substantial commercial interest to push various types of user interface and sensor technologies to the classrooms.[1] There is also interest from education

technology companies to gain access to other learner relate data sources, such as gaming and social media platforms.[1]

3.9 New AI-enabled assessment methods can potentially change the nature of educational assessments. The current education system uses a combination of summative assessments which measure student outcomes of a programme for evaluative and effectiveness judgments and formative assessments which measure student progress during the process of learning for instructional and learning decisions. Due to the reliance on summative assessment for reporting and credentialing, and with pubic visibility it often comes with high stakes for the learner and teacher which can place pressure to narrow the focus of education to ensure good performance in the assessment. The fairness of the summative assessment is another area of concern, and there are ongoing debates about their effectiveness in the evaluation of learning. AI can enable automatic assessment generation and evaluation, as well as new ways of measuring the engagement of students in the learning process. It is possible that the high reliance on summative testing will be lessened by the increase of frequent, low-stakes AI-driven formative assessments.[1] With such ongoing formative assessments, broader evidence may be incorporated for assessing skills and competencies.

Recommendations and commentaries

3.10 Encourage innovation with funding of a national R&D strategy. Development of methods for monitoring and measuring the impact of AI in education should inform educational guidelines and policymaking. In order to build up evidence-based practices of effective incorporation of AI in education, school-wide pilot tests should be encouraged.

3.11 AI technologies have the potential to enhance teaching and learning but should be used with caution. Due to its relative novelty, there is limited guidance and evidence on the effective use of AI in the classroom. Thus, it is recommended to apply AI where the benefits clearly outweigh the risks. Feedback from teachers needs to be incorporated in the development of AI tools for education. Aotearoa New Zealand should commit to data ethics guidelines, such as those published by Stats NZ, with input from the Data Ethics Advisory Group.

3.12 Ensuring that teacher training is in alignment with national development goals will enable education to help develop our nation's economy and society. The Beijing consensus,[9] a document published by UNESCO that offers guidance for harnessing AI technologies in education makes the following recommendation about training of teachers: "Dynamically review and define teachers' roles and required competencies in the context of teacher policies, strengthen teacher training institutions, and develop appropriate capacity-building programmes to prepare teachers to work effectively in AI-rich settings."

4. Towards adaptive, equitable and inclusive learning

The opportunity

4.1 AI-based adaptive learning platforms (ALP) can improve education equity and inclusivity. ALP is a computer system that optimally delivers customised resources and learning activities to address the unique situation of each learner. With ALP technologies, students in a class can progress through learning tasks at their own pace instead of as a collective at the same time. ALP avoids the need to stream classes according to students' ability and addresses the challenge seen in modern classrooms where teachers are unable to put individualised growth-focused

teaching to practice consistently. The ALP is designed to keep all students engaged as it can optimise learning objectives, instructional approaches and contents according to the student's own understanding, abilities and needs. This enables a shift from the current, industrial model of education to one that is focused on individual learner growth and achievement.

The democratisation of quality education in Brazil using the 'Geekie' ALP

- Geekie is a web-based ALP accredited by the Brazilian Ministry of Education that assists learners to self-educate and self-assess for the Enem (Brazilian national exam).[10]
- Geekie aims to democratise quality education in Brazil via personalised delivery of the school syllabus to students in digital lessons that combine video, images and text. It also quizzes and assesses students and passes this data onto their teacher. With increased use, the software provides more personalised content and becomes better at identifying the student's learning difficulties for prompting teacher assistance.
- Geekie has reached more than 12 million students and is currently used by more than 5,000 schools across Brazil[10].

Technology-assistance for those with learning difficulties in the UK

- The City of London Academy (Southwark) has a strategic approach to using technology to enable students with dyslexia and other learning difficulties to achieve their full potential within the mainstream classroom environment.[11]
- All students are screened for literacy needs in Year 7, and subsequently, those identified to have additional needs can use a computer in class and for summative assessments.
- The built-in word processing capabilities, as well as the ability to convert between text and speech, help students overcome difficulties with handwriting, spelling and reading.
- Technology assistance enables students to demonstrate their capabilities beyond their difficulties, as it allows teachers to see past the illegible handwriting or incomprehensible spelling errors to see the thinking and good intentions that have been put into the work.

4.2 New skillsets are needed to thrive in the 21st-century economy, and lifelong learning (LLL) is required to keep up with the rapid pace of change. It is important to increase the number of highly skilled workers, but perhaps more important and urgent is the need to ensure that low skilled workers are not marginalised. Numerous sources view low skilled workers are most vulnerable to job displacement as a result of AI and its applications. Increasingly, there is global recognition of the importance of LLL, with many industries considering LLL as the appropriate skill formation strategy for the 'new economy'.[12] LLL not only enables the workforce to keep up with the rapid evolution of necessary knowledge and skills, but it is also a way of reskilling disadvantaged individuals for the transition to new jobs.

4.3 AI has fuelled the need for continuous adaptation and change but also presented new approaches of LLL to keep up with the changes. It is often challenging for individuals who are in the middle of their lives to pause their careers, relocate and dedicate years to studying at educational institutions. Thus, to increase the appeal of LLL, courses need to be shorter and

more convenient location- and timewise. One approach to encouraging LLL is through massive open online courses (MOOCs). Anyone can enrol in MOOCs, which provides an affordable and flexible way to learn new skills. Despite support for the MOOCs initiative from the world's top universities, the effectiveness of MOOCs is debatable.[3] Due to the often self-driven nature of MOOCs, simple measures such as participation, persistence, completion and satisfaction may be insufficient and more sophisticated metrics should arise. ALP (section 4.1) and ITS (section 3.3) present an effective way of orchestrating and supporting self-motivated education, both of which can be adapted and integrated to enhance the effectiveness of MOOCs and the shift to micro-credentialing.

Selected international initiatives to promote LLL:

Singapore's SkillsFuture initiative

- SkillsFuture is Singapore's movement to providing LLL and skills development opportunities to its citizens, with a view to support the nation's economic advancement.[13] The initiative aims to unlock the full potential of all Singaporeans, regardless of their education and work backgrounds.
- An array of policy instruments is used to provide resources and support for those who are at school, in their early career, mid-career or even those who are expecting a change in their career. The SkillsFuture portal is AI-enhanced to provide custom course and content recommendations to the user.
- The Singaporean government provides every citizen aged 25 and above 500 SGD (approximately 570 NZD) worth of SkillsFuture credit to invest in their personal learning. This sum is topped up periodically and can be used for a wide range of courses from local tertiary institutions, other approved training programmes or MOOCs.
- Since the launch of the initiative in 2016 to the end of 2017, more than 285,000 Singaporeans (approximately 5% of the national population) have used their SkillsFuture credit.
- In 2019, SkillsFuture partnered with IBM to launch a suite of educational material on AI and its application in areas such as media, human resource and supply chain management.[14] Through this partnership, they plan to train 2,500 Singaporeans in AI and related emerging skills within the next three years.

UK's National Retraining Scheme (NRS)

- The UK government has committed to the development of a National Retraining Scheme to support people to re-skill. An initial investment of £64 million has been allocated in part for digital training[15].
- In preparation for the NRS, several pilots and associated projects have been carried out with the aim of boosting the participation in adult learning, these include:
    - *The flexible learning fund,* which encompasses 30 projects that test the design and provision of flexible and accessible methods of learning for working adults with low or intermediate skills. Most of the projects provide accredited functional skills qualifications, and the majority make use of technology, with most offering a combination of online and in-person learning.
    - *The adult learning technology innovation fund,* which has received £5 million from the government to encourage technology companies to develop solutions that use AI to improve the quality of online learning for adults. Businesses and education providers will be encouraged to use AI to develop personalised and engaging online training opportunities, and career guidance services for adults.

Implications for teachers

4.4 Teachers matter even more in adaptive learning classrooms than they might in traditional ones. With ALP technologies, teachers can spend more time responding directly to student queries, gain deeper insight into each individual's learning progress and style, and act as mentors and motivators. The technology can both make more time available for teachers to design the curriculum, and also add resources for that curriculum.

4.5 Addressing teachers' hesitance to adopt ALP is key, as they need to trust the tool in order to implement it in the classroom effectively. Choosing the right type of ALP from a suitable service provider will be crucial. Many adaptive learning systems can be customised to the needs of the school, so teachers have the option of retaining their own curated teaching material and embedding these into the ALP. It may be beneficial to use ALP in the professional training of teachers so that they gain familiarity with and experience in the technology from the student's perspective. As outlined in section 3.5, teachers will need new competencies in order to take full advantage of the capabilities of ALP and other AI-enabled technologies.

4.6 Be selective with how AI is used to help. The use of AI to promote specific skills – such as text-to-speech conversions or ITS enhancing writing quality – will not replace the need to learn foundational literacy, language and numeracy skills. This is because many of the advanced skills such as critical thinking and advanced maths, are built upon fundamental skills, including reading, writing and basic mental arithmetic.

Implications for learners

4.7 As it becomes technically possible to monitor student actions, attention and emotions in real-time, privacy and security become ever more important. As described in section 3.7, with AI-augmentation of the classroom, we can expect the integration of individual's data from various sources, including social media platforms. AI systems can provide improved personalisation and

services when given more user information, but there are also risks that come with a large concentration of data (more on this in section 6).

4.8 There will be learners who are uncomfortable with extensive reliance on technology, and it is important not to exclude them. Education providers should always strive to help learners (and if necessary, their guardians) understand the benefits and risks involved with using AI technologies and provide them with the choice of opting out if there are concerns. Learners should not be disadvantaged or excluded if they choose alternative learning methods.

4.9 How personalised are the recommendations from AI-based learning systems? In many cases, recommendations may be based on a large set of previous user data. Depending on the age, educational and cultural background of the population whose data was used to build the model, the recommendations may be biased and yield sub-optimal results when used on a different group of learners. This issue of bias may be mitigated if the recommendations are based on the own learning history of the student, or if a dataset that is representative of the final user population is used to train the models. In any case, ALPs used in other countries may have to be extensively modified to fit with our nation's local curriculum and culture.

4.10 A nationwide cultural change is needed to encourage LLL. Currently, undergraduate education consists mostly of those who are between the ages of 18 to 23. This concentration of learning at the beginning of one's life is expected to have the greatest return and is largely based on the historical assumptions that jobs rarely become obsolete. However, due to the rapidity of change in today's society, individuals have to continually upgrade and reskill to stay longer in the workforce. Thus, instead of it being the exception for people aged 30 to 60 to undertake tertiary or other forms of professional education, it needs to become a widely accepted norm. Accordingly, course design should reflect their modes of learning and needs.

Recommendations & commentaries

4.11 Promote equitable and inclusive use of AI in education. The Beijing consensus[9] published by UNESCO makes the following recommendation about AI, equity and inclusivity in education: "Reaffirm that technological breakthroughs in the field of AI in education are an opportunity to improve access to education for the most vulnerable groups. Ensure that AI promotes high-quality education and learning opportunities for all." Its development and use "in education should not deepen the digital divide and must not display bias against any minority or vulnerable groups." In fact, there are at least two forms of digital divide: the first is differential access to devices and infrastructure. The second is a phenomenon where students from poorer and less privileged communities display technology use patterns that are less complex and less educationally relevant. The shift to online and at-home learning during the COVID-19 pandemic has led to some efforts to redress differential access among Māori and Pasifika in particular; but the outcomes remain unclear. In addition, educational resources selected for Aotearoa New Zealand should be curated with input from relevant stakeholders to ensure its contents are appropriate for our unique cultural context.

4.12 Recognise the potential of AI as a general approach toward flexible LLL for all. The Beijing consensus[9] makes the following recommendation: "Adopt AI platforms and data-based learning analytics as key technologies in building integrated lifelong learning systems to enable personalised learning anytime, anywhere and potentially for anyone, with respect for learners' agency. Exploit the potential of AI to enable flexible learning pathways and the accumulation, recognition, certification and transfer of individual learning outcomes."

4.13 Effective LLL programs may require a tripartite approach involving the government, education providers and industries. Ongoing coordination with industry is needed to ensure that educational materials align with the needs of the labour market. As AI technologies advance, instructional programmes may need to be regularly rethought and redesigned. By enabling a highly-skilled and competitive workforce, our citizens have the potential to secure better jobs, higher incomes and enjoy higher standards of living and wellbeing.

4.14 Reformed safety nets are required to enable LLL and risk-taking. Currently, it is financially challenging for a person to take time off work between the ages of 30 to 60. The challenge is three-fold:

- the financial responsibilities are often the greatest for individuals at this age,
- it is difficult to obtain education loans later in life and
- access to superannuation savings are restricted before retirement.

The government may look to the example of other countries that provide incentives for either individuals or their employers to support learning and reskilling.

5. Rethink the aims of education

The opportunity

5.1 The shift from instrumental to developmental education. In the workplace, productive processes are being automated using AI more and more, and the nature of jobs is rapidly evolving. Educational institutions may need to reinvent themselves, as it is possible that formal education will play a diminishing role in directly creating job-related competencies.[1] The role of education in the future may shift away from the instrumental approach of 'preparing future workers for jobs' to the developmental approach of 'realising human potential' and supporting human development.[1]

5.2 Emphasise the teaching of human-centric 'soft' skills. With AI being able to help build knowledge and skills in defined areas, teachers will be more able to focus on other human capabilities. Experts believe that occupations that require human-centric intelligence are relatively unlikely to be automated and those skills often labelled as 21st-century skills will become increasingly important.[1] Thus, education may focus more on non-routine activities which require complex critical thinking skills, and both interpersonal (e.g. perspective taking, empathy and prosocial skills) and intrapersonal (e.g. self-control and persistence) skills. In addition to their importance for jobs that are unlikely to be automated, these skills can also contribute to improved mental health and wellbeing.[16]

Building social and emotional learning at the UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP)

- The UNESCO MGIEP[17] is an educational research institute based in New Delhi, established in 2012 by the Government of India in cooperation with UNESCO. The institute is developing programmes that promote social and emotional learning, innovate digital pedagogies and empower youth.
- One of MGIEP's projects focuses on harnessing the benefits of active-engagement learning (as opposed to traditional 'transmission' learning) through games. This initiative aims to transform traditional formal education, enabling new forms of learning that are needed to tackle the increasingly complex and multifaceted problems of the 21st century.
- Through its 'Games for Learning' project, the MGIEP is designing games and game-based courses conveying social and emotional skills. In particular, games are designed so that the learner becomes more mindful, empathetic, compassionate and critical. Examples of games developed include:

Source: https://mgiep.unesco.org/games-for-learning

    - 'World Rescue', a narrative, research-based video game inspired by the UN's sustainable development goals. The game is set in Kenya, Norway, Brazil, India and China, where learners help solve global problems such as displacement, disease, deforestation, drought and pollution. This game has been downloaded over 13,000 times.
    - A game-based course inspired by an Australian girl called Florence teaches learners about perspective-taking. It takes the learner on a journey of Florence's life and relationships, to explore the concepts of identity and gender.

Immersive learning through virtual role-play using Alelo (USA)

- Alelo[18] is an e-learning product and solutions company that leverages virtual role-play simulations for experiential learning.
- Alelo combines innovations in AI, social science and learning science to design learning programs for the specific needs of clients, ranging from schools and governments to corporations. Examples of simulation-based learning courses include:
    - 'Virtual Chinese' –a course developed by Alelo in partnership with the Virtual Virginia Online School. The course teaches Chinese in an authentic language environment. The learner is immersed in rich multimedia and interacts with socially intelligent virtual human avatars in dynamic scenarios.
    - The 'Tactical Interaction Simulator' – a tool initially developed for the Australian Defence Force School of Languages. The learner practices their communication skills

with a virtual avatar in the foreign language. The simulated encounter progressively increases in difficulty.

Source: https://www.alelo.com/tactical-interaction-simulator/

5.3 The importance of digital literacy in building resilience in the age of AI. Digital literacy encompasses two areas. One is understanding AI, and algorithmic thinking. In addition, there are skills sometime called critical literacy or critical thinking skills which include being able to evaluate information critically. The overall mastery of digital literacy will build students' resilience against increasing threats from misinformation, bots and social media incubators of extreme views. Classroom education should thus incorporate a greater focus on teaching AI and critical literacy to equip young people with the skills necessary to avoid such manipulation.

Developing critical literacy & reasoning in New Zealand classrooms

- A recent study[16] based in New Zealand showed that it was possible to develop critical literacy and reasoning skills in the classroom. The four-year study was part of a digital initiative in 16 primary and secondary schools serving mostly Māori and Pasifika families from low socioeconomic communities.
- The online collaborative reasoning (argumentation) tool posed students as first responders to a Google Groups discussion board. A topic provocation was provided along with hyperlinks to contradictory online evidence. The students were required to evaluate the evidence base, adopt an independent viewpoint and contribute to the group discussion board.
- Students who used the online argumentation tool and received guidance from their teachers developed an awareness of the limitations of single perspective argumentation in online contexts. They learnt to participate respectfully in online discussions and appreciated the value of healthy intellectual scepticism.

Digital skills learning through gamification using the PlayMaker programme in Singapore

- The PlayMaker Programme[19] developed by Singapore's Info-communications Media Development Authority (IMDA) aims to inspire young children to play and make with tech toys.
- In 2016, the PlayMaker programme introduced robots to the curriculum in 160 preschools to develop young learners' appetite for robotics, programming and computer science. Guided by teachers, children in the programme will practise their logical thinking, reasoning, sequencing, estimation and inventive thinking. The use of robots also encourages teamwork which in turn helps with the development of social and communication skills.

Source: https://govinsider.asia/smart-gov/exclusive-singapore-puts-robots-in-pre-schools/

Curriculum update for digital literacy in the UK

- In 2012, the UK's Royal Society published a report[20] that argued for the importance of digital literacy skills, which led to the design and implementation of a new computing curriculum in 2014.[3]
- Before the Royal Society report, the UK's old ICT education merely aimed for students to acquire basic technological capabilities, such as the general ability to use computers and its basic programs.
- In contrast, the new curriculum oriented towards fostering an understanding of fundamental principles in computer science and their applications. It also develops the learners' ability to analyse problems and understand how computer programs can be used to solve those problems.
- Desired learning outcomes are well-defined and proceed along four key stages from preschool, primary school, lower secondary school and upper secondary school.

Implications for teachers

5.4 Teacher's guidance will determine how well students learn human-centric higher-order thinking and social skills. There is evidence that using digital tools (e.g. computers, robots and games) in classrooms is associated with more focus, persistence and independence. However, the effectiveness of learning through digital tools is dependent on multiple factors. These include the quality of instructional support provided by the teacher and how well matched the students' abilities are with the activities they are assigned. The 'role model' aspect of the teaching profession will also be amplified due to the increased focus on inter- and intrapersonal skills, as these skills are most noticeable through in-person interactions.

Recommendations & commentaries

5.5 Be mindful of the systemic and long-term transformations of the labour market and ensure the relevance of education curricula. The Beijing consensus[9] highlights the need to align education with the needs of future jobs: "Update and develop mechanisms and tools to anticipate and identify current and future skills needs in relation to AI development, in order to ensure the relevance of curricula to changing economies, labour markets and societies." In addition, it emphasises that we should "be cognizant of the emergence of a set of [digital literacy] skills required for effective human-machine collaboration, without losing sight of the need for foundational skills such as literacy and numeracy."

5.6 Determining the role of AI in education needs a future-oriented strategy. There are many ways to imagine how AI can impact the future of education and increasingly, private ventures are seizing opportunities in this space. However, unless guided by clear pedagogical principles and foresight, it is likely that the AI vendors will provide solutions that address existing immediate problems instead of the underlying social and economic challenges. Thus, clear visions and policies are needed to align emerging technologies with the broader context of the future of education.

5.7 Building wellbeing and encouraging community participation. With the full or partial automation of numerous jobs in the future, a higher proportion of the population may be employed for fewer hours than ever before. Thus, arguably the education system should shift from preparing pupils for work to helping them make the most of life with increased leisure time. To achieve this, schools could emphasise the importance of other facets of life such as volunteering, civic engagement and creative pursuits. Such actions could benefit society by strengthening a sense of shared purpose and citizenry. To help facilitate this, the government could consider ways it can encourage partnerships between schools and local organisations and NGOs to undertake community participation and volunteering.

6. AI in education planning & management

The opportunity

6.1 The potential for AI-enhanced Education Management Information Systems (EMIS) to contribute to a more abundant and evidence-based policy and planning environment in education. An EMIS is a system that collects, stores, processes, analyses and disseminates information to support monitoring and planning for the education system. AI-enhanced systems would have a greater capacity to automatically analyse data and generate statistics and analytical insights for the education system, at the school, regional or national scale.

6.2 An efficient information management system enables dynamic decision making for education policy planning. The ability of AI-enhanced systems to integrate real-time data and rapidly produce analysis results can support dynamic decision making in every aspect of education sector management.[3] Moving forward, AI-enhanced systems open the potential for developing predictive decision-making algorithms that provide recommendations for decision-makers. Internationally, countries are increasingly interested in transforming their current system from a school- or cluster-based admin data management system into an integrated and dynamic learning management system.[3]

Leveraging big data for education policy in Chile

- In 2015, with the support of a $50 million loan from the Inter-American Development Bank, Chile launched its public education improvement programme.[21] The *Program to Strengthen Education Sector Management* seeks to improve the quality of the public education system in Chile by promoting effective strategic and educational management at both the central and local levels.
- Already, Chilean researchers have used open data published by the government to evaluate the connections between students' social, geographical and educational characteristics.[3] From this big data analysis, 127 features were extracted to create geographic models of educational opportunities. The outputs included detailed maps of the schools, access, academic results and drop-out predictions. Identifying the potential needs of particular areas can then be used to inform decision making regarding appropriate support interventions.

AI-enhanced EMIS in the United Arab Emirates (UAE)

- UAE's Ministry of Education has rolled out one of the largest learning analytics implementations in the world.[22] Its advanced EMIS has been adopted by over 1200 schools and 70 higher education institutions, impacting more than 1.2 million students nationwide.
- The Ministry's EMIS contains data on curricula, teachers' professional development, learning resources, performance reporting, scores from international assessments (e.g. PISA and TIMSS), operations, financials, and student/teacher/parental feedback.
- The convenient integration of information and efficient insight generation has helped educators to identify where students are struggling, evaluate the effectiveness of assessments and determine personnel needs and resource allocation priorities.
- At the policy level, the Ministry uses the new tool to anticipate, through scenario modelling, the likely impact of various interventions including changes in class size, expenditure per student, parental engagement and teaching time.
- Current developments are underway to provide each teacher in the UAE with a virtual teaching assistant similar to Apple's Siri. The virtual assistant is expected to enhance the teacher's role by advising on student learning pathways based on the behavioural data stored within its system.

6.3 Understanding the needs of the job market through AI-enhanced talent demand analysis. In addition to using AI and advanced analytics to monitor and plan to improve the education system, these technological capabilities can also help in the curation of educational content. The traditional way to understand skills demand relies on surveys, and it can take several years to analyse the findings and use them to adapt curricula and training. To address this problem, various public and private initiatives are developing AI systems to mine and analyse data for the purpose of understanding workforce needs. The real-time identification of in-demand skills can

help education providers plan relevant courses, future-proof people and organisations, and help learners make informed decisions about their own education and career pathways.

Labour Market Information (LMI) System in Greece

- The LMI[23] is a skills diagnosis mechanism launched in 2016 in Greece. It was developed by the European Centre for the Development of Vocational Training.
- The LMI system addresses the need for regularly updated and detailed information on medium-term trends in labour market needs. It aims to provide evidence-based data for designing education and employment policies.
- Governance of the LMI system is shared between Greece's Ministry of Labour and Social Affairs, its National Labour and Human Resources Institute, a scientific committee of experts and the National Employment Committee.
- Following its first few years of operation, the LMI system has already produced an initial set of concrete results which showed a demand for particular occupations and illustrated the distribution of skill levels. The system identified various highly demanded skills using data obtained from job vacancies, which include project management, adaptability, and understanding other languages.[24] This demand analysis emphasises the importance of the more human-centric skills such as communication, empathy and cultural agility.

6.4 A database system for AI innovation in the education space. AI-based systems that service the education sector can only be designed and generated if given the appropriate data. At present, certain data can be obtained online (e.g. skills demand data from mining job advertisements) but most existing datasets are independently distributed among various public or private ventures. To develop a cohesive effort toward AI-improved education planning and management, the organisation and governance of large datasets need to be addressed. Policymakers need to address the challenges of how to prevent a few large corporations monopolising the education data of citizens, and how to make some data more widely available to encourage innovation.

6.5 Design the database system for inclusion. To account for inequalities, any database should preserve an individual's learning outcomes as well as demographic factors such as gender, age, ethnicity, and socio-economic background. The generation of insights from such database systems will allow policymakers to determine the educational disadvantages experienced by specific portions of the society and to design the necessary support they require.

Implications for learners and teachers

6.6 Security concerns of a centralised database system. Retaining the personal information of both students and teachers – especially in the form of centralised large administrative data sets such as the Integrated Data Infrastructure (IDI) – poses a privacy risk, as large concentrations of personal data are attractive targets for cyber criminals.[3] Thus, it will be critical to maintain safeguards to prevent data theft.

6.7 Privacy concerns of a centralised database system. An important policy task is to manage how personal data can be used while ensuring that personally identifiable information and individual

privacy preferences are upheld. This is particularly challenging regarding young learners, who may be unable to legally express consent concerning the collection and use of their personal data. Presumably parents or guardians would need to consent on a child's behalf as per current ethics guidelines and future data ethics guidelines.

6.8 There is general public distrust in AI. Various studies and reports show a growing public distrust in systems that collect and use personal data, as individuals are often unsure of how their data will be used.[3] Part of the problem is that current AI systems are 'black boxes' with hardly any explanatory capabilities, which understandably makes people sceptical about their outputs. For this reason, it is important to keep humans in the decision-making loop and ensuring that each step towards the conclusion is based on reason and can be justified.

6.9 Data ownership and sovereignty must be respected. As per the Data Protection and Use Policy (DPUP), institutions and organisations are kaitiaki (stewards) of individuals' information and must respect and protect the rights of individuals. Data sovereignty and governance is of particular concern for Māori. Guidance should be sought from Te Mana Raraunga – the Māori Data Sovereignty Network in development of systems that collect, store and use Māori data.

Recommendations & Commentaries

6.10 Upgrade of the information systems will enhance educational data collection, processing and management. The Beijing consensus,[9] published by UNESCO, encourages nations to "be cognizant of the breakthrough in the use of data in transforming evidence-based policy planning processes. Consider integrating or developing AI technologies and tools that are relevant for upgrading education management information systems." A well-designed system will also be a step forward in helping policymakers ensure education provision is made more equitable and inclusive.

6.11 Ensuring the privacy and security of individuals' data needs to be prioritised. The Beijing consensus[9] recommends policymakers "be cognizant of the dilemmas of balancing between open access to data and data privacy protection." In addition, nations should "develop comprehensive data protection laws and regulations frameworks to guarantee the ethical, non-discriminatory, equitable, transparent and auditable use and reuse of learners' data." The *OECD AI Policy Observatory* launched in late 2019 could be a starting guide towards a common framework for the governance of ethical and transparent of AI technologies and data. The Observatory is undertaking work to combine resources from across the OECD with those of various stakeholder groups to facilitate dialogue and provide multidisciplinary, evidence-based policy analysis about AI.

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