The Educational Intelligent Economy – Lifelong Learning – A vision for the future

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Introduction

All the chapters in this book raise questions, albeit in different ways, regarding the role of Big Data, Artificial intelligence, Machine learning, and block-chain in education using a comparative perspective. However, the discourse surrounding the "value of cutting-edge technology" is not entirely novel, as the socio-political debates regarding the impact of technology on Comparative and International Education have been around since the early 1900s. When radio broadcasting was introduced to the world in the early 1920s, it was heralded as the `significant technological advancement that broke down barriers of distance and time' (Dousay and Janak, 2018, p. 556). While some educators embraced this new technology with enthusiasm, some feared it as a threat to their practice.

This shows that the idea of disrupting education using state-of-the-art technology is not new. From blackboards and typewriters to laptops and mobile devices; and from radio broadcasts to virtual online classrooms, the face of technology has changed drastically with fast-paced innovation, without any significant transformation in the systemic foundation of formal education. Then why the sudden need to consider the societal implications of the latest technological advances? Technological innovations perhaps began with the introduction of the modern library and the use of pencils in the mid-1600s and progressed to the first integration of computers in schools in the 1970s. However, technological advances since the 1970s have accelerated at unprecedented speed due to the developments in digital technologies. The impact that any other past technology could have had on education and society pales in comparison to the potential of computing, artificial intelligence, or blockchain technologies (Mayer-Schönberger & Cukier, 2013).

In this chapter, we posit that disruption is inevitable, and to transcend the disruption, it is necessary that we change our view of education. The idea that education ends once we receive our diplomas is not just obsolete but also dangerous. We live in a world characterised by innovation, uncertainty, and constant change. In such a world, adaptation and continuous learning are essential for survival. Lifelong learning is the key to stay relevant with the changing times. Rapid technological advances have accelerated the pace of the world that we are living in, and it shows no signs of slowing down. We argue that technology is not only altering the material environment, but has transformed the way we live, think, and perceive. Thus, it has also changed the way we absorb information and perceive knowledge.

This chapter presents the nuances and recent research trends spurred by technological advancements that have influenced the education sector and highlights the need to look beyond the technical boundaries using a socio-semiotic lens. With the explosion of available information and digital technologies pervading cultural, social, political as well as economic spaces, being a lifelong learner is pivotal for success. However, technology on its own is not sufficient to drive this change. For technology to be successful, it should complement individual learning cultures and education systems. This chapter is broadly divided into two main sections. In the first section, we contemplate a vision for the future which is deemed possible based on ongoing digital and computing advancements. The second section elaborates the technological, pedagogical, cultural, and political requirements to attain that vision.

Vision for the future

Future insight can be difficult to forecast. There is a tendency to predict the future based on the current norms and ways of being. Education, which is rooted in cultural norms and ways of being, is particularly difficult to forecast. Many education futures have been imagined in tandem with socio-technological developments – technologies that emerge and disruptions these engender. Often these technologies are absorbed into the socio-cultural values and norms of education in ways that augment, rather than disrupt. Lectures in classrooms become video lectures embedded within MOOCs. Multiple-choice assessments become online quizzes. Teachers' intuitions on which students are likely to pass exams become predictive modelling algorithms. Rather than provoking significant disruption, technological innovations are absorbed into educational systems that evolve incrementally. Ensuring beneficial outcomes in an educational intelligent economy requires a much faster cycle of change.

In 2012, the European Commission invited experts to develop position papers outlining a vision for lifelong learning in 2030 (European Commission, 2013). From the papers submitted, six futuristic visions were selected for further interrogation. These visions imagined a society where knowledge and work evolve rapidly, and people have to learn continually. Rather than following pathways pre-determined by teachers, autonomous learners would make choices about their own learning (Falconer, Littlejohn and McGill, 2013). In some cases, they might opt to join formal courses, but they would not limit themselves to predefined learning experiences to the education system we envision would empower learners to make their own decisions about what, when, and how to learn. Learners would have to be able to learn autonomously and socially. They would consider it natural to set their own goals and to use intelligent, digital systems to help them source learning resources and courses. These resources would be provided by a range of organisations spanning the private, public and third sectors.

Personalised knowledge and learning management would help learners navigate their learning pathways (Misuraca, Broster, and Centeno, 2012) and would also connect them with others who had similar learning goals (Littlejohn, Milligan and Margaryan, 2012). Intelligent, networked systems are needed to enable learners to operate across networked spaces, finding others with similar motivations and needs. These learners contribute to the learning of others not only through direct dialogue and interaction, but also through their digital traces that are collected and analysed using integrative systems (ibid).

Intelligent digital systems offer new means of accreditation through expert consensus and online activity-tracking. Thus, an assessment would be performed by a range of different types of people, including peers and experts in companies, not just by teachers. Smart algorithms would identify and measure when learning had been achieved, moving towards authentic forms of assessment embedded within, rather than separate from learning processes (Jackson, 2013).

For this sort of vision to become a reality it is not sufficient only to develop and embed technological tools within education systems. Fundamentally new systemic and individual cultures of learning, based on demonstrated capability and ability, have to be engendered (Canonne, 2013). Learners have to be able, cognitively and culturally, to structure their learning through connections with different communities and networks (Littlejohn, Falconer and McGill, 2014). This means learners have to be able to evolve their networks, strengthening links and striking out in new directions, depending on their goals. Thus, they have to understand how to move in and out of networks fluidly, developing close ties in tightly knit groups, recognising that learning requires them continually to develop links to new people and knowledge (ibid).

What we need to do to achieve that future

The previous section envisaged a potential future for education fuelled by rapid technological advances, and a gradual shift from the knowledge economy towards an educational intelligent economy. The vision for the future highlights the importance of lifelong learning, placing the learner and learning at the core of an educational journey. This calls for a fundamental shift in the provision of learning facilities, the digital competency skills that prepare learners to survive in an intelligent economy, and the government policies that can bring about systemic changes in the way learners are supported in their lifelong learning activities. In this section, we examine the pedagogical/cultural, technological, and political building blocks that have the potential to reify this vision for the future.

Digital competency and literacy

In a future that utilises technologies embodying the educational intelligent economy, as envisioned at the beginning of this chapter, a rapid shift in competencies is needed, matching the pace at which technology is evolving. As we prepare learners, both in schools and in the workforce, for a future that cannot be predicted with any certainty, it becomes critical that the competencies developed are flexible. This flexibility will enable individuals to adapt to new situations, rather than becoming an expert in a narrow field. This is particularly relevant with regards to digital literacy. Leu et al. (2004) described digital literacy as being 'deictic', referring to the rapid speed at which skills need to develop to remain literate. While it is possible to become an expert in a particular technology, such as Microsoft Word, this is no longer enough to be considered digitally literate, as word processing technology advances at an almost constant rate. The competency that is required is not the ability to use a particular tool, but the ability to learn to use new tools quickly (Leu et al., 2013).

This need for digital literacy becomes increasingly apparent when considering the shift of different education systems around the world to more technologically based ecosystems. In the field of higher education, many universities have begun to convert their classes into offerings on MOOC platforms, such as Kyoto University on the edX platform or Stanford University on Coursera ("KyotoUx," n.d.; "Stanford University Online Courses," n.d.). This move could, in theory, open up much of the world's leading knowledge, removing barriers such as high tuition fees. The increased availability of knowledge is an important step towards the vision of this chapter. Nonetheless, these opportunities can only be capitalised upon by those with the digital competencies required to effectively find and use such systems (Littlejohn and Hood, 2018).

Primary and secondary education has also seen a move towards the integration of digital systems into their supporting scaffolding. Blended learning, where learning is structured around the use of complementary online and offline activities, is becoming more common in pedagogical innovations, such as the flipped classroom (McLaughlin et al., 2014). Platforms to provide a potentially lifelong record of learning endeavours at different institutes are also beginning to become embedded in national education systems. Finland, for example, has developed peda.net: a platform that institutions of all types can use to create, distribute and manage content (Koskela, 2018). The premise of peda.net is to create a single record of education that can be a resource and reference for individuals throughout their lifespan. These types of platforms, if integrated across countries, hold the potential to enable comparisons of international educational systems based on big data generated by students and institutions alike. Currently, international comparisons such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) (Mullis et al., 2016; OECD, 2016), focus primarily on the results of standardised tests. Big data from an integrated system could afford more nuanced comparison, including educational data that expands beyond the formal education system, for example from workplaces.

As educational technology evolves it is also likely that digital literacy will rely on incorporating competencies that are often considered separate, such as communication (Voogt et al., 2013). Recent research has suggested that online courses that are designed with social elements are significant predictors of educational attainment (Rienties and Toetenel, 2016). Wegerif (2015) suggested that online platforms can become dialogic spaces for people from different backgrounds to come and share knowledge, perspectives, and create insights. Nonaka and Konno (1998) suggest that a place such as this is similar to the Japanese concept of 'ba': a physical, mental, virtual space where emerging relationships form and enable the creation of knowledge. Digital platforms already hold the potential to be examples of 'ba'. For these spaces to enable effective education, nonetheless, competence in being able to use the digital platform is not enough, as critical thinking and communication are also essential and can be considered parts of digital literacy in an educational intelligent economy.

The skills needed for digital literacy are similar to those that have always been needed for a society where information has been exchanged through in-person discussion and written documents. However, there are several additional skills that become even more fundamental, particularly critical thinking, as information can be created and distributed by anyone. In the past, a printed book needed at least to be reviewed by an editor, but in modern times anyone can create a website or blog to spread their views to a wide audience (Coiro and Dobler, 2007). It is essential that learners, both in school and the workplace, develop skills to be able to critically reflect on information they receive to intelligently use that knowledge and create new ideas. National curricula in schools are beginning to reflect this shift, such as in the Australian Curriculum (Australian Curriculum Assessment and Reporting Authority, n.d.). The

Australian Curriculum specifically states students must learn to use ICT effectively and appropriately to access, create and communicate information and ideas, solve problems and work collaboratively in all learning areas at school and their lives beyond school. However, many other countries fail to reflect this shift in focus in their curricula (Leu et al., 2011).

In addition to digital literacy, learners who have been empowered to follow personalised lifelong learning pathways will require the ability to regulate their education. Self-regulation of learning is a complex skill that has several dimensions, such as goal setting and assessment of learning strategies employed (Zimmerman, 2002). As such, there runs the risk that increasingly open educational opportunities will privilege those who have already cultivated metacognitive skills, widening the gap between those from advantaged and disadvantaged backgrounds (Allison and Hood, 2018). While this self-regulation is clearly needed in an educational intelligent economy, it is not always included in frameworks of 21st-century skills (Binkley et al., 2012; Voogt et al., 2012).

Technological advancements, nonetheless, have begun to address potential imbalances in self-regulation, as various software tools have emerged to scaffold these thought processes (Killi et al., 2016; Zhang and Quintana, 2012). These interfaces usually help students to regulate their own work via prompts delivered at the right time. Ensuring that any large-scale technological educational systems incorporates these affordances will be vital to minimising the digital divide.

Big data-based analytics also hold potential to facilitate intelligent self-regulation in the future. As highlighted by a report jointly written by the International Labour Organisation, Cedefop, the European Training Foundation, and the Organisation for Economic Cooperation and Development (ILO, Cedefop, ETF, and OECD, 2017), the needs of current labour markets could be available to learners by extracting data from job advertisements and databases of workers' skills. Having this information about the potential market value of different skills could enable learners to make informed choices about where to focus their developmental efforts. Also, learning analytics techniques could allow learners to have visualised feedback on their learning strategies and patterns as input for assessing their learning.

Technology

As discussed in the digital literacies section, our education curriculum is evolving to cater to the needs of a changing world. In this section, we examine the technological advances that have inspired and in some cases mandated this change, and critically review the advantages and challenges associated with it. Despite the flurry of scientific literature and academic discourse surrounding the role of technology in education, there is a lack of common understanding about the core concepts of artificial intelligence, big data, machine learning, learning analytics, and blockchain. In this section, we illustrate our understanding of each of these concepts, by delving into the discussion of the opportunities and challenges that they present, and the role they play in realising the vision for the future of learning in an educational intelligent economy.

Opportunities and Challenges of big data and artificial intelligence in education (AIED)

Due to the rapid evolution of the big data concept and proliferation of associated technology, a universal definition of big data is yet to emerge. However, there have been constant efforts to revise the definitions to accommodate the dynamic nature of big data. Based on the synthesis of all the contemporary interpretations of big data, De Mauro et al. (2015) have proposed a new definition that accounts for information, technology, methods, and impact of big data:

> *"Big Data represents the information assets characterised by such a High Volume, Velocity and Variety to require specific technology and analytical methods for its transformation into Value." (ibid, p.103)*

In the context of big data, volume refers to the massive amount of data available online. Administrative data such as student records or performance statistics, learning analytics data collected from online learning platforms such as clickstream data, online behavioural data, and data collected from networked sensors from the Internet of Things are typical examples of the large volume of educational data that can be obtained, stored, and analysed. The volume of data created is on the rise due to the increasing number of learners engaging with Open Educational Resources (OER), Massive Open Online Courses (MOOCs), and education management systems. According to the ICEF Monitor, enrolment in MOOC platforms alone surpassed 35 million students in 2015 (ICEF, 2016). Increase in the number of online learners naturally increases the rate of data generation. Velocity refers to the rate of data creation. One example of high-speed data creation is 'clickstream data' which are generated as students interact with course platform tools, content and with their peers through online discussion forums. Data created in the form of text messages (including Twitter feeds), images, or audio content during these interactions may be collected, processed, and stored in a meaningful way to allow for intelligent analysis. Data is generated rapidly and requires specialised technology for storage and retrieval. Variety describes the diversity of big data sources, such as images, textual data, tweets, and click-stream data. Data from these sources are often unstructured and even within the same source varies widely. For example, educational data could be in various formats such as video, audio, graphics, or simulations.

Big data techniques associated with analysing large volumes of complex varied learning data are being used by the emerging field of learning analytics in education (Siemens and Long, 2011). Analysis of student data to measure learning indicators is undoubtedly not a new practice. However, with advances in big data technology the field of learning analytics has gained momentum among education researchers (Williamson, 2017). With the potential for personalisation and targeted learning, learning analytics platforms have significantly influenced the enhancement of formal (Rienties and Toetenel, 2016; Siemens, 2013; Toetenel and Rienties, 2016) and informal education (Siadaty, Gašević, and Hatala, 2016), especially the lifelong learning community (Horrigan, 2016). How to efficiently use technology to support lifelong learners has been an ongoing discussion within the learning analytics community for a long time now. However, Kopper and Tatershall (2004) argue that specific characteristics of lifelong learners, such as their ability to self-direct their learning paths, should be considered before developing technological systems to support their learning.

Apart from big data and learning analytics, artificial intelligence has a significant role to play in an educational intelligent economy (Roll and Wylie, 2016). John McCarthy first coined the term 'artificial intelligence' during the Dartmouth conference (McCarthy et al. 1955). At its inception phase, artificial intelligence (AI) referred to the science of programming a machine to act intelligently, mimicking the actions of a human. It was during this conference that the concepts of neural nets, language simulation, complexity theory, and the relation of randomness to creative thinking crystallised to form the science of AI. Like big data, the term 'artificial intelligence' has been clouded by fragmentation (Brachman, 2006) and lack of universal understanding (Wang, 2008). Wang (2008) emphasises a strong need to agree upon a working definition for AI to have a guiding focus for AI research. Based on a thorough review of the literature, Wang proposed that the term AI can be used to refer to anything that is 'followed by the human mind, can be followed by computer systems, is not followed by traditional computer systems (p.372, 2008). Thus, it can be asserted that AI refers to the technological ability of any machine to visualise and learn from a large volume, variety, and velocity of data through pattern recognition, natural language processing, or other techniques that give an illusion of intelligence. Based on this definition, there are a plethora of examples of artificial intelligence being used in contemporary educational settings in the form of pedagogical agents (Veletsianos and Russell, 2013), authoring tools and ontologies (Blessing et al., 2018), and gamification of learning (Manske and Conati, 2005).

Despite the technocentric claims in favour of artificial intelligence and big data to revive traditional education systems, success has been more difficult than anticipated and there are a number of problems limiting their applications. These challenges are not just restricted to the intricacies of sourcing, storing and analysing big data, but extend into much more profound levels of ethical, legal and social implications. Learning data can be obtained from multiple sources such as LMS data, social media data, or administrative data. To enable comparability, data must have standardised quantitative and qualitative indicators that offer insights for fair usage in policy and practice. Other issues relate to the assumptions underlying the interpretation of the data. One danger is the over-simplification of the complex interpretation and analysis processes. Gathering micro-level learner data is complicated, not only because the variables are complex, but also because it requires intensive data-gathering and real-time analysis. The available data is limited to online learner activity, with evidence of offline activity and cognitive development often unavailable. Moreover, there are significant ethical implications associated with the use of student data (Slade and Prinsloo, 2013), such as transparency, consent, and rights to seek redress. Concerns over data ownership, privacy, and digital exclusion brought about by algorithmic biases are the major challenges associated with artificial intelligence in education that need to be addressed:

1) Data Ownership:

One of the most debated questions regarding the vast repositories of unstructured and multi-formatted data is, 'who owns this big data?' (Nielsen 2014). This question becomes especially vital in a future where lifelong learning would be the norm, where an ownership battle would ensue between corporate institutions that capture learner data and the individuals whose data is being tracked. Since these challenges of the digital age are relatively recent, the laws and policies regulating such issues are still in their infantile stage, and hence must be deliberated with extreme caution. In one of the rulings of the Court of justice of the European Union, an individual's right to be forgotten was upheld over the company's property rights, even though the company had made a huge investment in collection of that data (European Commission 2014). This highlights the ethical conundrum regarding ownership of data. Does it belong to those who have collected it or to whom it is collected from? Even if the EU ruling that data belongs to the individual is taken as a precedent, episodes such as the Facebook and Cambridge Analytica scandal has made it clear that individuals do not fully comprehend the intricacies of data captured from their online activities, let alone possess the skills to be prudent about its ownership. Future policies governing the ownership of educational data must be mindful of these ethical concerns.

2) Data Privacy:

Educational institutions that capture learner data justify it under the pretext of providing personalisation of learning preferences and adaptive recommender systems. The traditional privacy measures resorting to consent mechanisms lack the transparency needed for educational data (D'Acquisto et al. 2015). The consent procedures adopted in such cases are reduced to a mere tick-box activity, where the terms and conditions are presented in convoluted legalised terms, leaving the learner feeling less in control over their data. Although there are laws in place, such as the right to object to the possession of one's data, it is very rarely exercised. Learners must be made aware of their rights, and emphasis must be placed on user control and transparency. The European Union's General Data Protection Regulation (GDPR) that came into effect May 2018, is an important step in the direction of strengthening online privacy rights in response to the 'technological progress and globalisation that have profoundly changed the way our data is collected, accessed and used' (European Commission, 2012). GDPR takes an innovative approach to the traditional concept of 'consent' and 'personal data', by accentuating the role of transparency, and mandating data controllers to communicate 'in a concise, transparent, intelligible and easily accessible form, using clear and plain language' (EU GDPR - Art.12, 2015). Apart from transparency, the GDPR also mandates 'data protection by design and default' (EU GDPR, 2015b). Thus, any data collection activity will have to account for encryption, and anonymization of data. For achieving the vision for the future of lifelong learning, such legal and technological solutions pertaining to data privacy should form the crux of educational political discourse.

3) Digital exclusion due to algorithmic biases:

Despite measures taken to ensure data privacy and transparent processes, it is important to recognise that complete transparency is difficult to achieve due to the machine learning algorithms that underpin any technology. Burrell (2016) contends that algorithms are inherently opaque, and it is impossible to have a clear idea of the trajectory traversed by the algorithm in arriving at classification decisions. She further asserts that the opacity of algorithmic decision making is further clouded by the imperfect knowledge about the inputs used by the algorithm. This is especially dangerous when it comes to education systems, because biased inputs, such as missing data on certain sections of the society, may further increase the societal divide. For example, the digital inclusion evidence project carried out by AgeUK in 2013 revealed that approximately 8 million adults in the UK are offline (Green and Rossall 2013). O'Neil (2016) warns about the perils of digital exclusion, as she asserts that algorithms used to analyse big data 'tend to punish the poor' (ibid, pg.8). When we envision a future of lifelong learning supported by intelligent algorithms, they play a key role in opening access to learning opportunities, better job prospects, and effective social interactions. Thus, digital exclusion means large proportions of society are under-represented in terms of their needs and expectations. To circumvent these challenges, it is imperative that educational policies account for the digital inclusion of learners from all strata of society.

Opportunities and challenges of Blockchain in Education

Any discussion about the future of education in an era dominated by complex technologies is incomplete without the mention of blockchain technology. The term blockchain refers to a public decentralised trustless ledger that does not require a central authority for regulating the transactions but is powered by algorithmic policing between networked nodes. Satoshi Nakamoto coined the term in 2008, to refer to the technology underpinning the alternative currency called Bitcoin. Since then there has been an increasing interest in the concept of the blockchain, mainly because of its affordances of precision, security, and data integrity for transactions on a global and universal scale, which as discussed above, was previously deemed impossible. After cryptocurrency and smart contracts garnered significant interest both from the academic and industrial community, the applications of blockchain in education are now being explored as part of the blockchain 3.0 wave (Swan, 2015).

United Kingdom's Open University was among the first to recognise the potential of blockchain in education, as their innovating pedagogy report listed it as one of the top ten innovations to influence education (Sharples et al., 2016). An important study in this context was carried out by European Commission's Joint Research Centre (JRC). An imperative conclusion of this study was that although the role of blockchain in education is still at the 'infancy' stage, the blockchain technology offers significant possibilities from a social perspective such as 'self-sovereignty, trust, transparency and provenance, immutability, disintermediation, and collaboration' (Grech and Camilleri, 2017, p.8). As per the JRC report, blockchain technology is posited to help secure and permanent storage of records, to enable educational institutes to issue reliable certificates, and to track lifelong learning achievements without any reliance on a central authority for validation. Although there is an increasing body of scientific literature examining the potential of blockchain in education (Chen et al., 2018; Sharples and John, 2016), one of the major limitations is that majority of the research in this area is concentrated on security and privacy, and little attention is given to increasing the scalability of blockchain (Yli-Huumo et al., 2016). In her book 'Blockchain – blueprint for a new economy', Swan (2015) categorises the challenges associated with blockchain in three broad categories: technical, business models, and public perception. Technical challenges such as issues of latency, wasted resources, and usability may restrict the large-scale implementation of blockchain technologies in education, but research is underway to address these challenges.

Government Policies

As technology, big data, and learning analytics are harnessed to empower more personalised and tailored educational experiences; several ethical issues arise that require careful consideration from the perspective of government and organisational policies. This section will examine several of the ethical concerns that are inherent in the vision described at the beginning of this chapter, before making recommendations for how government policies should address these issues to safeguard the rights of learners.

Linked closely to the topic of algorithm bias is the idea of inclusion and exclusion on digital platforms. As previously mentioned, an algorithm can only produce recommendations on the data available to it, and this can lead to valuable offline data not being taken into consideration when personalising education. As described in the vision that began this chapter, an educationally intelligent society would potentially move away from education being viewed as a formal process, embracing the value of a variety of ways to develop, such as learning on the job or taking part in any kind of problem-solving activity. Systems to support educational activities are increasingly evolving to incorporate big data, but the data currently available captures little of these alternative modes of education. Publicly available social media could be one source of this kind of information, but the use of social media data in this way contains many ethical dimensions on what can be harvested, especially from potentially private platforms such as Facebook. Given public outrage on social media platforms collecting data when not expressly permitted (Kleinman, 2018), and the introduction of more strict government regulations on data use (European Commission, 2016), careful consideration must be given to the use of any user data. While there are many benefits to the individual, it is vital that learners can carefully control the use of their data. This in itself is a difficult reality to realise, needing both technological tools that empower learners to control what parts of their data can be used, and learners who have the competencies needed to do this effectively in an informed manner. From a systems perspective, this need for ethical data use can make the difficulties that arise from missing data more pronounced, as users will likely grant different levels of access. This could lead to increased bias in digital systems supporting education, perhaps providing better recommendations or experiences for those who share more data.

As educational systems are increasingly supported by digital tools, there may be unintended social issues that arise. Cyberbullying, for example, has emerged in recent years as a significant problem (Dalla Pozza et al., 2016). The integration of social media data into life-long educational support systems, therefore, becomes a double-edged sword: big data could perhaps be used to identify cases where issues such as cyber-bullying are arising, but equally could introduce additional opportunities for unintended social difficulties. The scope and role of any technological advancement for enabling an educational intelligent economy must be well defined, as platforms could easily be used for purposes other than intended. This would require active communication between government institutions, the private sector, and the public sector. However, government policies can only protect the rights of citizens when the government is fully informed on the latest developments.

Similar opportunities and dilemmas also arise when considering the use of data created through the increasing integration of technology into everyday life. For example, the use of geographical data could advise on the need to develop skills that are currently missing in a person's immediate workplace, based on the educational profiles of those located in a similar area. In an extreme version of this future, conversations overheard by devices could even be analysed to produce recommendations. The ethical issues that arise here, particularly involving informed consent, are complex. Data security adds an additional dimension to this discussion, as personal information could be used for nefarious purposes if not properly safeguarded. Governments and institutions, therefore, have a responsibility to not only be actively aware of what data is being collected and used for educational purposes, but to actively invest in technology such as blockchains that could add an extra layer of security to data storage.

Closely linked to informed consent is the issue of data ownership (Ruppert, 2015; Slade and Prinsloo, 2013). While governments have collected the data of their citizens for centuries, the production of data that is now collected, stored, and analysed by private corporations is common as it is generated through use of commercial products. This shift towards private corporations holding vast amounts of data on the interests and habits of populations means that who owns data is a question central to current debates on big data and technology. Data could be harnessed to allow learners to make informed choices and decisions on their educational pathways if visualised in a way that is easy to understand and interpret (Arnold and Pistilli, 2012). If a corporation or research team owns the big data generated through use of publicly available products, such as the Google search engine, then creating these visualisations is purely a technical problem. However, if data generated is owned exclusively by the individual creating the data then collecting specific permission on how it can be used is an increasingly difficult task (Willis, Slade, and Prinsloo, 2016). Additionally, the data of multiple people are often required to allow data to become meaningful information, for example, by providing descriptive statistics of a given population as a reference for your data, or producing predictive models based on the behaviours of a large number of people. Should data be partially owned by the government in that case, ensuring that it can be used for the good of its population? Or by the companies whose tools generate and automatically analyse the data of many? There is no clear answer on who owns data, and several dimensions must be considered, including practical limitations, the amount of good that can come from its use by certain parties, and the potential damage that could be inflicted on the individual from whom the data arises.

Currently, legislation appears to be tending towards protecting the rights of individuals, for example by explicitly granting a person the ability to delete their data if they should consider it inappropriately used (European Commission, 2016). Although attitudes towards many of the ethical issues raised here will vary greatly according to cultural norms across the world, it would be beneficial for governments to cooperate. It is likely that digital platforms for educationally intelligent workforces will cross geographical boundaries, for example, as platforms to support MOOCs currently do (KyotoUx, n.d.; Stanford University Online Courses, n.d.). If issues arise, such as abuse of data privacy, it is unlikely to be clear where legal jurisdiction lies, and so the more cooperation that occurs between governments, hopefully with an aim to align policies where possible, the smoother problems are likely to be resolved. Resources such as Europass (Cedefop, 2018) represent current efforts to begin aligning educational and vocational systems to allow easier movement of citizens. Support should also be provided to programmes that allow representatives of educational systems to spend time abroad to understand the issues faced by other countries, and solutions that have been implemented. Programmes such as the Fulbright Teacher Exchange provide examples of how such exchange initiatives can broaden the horizons of participants and work towards an exchange of understanding at a grass roots level (IIE, 2018). This kind of alignment could prove beneficial to governments looking to develop an ethical educational ecosystem.

Integration of systems between countries could also lead to governments having access to big data gathered across nations for comparison. This approach could provide a more nuanced understanding of the differences between the performance of different educational systems in contrast to current comparisons such as PISA and TIMSS (Meyer and Benavot, 2013; Mullis et al., 2016; OECD, 2016). For example, the marriage of behavioural data captured while using learning management systems with standardised global assessment data could highlight strengths and weaknesses of various educational systems (Steiner-Khamsi, 2004). Nonetheless, while alignment of educational platforms could produce more detailed analysis, the limitations of learning analytics described earlier should be kept in mind by any government assessing weaknesses and strengths of different systems.

An additional consideration for governments, as highlighted in the competencies section of this chapter, is the need for ensuring that a population is educated on relevant skills and ethical dimensions of society’s educational systems as they advance. Several competencies are needed for a population to succeed in the 21st century (Voogt et al., 2013). An essential part of this is to learn about data and privacy to allow learners to make informed decisions (Berendt et al., 2017). An important way that the topics here should influence government policy is through the primary and secondary school curriculums. Nevertheless, efforts to educate on these important aspects of society should not be limited to just formal education. The majority of the population has already left formal education, but are equally in need of courses on the importance of data ownership, transparency, and consent. Workplaces and community centres should be supported by the government to reach those no longer in formal education.

Governments need to play several roles as technology advances to allow a more flexible lifelong educational journey. If all citizens are not equipped with the basic competencies to adapt to new technologies and the skills required to succeed, then inequalities in society will become emboldened. Governments must place careful consideration on how educational budgets are spent to best enable equity in the creation of opportunities through education. Also the government must take an informed and active part in discussions on the ethical dimensions of technologies supporting education. This is likely to involve close cooperation between government and those involved in creating technology, as otherwise, the government is unlikely to be able to contribute meaningfully (Griffin, 2018).

Conclusion

The United Nations Educational, Scientific, and Cultural Organisation defines education as the ‘means to empower children and adults alike to become active participants in the transformation of their societies, (by focusing on) values, attitudes and behaviours which enable individuals to learn to live together in a world characterised by diversity and pluralism’.

As we move towards an educationally intelligent society there is a paradigm change in education spurred by social, cultural, and political shifts. The new technologies that offer individuals the opportunity to self-direct their learning journeys, and the ability to access and evaluate information as per their needs are reshaping the role of education in society. Education is not just restricted to delivery of information, but the ability to transform that information into knowledge that will enable the learner to navigate the complexities of the changing world. In an open and democratic society education is a lifelong activity, where every individual should be prepared to take advantage of the learning opportunities. We live in a society where knowledge is tacit, continually adapting, and action lead. Thus, preparing individuals for continuous lifelong learning should be the primary focus of education in an educational intelligent economy.

Further research is called for to theorise the complex interactions between humans and technology, which would lay the foundations of an intelligent curriculum that strives to make these interactions more efficient for the individual as well as the society. In conclusion, it can be posited that survival in an educational intelligent economy calls for awareness of higher-order social and digital skills, and appropriate regulatory practices. It also highlights the increasing demand for inculcating a culture of digital awareness in educational institutions. It inculcates an impetus to create a learning culture that will educate a digitally competent generation, who is not only able to communicate with and modify technology efficiently, but also will understand the political economy and inherent biases of the digital world, thus equipped to competently serve their role as a digital citizen.

References

Australian Curriculum Assessment and Reporting Authority. (n.d.). The Australian Curriculum, v1.2. Retrieved March 09, 2018, from https://www.australiancurriculum.edu.au/f-10-curriculum/general-capabilities/information-and-communication-technology-ict-capability/

Arnold, K. E., and Pistilli, M. D. (2012, April). Course signals at Purdue: Using learning analytics to increase student success. In Proceedings of the 2nd international conference on learning analytics and knowledge (pp. 267-270). ACM.

Berendt, B., Littlejohn, A., Kern, P., Mitros, P., Shacklock, X., and Blakemore, M. (2017). Big Data for monitoring educational systems.

Blessing, S., Gilbert, S., Ourada, S., and Ritter, S. (2018). Lowering the Bar for Creating Model-Tracing Intelligent Tutoring Systems. In R. Luckin (Ed.), *Artificial Intelligence in Education : Building Technology Rich Learning Contexts that Work* (pp. 443–476).

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., and Rumble, M. (2012). Defining twenty-first century skills. In Assessment and teaching of 21st century skills (pp. 17-66). Springer, Dordrecht.

Burrell, J. (2016). How the machine 'thinks': Understanding opacity in machine learning algorithms. *Big Data and Society*, *3*(1), 205395171562251. http://doi.org/10.1177/2053951715622512

Canonne, J. (2013). The learning individual: Towards a culture of learning based on capability and ability. In Open Education 2030. JRC-IPTS call for vision papers. Part I: Lifelong learning (pp. 9-12). Retrieved from https://blogs.ec.europa.eu/openeducation2030/files/2013/04/Canonne-OE2030-LLL.pdf

Cedefop. (2018). Europass. Retrieved from https://europass.cedefop.europa.eu/

Chen, G., Xu, B., Lu, M., and Chen, N.-S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, *5*(1), 1. http://doi.org/10.1186/s40561-017-0050-x

Coiro, J., and Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. Reading Research Quarterly, 42(2), 214-257.

D'Acquisto, G. et al., 2015. Privacy by design in big data: An overview of privacy enhancing technologies in the era of big data analytics

Dalla Pozza, V., Di Pietro, A., Morel, S., and Psaila, E. (2016). Cyberbullying among young people. Brussels, Belgium: Policy Department for Citizen's Rights and Constitutional Affairs.

De Mauro, A., Greco, M. and Grimaldi, M., 2015. What is big data? A consensual definition and a review of key research topics. AIP Conference Proceedings, 1644, pp.97–104.

Dousay, T. A., and Janak, E. (2018). All Things Considered: Educational Radio as the First MOOCs. TechTrends, 1-8.

European Commission (2012). Proposal for a Regulation of the European Parliament and of the Council on the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation) COM(2012)11 Final

European Commission. (2013). Open education 2030. JRC-IPTS call for vision papers. Part I: Lifelong learning. Retrieved from https://blogs.ec.europa.eu/openeducation2030/files/2013/04/OE2030_LLL_Booklet.pdf

European Comission, 2014. Factsheet on the "Right to be Forgotten" ruling (c-131/12). European Comission. Available at: http://ec.europa.eu/justice/data-protection/files/factsheets/factsheet_data_protection_en.pdf.

European Commission (2015). The EU data protection reform and big data [Fact sheet]. Retrieved from https://ec.europa.eu/info/law/law-topic/data-protection_en

European Commission. (2016). Interinstitutional file: 2012/0011 (COD). Luxembourg: Office for Official Publications of the European Communities. Retrieved from http://data.consilium.europa.eu/doc/document/ST-5419-2016-INIT/en/pdf

EU GDPR. (2015a). Article 12 - Transparent information, communication and modalities for the exercise of the rights of the data subject. Retrieved April 20, 2018, from http://www.privacy-regulation.eu/en/article-12-transparent-information-communication-and-modalities-for-the-exercise-of-the-rights-of-the-data-subject-GDPR.htm

EU GDPR. (2015b). Article 25 - Data protection by design and by default. Retrieved from http://www.privacy-regulation.eu/en/article-25-data-protection-by-design-and-by-default-GDPR.htm

Falconer, I., Littlejohn, A., and McGill, L. (2013). Fluid learning: vision for lifelong learning in 2030. In Open Education 2030. JRC-IPTS call for vision papers. Part I: Lifelong learning (pp. 12-19). Retrieved from https://blogs.ec.europa.eu/openeducation2030/files/2013/04/OE2030_LLL_Booklet.pdf

Grech, A., and Camilleri, A. F. (2017). *Blockchain in Education*. *JRC Science for Policy Report*. http://doi.org/10.2760/60649

Green, M. and Rossall, P., 2013. Digital inclusion evidence review. , pp.1–37. Available at: http://www.ageuk.org.uk/Documents/EN-GB/For-professionals/Research/Age UK Digital Inclusion Evidence Review 2013.pdf?dtrk=true.

Griffin, A. (2018, April 11). Zuckerberg congress hearing: The most excruciating moments from The Facebook boss' questioning. The Independent. Retrieved from https://www.independent.co.uk/life-style/gadgets-and-tech/news/facebook-mark-zuckerberg-hearing-congress-moments-whatsapp-twitter-a8299511.html

Horrigan, J. B. (2016). Lifelong Learning and Technology. *Pew Research Center*. Retrieved from http://www.pewinternet.org/2016/03/22/lifelong-learning-and-technology/

ICEF. 2016. MOOC enrolment surpassed 35 million in 2015. ICEF Monitor. Published January 5. Available: http://monitor.icef.com/2016/01/mooc-enrolment- surpassed-35-million-in-2015/. [Accessed March 3 2016]

IIE. (2018). Fulbright Distinguished Teaching Awards in Teaching Program for U.S. Teachers. Retrieved from https://www.fulbrightteacherexchange.org/

ILO, Cedefop, ETF, and OECD. (2017). Skill needs anticipation: Analysis of stakeholder survey on skill needs assessment and anticipation. Geneva, Switzerland: ILO.

Jackson, N. (2013). EU lifewide development award. In Open Education 2030. JRC-IPTS call for vision papers. Part I: Lifelong learning (pp. 19-27). Retrieved from https://blogs.ec.europa.eu/openeducation2030/files/2013/04/OE2030_LLL_Booklet.pdf

Kiili, C., Coiro, J., and Hämäläinen, J. (2016). An online inquiry tool to support the exploration of controversial issues on the Internet. Journal of Literacy and Technology, 17 (1-2), 31-52.

Kleinman, Z. (2018, April 9). Facebook: Cambridge Analytica warning sent to users. BBC. Retrieved from http://www.bbc.co.uk/news/technology-43698733

Koskela, M. E. (2018). Peda.net - a learning portal for lifetime. On the Horizon.

KyotoUx. (n.d.). Retrieved from https://www.edx.org/school/kyotoux

Leu, D. J., Kinzer, C. K., Coiro, J. L., and Cammack, D. W. (2004). Toward a theory of new literacies emerging from the Internet and other information and communication technologies. Theoretical models and processes of reading, 5(1), 1570-1613.

Leu, D. J., Kinzer, C. K., Coiro, J., Castek, J., and Henry, L. A. (2013). New literacies: A dual level theory of the changing nature of literacy, instruction, and assessment. In D. E. Alvermann, N. J. Unrau, and R. B. Ruddell (Eds.), Theoretical models and processes of reading (6th ed., pp. 1150-1181). Newark, DE: International Reading Association.

Leu, D. J., McVerry, J. G., O'Byrne, W. I., Kiili, C., Zawilinski, L., Everett-Cacopardo, H., ... and Forzani, E. (2011). The new literacies of online reading comprehension: Expanding the literacy and learning curriculum. Journal of Adolescent and Adult Literacy, 55(1), 5-14.

Littlejohn, A., Falconer, I., and McGill, L. (2014). Open, lifewide learning: A vision. In A. Littlejohn and C. Pegler (Eds.), Reusing open resources: Learning in open networks for work, life and education. Abingdon, UK: Routledge.

Littlejohn, A., and Hood, N. (2018). Reconceptualising learning in the digital age: The [un]democratising potential of MOOCs. Singapore: Springer.

Littlejohn, A., Milligan, C., and Margaryan, A. (2012). Charting collective knowledge: Supporting self-regulated learning in the workplace. Journal of Workplace Learning, 24(3), 226–238.

Manske, M., and Conati, C. (2005). Modelling Learning in an Educational Game. *Artificial Intelligence in Education*, 411–418. Retrieved from http://scholar.google.com/scholar?hl=enandbtnG=Searchandq=intitle:Modelling+Learning+in+an+Educational+Game#0

Mayer-Schönberger, V., and Cukier, K. (2013). Big data: A revolution that will transform how we live, work, and think. Houghton Mifflin Harcourt.

McCarthy, J., Minsky, M., Rochester, N., and Shannon, C. E. (1955). A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence. Projektantrag.

McLaughlin, J. E., Roth, M. T., Glatt, D. M., Gharkholonarehe, N., Davidson, C. A., Griffin, L. M., … Mumper, R. J. (2014). The flipped classroom: A Course redesign to foster learning and engagement in a health professions school. Academic Medicine, 89(2), 236–243.

Meyer, H. D., and Benavot, A. (Eds.). (2013). PISA, power, and policy: The emergence of global educational governance. Oxford, UK: Symposium Books Ltd.

Misuraca, G., Broster, D., and Centeno, C. (2012). Digital Europe 2030: Designing scenarios for ICT in future governance and policy making. Government Information Quarterly, 29, S121-S131.

Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). TIMSS 2015 international results in mathematics. Boston, MA: TIMSS and PIRLS

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. *Www.Bitcoin.Org*, 9. http://doi.org/10.1007/s10838-008-9062-0

Nielsen, M., 2014. Who Owns Big Data? Open Mind, BBVA Change: 19 Key Essays on How the Internet is Changing Our Lives, pp.88–101.

Nonaka, I., and Konno, N. (1998). The concept of "ba": Building a foundation for knowledge creation. California Management Review, 40(3), 40-54.

OECD. (2016). PISA 2015 results (volume I): Excellent and equity in education. Paris, France:

OECD Publishing.

O'Neil, C., 2016. Weapons of math destruction: How big data increases inequality and threatens democracy, NY: Crown Publishing Group.

Pei, Wang. (2008). What Do You Mean by "AI"?. Artificial General Intelligence, 362-373.

Rienties, B., and Toetenel, L. (2016). The impact of learning design on student behaviour, satisfaction and performance: A cross-institutional comparison across 151 modules. Computers in Human Behavior, 60, 333-341.

Roll, I., and Wylie, R. (2016). Evolution and Revolution in Artificial Intelligence in Education. *International Journal of Artificial Intelligence in Education*, *26*(2), 582–599. http://doi.org/10.1007/s40593-016-0110-3

Sharples, M., De Roock, R., Ferguson, R., Gaved, M., Herodotou, C., Koh, E., … Wong, L. H. (2016). *Innovating Pedagogy 2016 - Exploring new forms of teaching, learning and assessment, to guide educators and policy makers*. http://doi.org/10.13140/RG.2.2.20677.04325

Sharples, Mike and Domingue, John (2016). The Blockchain and Kudos: A Distributed System for Educational Record, Reputation and Reward. In: Verbert, K.; Sharples, M. and Klobucar, T. eds. Adaptive and Adaptable Learning: Proceedings of 11th European Conference on Technology Enhanced Learning (EC-TEL 2015), Lyon, France, 13 - 16 September 2016. Lecture Notes in Computer Science. Switzerland: Springer, pp. 490–496.

Siadaty, M., Gašević, D., and Hatala, M. (2016). Associations between technological scaffolding and micro-level processes of self-regulated learning: A workplace study. *Computers in Human Behavior*, *55*, 1007–1019. http://doi.org/10.1016/j.chb.2015.10.035

Siemens, G., and Long, P. (2011). Penetrating the fog: Analytics in learning and education. EDUCAUSE review, 46(5), 30.

Siemens, G. (2013). Learning Analytics: The Emergence of a Discipline. *American Behavioral Scientist*, *57*(10), 1380–1400. http://doi.org/10.1177/0002764213498851

Slade, S., and Prinsloo, P. (2013). Learning analytics: Ethical issues and dilemmas. American Behavioral Scientist, 57(10), 1510-1529.

Sony and Sony Global Education Launch a New Blockchain-Based Student Education Records Platform. Wireless News, 14 Aug. 2017. Computer Database, http://link.galegroup.com/apps/doc/A500495333/CDB?u=touandsid=CDBandxid=98b313a5. Accessed 25 Apr. 2018.

Stanford University Online Courses. (n.d.). Retrieved from https://www.coursera.org/stanford

Steiner-Khamsi, G. (Ed.). (2004). The global politics of educational borrowing and lending.

Teachers College Press.

Swan, M. (2015). *Blockchain - Blueprint for a New Economy*. *O'Reilly* (Vol. 2). O'Reilly Media, Inc. http://doi.org/10.1016/S0197-4572(81)80089-4

Toetenel, L. and Rienties, B. (2016). Analysing 157 learning designs using learning analytic approaches as a means to evaluate the impact of pedagogical decision-making (Early View). *British Journal of Educational Technology (Early View)*.

Veletsianos, G., and Russell, G. S. (2013). Tools for Authoring a Dialogue Agent that Participates in Learning Studies. *Handbook of Research on Educational Communications and Technology*. http://doi.org/10.1007/978-1-4614-3185-5

Voogt, J., Erstad, O., Dede, C., and Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. Journal of computer assisted learning, 29(5), 403-413.

Wegerif, R. (2015). Toward Dialogic Literacy Education for the Internet Age. Literacy Research: Theory, Method, and Practice, 64(1), 56–72.

Williamson, B. (2017). Big data in education: The digital future of learning, policy and practice. Sage.

Willis, J. E., Slade, S., and Prinsloo, P. (2016). Ethical oversight of student data in learning analytics: a typology derived from a cross-continental, cross-institutional perspective. Educational Technology Research and Development, 64(5), 881-901.

Yli-Huumo, J., Ko, D., Choi, S., Park, S., and Smolander, K. (2016). Where is current research on Blockchain technology? - A systematic review. *PLoS ONE*, *11*(10), 1–27. http://doi.org/10.1371/journal.pone.0163477

Zhang, M., and Quintana, C. (2012). Scaffolding strategies for supporting middle school students' online inquiry processes. Computers and Education, 58(1), 181–196.

Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. Theory Into Practice, 41(2), 64–70.