DIGITAL TRANSFORMATION AND DISRUPTION OF HIGHER EDUCATION

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The AI Economy and Higher Education

Liz Coulter-Smith

This chapter focuses on four leading AI economies: China, the EU, the United States and the United Kingdom. We are interested in how these economic AI plans impact higher education (HE). Universities are critical to the workforce and, therefore, the financial health of a country. Nevertheless, are they ready to contribute to this AI economy? Are our governments preparing for the futuristic and ultramodern approach being adopted in, for instance, China? What will be the consequences if higher education falls far behind in some and not others? Some governments are (and have) made numerous alliances with large multinational industries, including Google, Microsoft, Facebook, Amazon, Huawei, Baidu and Alibaba, amongst the most prominent. Later in this chapter, we will take a look at some of these partnerships and the future thinking and planning taking place. The strategic plans, and approach to partnerships, differ in depth, substance and persuasive style in the documentation we are relying on. Some of these differences will alter how our universities adapt, plan and develop the curriculum necessary for a robust AI economy.

Higher education has a critical role to play in this economic shift and is in fact at a 'crossroads of disruption' as Kaplan suggests (Kaplan). Embracing the AI economy is broadly considered vital and transforma tional across all sectors of economic productivity and particularly as we recover from the COVID- crisis. This 'economic shift' cannot be understated as Chapter clearly points out. However, if universities choose to react too slowly, or if governments 'over focus' on the spin, research, regulation and industry partnerships, they will jeopardise broader student employability and the significant human workforce those students represent. A more comprehensive approach to addressing the curriculum at the HE level is needed urgently. It is critical to be aware of these changes as both educators and citizens.

There is a rather steady stream of strategic documents being released, so the challenge of keeping up-to-date is a real one. Just as this goes to press,

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the EU draft on AI regulations has been leaked and several other strategic documents have also recently been published in the United Kingdom. The 'UK AI Council: AI Roadmap' (AI Council) is, thankfully, closer to the US strategy and somewhat like the EU white paper, with more than a dozen recommendations relating to higher education, a section on skills and diversity and much less emphasis on financing initiatives.

For higher education, governmental approaches communicated about the AI economy

and best practices may be less than homogeneous, confusing, contradictory and signal an overarching ethos often filled with marketing speak – this is why examining these strategies closely is so critical for HE and endlessly interesting.

AI and Machine Intelligence

A definition of artificial intelligence is challenging to answer precisely. However, a simple way to think about it is as a process of making a machine behave in ways 'that could be called intelligent if a human were so behaving' (McCarthy, Shannon and Minsky). Artificial intelligence's discipline is generally considered to have begun in at a Dartmouth College conference (Nilsson) but funded in . Alan Turing's research on computing machinery and intelligence before, during and after WWII is also considered foundational to AI. His work critically fuelled the following decades, having proposed the question 'Can machines think?' (Turing , p.). The simplicity of the algorithmic method imple mented in the 'imitation game', where two neural networks compete with a third 'discriminator' network was an antecedent to generative adversarial networks (GANs) and deep learning (Goodfellow et al.). Turing's research in algorithmic computation and intelligent machines has been foundational and the Dartmouth conference built on that work and coined the term 'artificial' but the origins of intelligence and machine learning (ML) lay with Turing. In terms of public awareness, AI and ML ebbed and flowed over the following fifty years, with many novel contributions, such as the work of Geoffrey Hinton (Rumelhart, Hinton and Williams ; LeCun, Bengio and Hinton). But public awareness and its impact came decades later with the successes of the IBM Watson's Jeopardy Challenge ( ) (Shah) and DeepMind's AlphaGo triumph ( ) (Bruder). The advancements in AI and ML demonstrate the rapid growth of machine and deep learning, with only five years between them.

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Disrupted Systems, Jobs, Upheavals and New Technologies

Future projections are always hazardous to make and this is especially so when involving emerging technologies. Comparisons are often made with the economic upheavals of the Industrial Revolution. That revolution brought employment, new technologies and eventually higher living stan dards. The disruptive period at the turn of the last century was an almost cataclysmic disruption to all aspects of life – and yes – serious abuses and ethical woes were common. However, that disruption brought about significant change, and I would hasten to add – for the better. A more recent example was just twenty years ago, at the time of the dot.com boom and just before, we can see a similar pattern, and is a much better example of what we can expect in the coming decades with AI. However, in higher education, there was a place that existed to adjust the curriculum

rather easily. Computer science departments had to change, but the raw materials were already present. With AI and ML now, one could make the same argument, except that the need for using data and understanding how to manipulate it is entering every part of the higher education ecosystem. Below is the projected economic impact of the Internet in from the Brookings Internet study – substitute 'AI' in place of 'Internet' and the comparison is striking: the accumulating evidence in the eight sectors examined in the Brookings Internet study suggests the following:

- The potential of the Internet to enhance productivity growth over the next few years is real.
- The greatest impact may not be felt in e-commerce but rather in a wide range of 'old economy' arenas, including health care and government, because of changes to the way information flows.
- As a result of the Internet, there is considerable scope for management efficiencies in product development, supply-chain management and a variety of other aspects of business performance, encouraged by enhanced competition.
- Much of the benefit from the Internet is likely to show up in improved consumer convenience and expanded choices, rather than in higher productivity and lower prices (Litan and Rivlin , pp. –).

We are in another wave of enormous disruption as pointed out throughout this book. Also, the parallels are clearly evident between the early years of the adoption of the Internet and what we are currently experiencing with the AI economy. Agrawal et al. also make this point (Agrawal, Gans and

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Goldfarb , p.). The mid- s were pivotal as we witnessed the Internet and related communication technologies emerging outside of research in HE and then to the wider public. This economic revolution, the dot-com boom or bubble as it is now termed, peaked between – then crashed. However, the Internet-connected economy continued to create multiple ecosystems, ecosystems that are still expand ing, disrupting and creating jobs today. In order to create jobs, investment has to be made. As with the dot-com boom, a long-term strategy was needed by universities to meet the demand for technologically skilled knowledge workers. Author points out that 'human-capital investment must be at the heart of any long-term strategy for producing skills that are complemented, rather than substituted, by technological change' (Coulter-Smith , ch.). The question is this: Will universities and their governments make the necessary investment in this next revolution in order to build this 'human-capital' for the coming

AI economy?

The Internet's impact created jobs, and a similar forward-moving change is happening again with AI. The COVID- crisis has accelerated not only online shopping by an estimated five to ten years (in the United Kingdom) and also catapulted online learning and teaching firmly into this century. The United Kingdom in particular has long lagged behind other countries where advances in online services is concerned. However, this next 'technological turn' offers us the ability to foster new methods of human to human interaction as well, it may be online and mediated by technology yet in HE and in terms of learning pedagogies the interactions are novel and deserve further investigation. During the COVID crisis, these differences have come to the fore and in many cases removed ethical barriers both physical and psychological, a renegotiation of what consti tutes 'presentism' in the workplace, and new flexible working patterns will likely benefit human job satisfaction in the longer term. It is time to also adopt a crisis stance in our take up of AI and accelerate this 'turn' in higher education, but we need to act quickly in response to the environment we now find ourselves in.

The rate of embedding AI and related technologies in our lives is on warp-drive. AI has moved into our homes as millions of us live with Alexa, Siri and Google. Speech recognition has changed the lives of many. These technologies are also often frustrating. With these often-painful changes come a few negatives – loss of privacy, systems listening to us in our homes and unknowingly being tracked on and offline. There are trade-offs. So, how do these developments underscore the need to adapt the higher

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education curriculum? Are our institutions too big and slow to act and are our governments working to correct this?

The ability to adapt to one's environment is considered a core aspect of intelligence. We have seen what lacking this ability has done to established institutions on our high streets (particularly in the western world) during the COVID- crisis. Businesses that had previously adapted to an online data-driven market or had evolved in the past decade or two have survived. Those companies or industries that did not see change coming are gone – some seemingly overnight. The situation with higher education gives us another perfect storm. If there is continued slowness to act, the inability to adapt content quickly and a perpetuation of an arrogant attitude about preparedness for the coming AI economy, then, like the high street, there will be a painful transition to come. The EU commission has flagged the fact that AI can even facilitate this transition for universities (Centre for Strategy & Evaluation Services , p.).

Higher education institutions may well experience the fate above

should they fail to adapt quickly enough. To correct this, university leaders must take action (Goldfarb, Gans and Agrawal , p.) and in a tangible way now. They must fast-track and embed the basics of using and manipulat ing data and algorithmic, computational and systems thinking at the minimum. Small changes are not going to be enough. Institutions fail – higher education institutions may be on the brink of that failure in many countries.

Trusting AI

Communicating to the public about the use of AI is crucial. EU docu ments refer to this as 'explainability and interpretability'. These terms also relate to issues around ethical governance in the EU and the problem of a person's 'right of explanation' should an algorithm's decision be disputed (Cath , p.). The recent A-level debacle in the United Kingdom is a good demonstration of the problems governments and institutions face without adequate advance public awareness (Elbanna and Engesmo).

The nature and potential of AI and ML and how they can improve basic day-to-day processes, systems and quality of life generally do not receive the same attention as pseudo-science and novel media fear-based fiction does. The benefits are most evident for the public in the health sector, where the positive effects of algorithmic patterns using ML achieve better accuracy than humans. Wherever large amounts of data or patterns or calculations are made, ML and deep learning neural networks will prevail

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over humans due to accuracy and speed, as is demonstrated with precision diagnosis (Cath , p.). Further benefits need to be communicated to the public regarding the efficiency of farming, sustainability in various systems and maintenance and public security.

The Competition: China, the EU, the UK and US Government Plans

So far, we have established the importance of speed to take up the AI economy and the crisis it could cause should we not act swiftly enough in HE. Also, the importance of keeping the public informed is a critical part of this mission. As with the introduction of the Internet, we will experi ence a tsunami of opportunity and disruption for businesses and higher education. In 'Accelerating Competitive

Advantage with AI', PwC pro poses an overview of the AI sector. Bias, jargon and hype characterise this document, but it states that the global AI market will be worth up to $. trillion by (PwC).

This next section will look at four reports or plans from China, the EU, the United Kingdom and the United States (OSTP ; Fa ; Hall and Pesenti ; European Commission). These are remarkably different documents in their presentation, technical content and persua siveness. An array of documents preceded both the UK and the US experience and are worth a closer examination but not in this chapter. The EU and China plans are concise and at a lower level, technically. The UK strategy seems fixated on the monetary amounts invested and a glossy marketing approach aimed at the general public. China seems to have a clear plan for physically building education through the development of smart campuses. Of the four plans, the United States and China offer more detail both technically and for higher education and AI. There are so many challenges, changes and shifting roles imminent in the workplace brought on by the AI transformation that, remarkably, the pace has yet to be reflected across the majority of higher education institutions in terms of adapting the curriculum across all disciplines. There are always exceptions, and this is a general observation.

Words matter, and they are especially revealing when it comes to government documents and their persuasive communication techniques. After noticing the high-frequency use of certain words and symbols in the UK document, a brief comparison of word frequency showed some glaring examples, and one stood out amongst the rest. The United Kingdom used the currency £ symbol sixty-eight times in its document. Compare this to the other three documents in Table . .

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Table . . *Word frequency of currency signs in government AI documents*

Government	UK £	EU €	China RMB	US $	Word frequency

Table . . *'Human' word frequency of currency signs in government AI documents*

Government	UK	EU	China	US	'Human' word frequency

After this surprising oddity, it followed that a check on many other words for frequency should be done. The count may include references so could vary slightly. Words related to the topic at hand found that the words 'student/s' and education/higher occurred in single figures for the United Kingdom and EU and slightly higher double figures for China and the United States. The United Kingdom

emphasised 'industry' four times as much as the EU and twice as much as the United States. Another difference was the use of the word 'business', featuring eighty-nine times in the UK document and less than ten times in the US, China and EU documents. And finally, the United States mentioned 'research' times as compared to for China, for the United Kingdom and for the EU. Another interesting divergent word usage (there are a few), was the use of the word 'human'. The word occurs times in the US document (Table .) and far exceeds the others.
As much as one can be an optimist generally about technology and AI in particular, it seems important to balance machines with the importance of humans and humanity at any stage of development.

China

China has been building strong enterprise links with universities for some time but there has been an escalation from about . This was also the year that they published their AI development plan. China's ambitions are not small as they seek to view AI as a 'main driving force ... upgrading

Frequency table of selected words in strategic AI documents: UK China US and EU. https://bit.ly/ pxAR .
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their economic transformation' (Fa , p.). They also anticipate 'world-leading' levels by in several areas. Development of 'intelligent' education includes online intelligent platforms, AI improvement systems for education, cross integration of AI and mathematics, educational assis tants, learner-centred environments and precision deployed education for lifelong education. The depth, breadth and clarity of this plan are worth closer inspection.
There are numerous partnerships as well. Facebook (FB) teamed up with Alibaba in . This brought together AI and FB's PyTorch open source machine learning library with Alibaba's machine learning cloud platform for AI. These are two technologies, cloud and ML, when com bined with G will change the landscape of AI/ML (Shumin). It is worth remembering that any competitiveness will rely on the ability to both gather and deploy data and drawing on a population of billions of citizens has its advantages. China may already be ahead in this arena.
Their advantage is, in part, due to the Huawei partnerships both in China and around the world in G and are coupled with Huawei's support of universities. For example, contributions of over million euros to both the University of Amsterdam and Vrije Universiteit Amsterdam were made recently to further their clear advantage towards ML cloud platforms (Bothewell). Often in the news, Huawei is leading in a number

of critical areas key to the AI economy; and due to this, a number of universities have also disregarded the security concerns of their governments.

Along with these partnerships, and there are too many to discuss here, another area of interest is their ambitious construction of 'smart' campuses. We are talking here about completely new campuses, most of which are centres targeted as innovation centres involving AI, ML cloud and G among other new and developing technologies. These technologies all fit together to support this economy that will supercharge their ability to educate and train researchers.

China appears to be taking the lead with five AI innovation centres being built in Beijing, Binhai New Area of Tianjin, Hangzhou of East China's Zhejiang Province, Guangzhou of South China's Guangdong Province and Chengdu of Southwest China's Sichuan Province, each strategically positioned towards research in particular AI areas covering intelligent vehicles, manufacturing, enhancement of utilities, strategy and government policy advancements, financial services, efficient future tech nologies, medical, road infrastructure and environment.

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The Competition

At this scale and level of investment there are few countries that have so well coordinated their AI innovation plans. There are also national AI mass innovation centres and AI industrial parks being built. This has all been taking place for four years now and it appears they are well on their way to meeting most of their targets. It would be foolhardy to guess at the investment but it has to be in the hundreds of billions if not trillions.

United Kingdom

The ambition of the United Kingdom is to be a 'scientific superpower' and to 'create a world-class education system' (ITV). One of the strengths of the UK strategy is to build upon Alan Turing's AI legacy discussed at the start of this chapter. The Alan Turing Institute has been given £ million in funding and will be a national academic institute for artificial intelligence and data science (Hall and Pesenti , p.). The United Kingdom published their *Industrial Strategy: Artificial Intelligence Sector Deal* in after a couple of prior white papers by the same authors. The 'Deal' is a glossy government plan that focuses on pledging (over sixty eight times) financial support throughout – totalling just under a billion dollars over a number of years. But the plan yearns for clarity, ambition and detail in comparison to China's plan featuring education and smart campuses.

The UK plan lacks momentum and feels like a slick 'academic' strategic plan. As it states, it is an industrial strategy and does include the usual suspects as partners: Google, Amazon and others but misses out on joined up ambition. The UK

government consistently authors white papers using high profile academics, usually heads of computer science departments from research-focused universities. This tends towards bias and self-dealing to creep in and poses a conflict of interest to any recommendations made.

A healthy mix of authorities, experts, researchers and industries is needed in place of this often unilateral approach. And, as highlighted earlier, the overstating of government finances feels like an over compensation for something else that is inadequate or missing. The main authors for all of the UK government AI strategy documents are the vice president, and now recently the president, of AI at Facebook, two govern ment officials and a professor whose university has significantly benefitted from the recommendations' outcome. In fact, it is worth noting that the three main documents leading up to the UK strategic plan all involved the same celebrated academic and Facebook VC – and feature that pesky pound sign at an ever-higher rate. The EU, China and US government

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authorship appear to be more diverse, less biased and more aware of the needs of higher education training and universities' role generally.

AI partnerships with large corporations and universities are common in the United Kingdom. The University of Cambridge joined Microsoft in a machine learning initiative worth millions in . The Microsoft Future Decoded conference announced this alliance. The conference also set out areas of work in the United Kingdom and the universities that they are supporting. Oxford University teamed up with Google just after the purchase of Deepmind in and with four PhD scholarships awarded in as part of an £ . million agreement from to (Reuters).

The EU

There is a strength of cooperation evident in the EU white paper. It is recognised that the EU's ability to support innovation and research may not equal the ability to coordinate across so many countries and institu tions. The EU document feels very rule-based and sometimes fragmented. But over the past few years, the EU has clearly and concisely covered higher education, digital and AI in a complete and detailed way in other documents.

EU strategic priorities also require universities to adopt a combination of 'disciplinary and interdisciplinary approaches' (Centre for Strategy & Evaluation Services , p.). They state that this will be increased compared to the past two decades to 'ensure the interdisciplinary can be better recognised and rewarded in career development in appraisal sys tems'. Such an approach is crucial as we move into the AI economy and

will be profound as students are educated within a system with this ethos. The number of strategic recommendations in the EU Vision docu ment is commendable and extensive. The EU has committed to co operation with other universities in Europe and has a healthy, outward looking approach.

The EU commission has also recommended widening the range of universities able to gain access to competitive research funding to benefit universities across Europe. There is recognition around the concentration of the EU tending to locate funding to the top twenty universities and the often-resulting brain drain from those universities being detrimental to both higher education and the ambition of widening the agenda from Horizon and thereby strengthening the EU further within its coun tries and their regions. Since , the EU has developed a strategic

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framework for cooperation in education and training (ET ; Lévesque et al.). It highlighted the importance of creativity and innovation as being crucial to developing enterprises and competition.

As part of the awareness of the importance of retaining talent, the EU has also underscored the need to reform researchers' careers. They recog nise that there will be fewer academic positions in the future, and prepa ration for employment outside of the academic sphere is critical. Also, related to higher education, the EU strategy states that researchers should be rewarded for both interdisciplinarity collaboration and research integ rity and service to community leadership and impact. Alongside this diverse approach to training students after higher education is the aware ness of virtual mobility and this recommendation preceded the COVID- crisis, so it has even more importance now.

United States

The first US AI report appeared in and was the first published governmental strategy (OSTP). Then, in , an updated version was published (US Government). The initial report was produced by the Select Committee on Artificial Intelligence of the National Science & Technology Council. The participating bodies are in stark contrast to the often narrow authorship of the UK plan. The United States, China and EU have produced strategic plans that are more in keeping with the norms one would expect for such an important endeavour – the AI economy. The critical state of higher education in relation to AI is highlighted, stating that 'U.S. academic institutions are struggling to keep pace with the explosive growth in student interest and enrollment in AI' (US Government , p.).

Strategic areas are broken into three sections. The first section includes manufacturing, logistics, finance, transportation, agriculture, marketing,

communications, science and technology. The second section for 'improved educational opportunity and quality of life' includes education, medicine, law and personal services. Finally, the third area includes secu rity and law enforcement and safety and prediction. These overarching areas are followed by a short synopsis of the state of AI. This section positions the United States in terms of their own research advancements and their own achievements. They also demonstrate the advancement of 'deep learning' in comparison to other countries' publications which shows, in , China in the lead followed by the United States and others clumped at the bottom of the chart. Clearly, there is an ambition or

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race with China at play here. The number of patents is also included as a marker of research capacity. Overall, the document demonstrates a strongly competitive nature, very different from the other three documents. Overall, it lays out the facts and is more research driven with reference to technol ogies than the other three strategies. The US document drills into the details of the technologies more than the other documents do.

Conclusion

AI is a strategic tool that has the capacity to increase global economies. There is a great deal of consensus supporting this in this book and, although these developments may seem futuristic, they are in fact already finely embedded into our everyday lives whether we recognise this or not. For the sake of the ongoing higher education ecosystem this idea needs to quickly take hold. There are changes discussed throughout this book and touched on in this chapter that will cost little financially but require significant paradigm shifts in thinking. This chapter asserts that some governments have not done enough to include higher education and are not acting quickly enough to adjust and prepare the curriculum to reflect the changes already taking place. There is a need to map these skills on to all areas of higher education – not just the sciences but all of the human ities are essential. Society needs students who are well rounded and able to work with humans, machines, data and the tools used to manipulate that data. These are different patterns of systematic thinking that need to be addressed. A broad general awareness of what constitutes an algorithm and its functions is also critical. However, the most important skill will be learning algorithmic, creative and computational systems thinking. Governments and higher education leaders can make huge gains with minimal cost by using education to focus the 'minds' of students and empower and equip them to enter the coming AI economy.

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