

Towards flexible personalized learning and the future educational system in the fourth industrial revolution in the wake of Covid-19

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Towards flexible personalized learning and the future educational system in the fourth industrial revolution in the wake of Covid-19

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ABSTRACT

The concept of the Fourth Industrial Revolution is related to a ubiquitously connected, pervasively proximate (UCaPP) world and its response to Covid-19. Pedagogies need to be aligned with institutional 'quality education' and changes in the nature of the undergraduate student intake to formulate a 'Future Educational System'. Considerations include students from 'non-traditional' sources adapting to existing university structures and how procedures might accommodate these students in addition to changes and disruptions resulting from Covid-19. Mobile devices allow Personal Learning Environments (PLEs) to be developed in accordance with individual students' needs. PLEs allow ubiquitous, flexible structures to develop educational quality. Policies should involve connectivist approaches and active learning via broad curriculum development and appreciate the importance of individual student needs and capabilities, socio-economic as well as academic. We stress the importance of broadening access to higher education, particularly for those who have been 'neglected' by current procedures.

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Introduction

Politicisation of the Higher Education (HE) sector in the United Kingdom (UK) can be seen in various pronouncements and decisions from funding to 'quality' in reports and government 'White Papers' over many years. The impact of the Sars-CoV-2 virus, as the Covid-19 pandemic, has affected the sector in 2020. Not least, a move towards 'online learning' with much reduced face-to-face contact between students and lecturers has disrupted the traditional education system. In April-May arrangements were made to award degrees, perhaps without 'final' examinations. In August 2020 governmental decisions regarding school leaving qualification (A-Level in England, Wales and Northern Ireland, 'Highers' in Scotland) were made and continue into 2021. Consequently, many students did not receive their expected results for entry to HE programmes, although universities and colleges have done their best to accommodate them. Such issues continue into 2021 and include 'digital poverty' for

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individual students and their families. Education and employment prospects of students are affected and school leavers may have to adjust to what is meant by a 'degree'.

Covid-19 places pressures on the nature of 'the university' in addition to challenges already identified. Collini (2012) has questioned the nature of the university and Zwaan (2017) considers the sector towards 2040. Reflections by Vaart and Heijnen (2018) are in a European context, while Carey (2016) and Arum and Roksa (2011) provide US-centred views. These authors suggest that 'change' in some form is inevitable. In the UK, the Augar Report (2019) evaluated funding for Post18, or tertiary education, in England. It raised issues such as 'low value HE' and that Post-18 education must be 'forward looking': 'The future challenges of technological innovation, artificial intelligence and shorter job cycles will require greater labour market flexibility. The post-18 education system needs to respond to this: doing more of the same will not be enough' (Augar, 2019, p. 18). However, the report did not indicate any pedagogic modifications for this forward look. Despite the importance of the Fourth Industrial Revolution (4IR) (Schwab, 2019), its likely effects on economies, business and education, are not discussed in the Augar Report. We explore the meaning of the 4IR in the UK HE system as indicative of the sector world-wide as political, social and economic changes to HE's traditions. We examine ways in which mobile technologies may be used by institutions, tutors and students to better accommodate present complexities and the learning future associated with the 4IR to develop a 'Future Educational System'.

Our 4IR future view is informed by statements and reports from government bodies and non-governmental organisations (NGOs) related to higher education using a content analysis approach. We have mainly used UK publications as these are most familiar to us, although the pressures are similar elsewhere. Published statements about the 4IR indicate what might require attention for student-related issues by developing suitable pedagogies. Together with some international publications, they provide information about possible changes in HE adjusting to Covid-19 pressures.

Covid19 and some constraints on higher education

Two consequences are evident of the pressures generated by Covid-19:

- (1) Lectures may be delivered online and most institutions are modifying current practices but educational systems will need to react to 'traditional' methods; lectures and examinations, practical classes and tutorials, yet still provide 'quality'.
- (2) Income disparities and the 'educational income gap' is well known in the USA (Albrecht & Albrecht, 2009) and the UK (Machin & Vignoles, 2004). Post-2020, existing family income disparities will increase across the UK so HE experiences may become rarer for some families (Donnelly & Gamsu, 2018). Inequalities include access to resources (e.g. digital poverty), attainment gaps and financial pressures will be widened by Covid-19 (Montacute, 2020) and more generally (Vignoles, 2013). These disparities are in addition to the 'HE neglected'; students who, although capable of attending university, for various reasons do not go to university (Boud & Falchikov, 2007; (Major & Banerjee, 2019). Similar effects have been noted from the USA (Jack, 2019).

Flexible responses and pedagogies for change and the fourth industrial revolution

Flexible responses to Covid-19 issues will help institutions to implement, even optimize, the delivery of quality higher education, developing *existing* pedagogies and modifying them for the *future*. We now explore some issues of ‘educational quality’, accessibility and pedagogic frameworks required by:

- exploring the 4IR for higher education and aspects of students’ learning environments
- suggesting how the HE sector might become more agile in procedures such as online programmes and delivery systems.
- developing ideas of flexible and distance learning in the context of mobile technologies that will help close ‘educational divides’.

The Fourth Industrial Revolution (4IR) assumes that following the industrial and third (computing/internet) revolutions, the fourth will add inter-connected technologies, hardware and software (figure 1).

A recent UK government report indicates that the 4IR, characterised by a fusion of technologies, will be of ‘a scale, speed and complexity that is unprecedented’ (DBIS, Department for Business Energy and Industrial Strategy, 2019). Another UK document (Störmer et al., 2014, xiv), indicates that, ‘Despite robust growth driven by strong high-

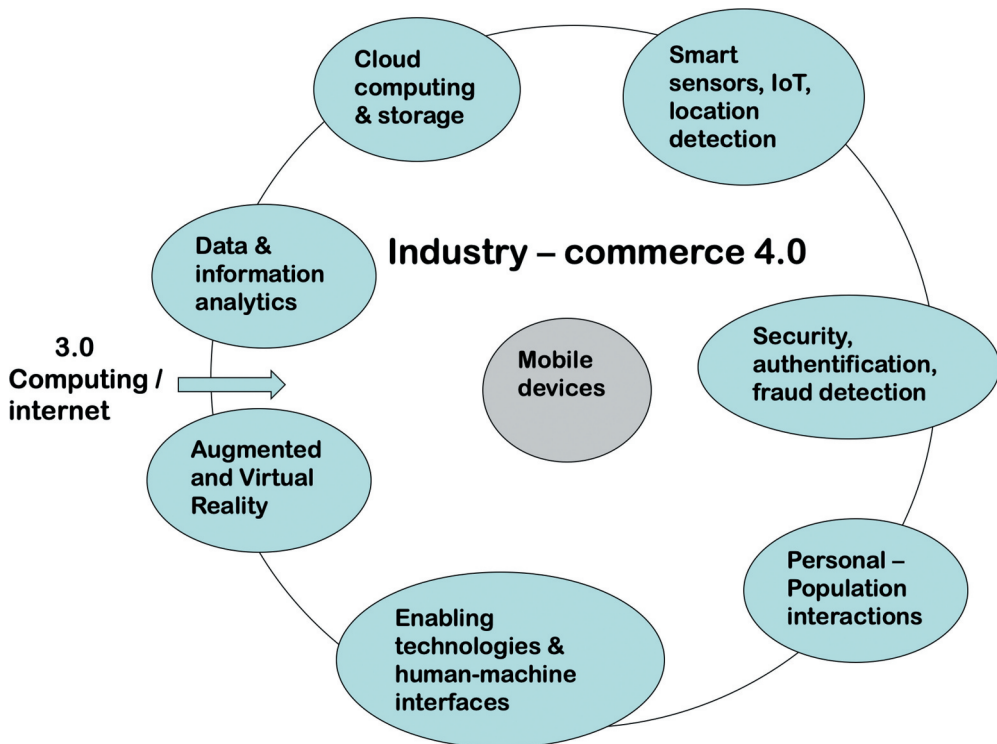


Figure 1. Main items of the 4th industrial revolution as adapted from Brown (2019) and based on a graphic from Shockoe (<https://shockoe.com/people/>).

tech industries, a two-tiered, divided society has emerged, reinforcing the divergence in the economic position of the “haves” and “have nots”. The World Economic Forum (Forum, 2018) looking at jobs in the next 20 years suggested that preparation for the 4IR should:

Rethink education

Fast technological change means that people . . . need to learn new skills – quickly. We need to build an education system for lifelong learning – and a culture that promotes it. . . . education should remain similarly accessible throughout someone’s working life.

Provide people with more freedom and flexibility

Acting together, government and business can make people’s lives easier by creating more inclusivity. . . . embracing remote work, flexible scheduling and the power of the platform. . . . Working in an office is often neither possible, nor practical, for new parents, single parents, some of those living with a disability or many others . . . given the option to work from home or set their own schedules, many would be able to earn an income.

This illustrates the basic aspects of the 4IR and the need to adapt, and is particularly relevant to post Covid-19 employment and participation in HE.

Supercomplexity and ‘the neglected’

Barnett (2000) introduced ‘supercomplexity’ to describe the interacting systems in HE. This includes students and institutions coping with ‘knowledge’ and the curriculum, ‘massification’ and conflicts from value and value for money. Raphael Reed, Gates, and Last (2007), discuss neglected potential undergraduates, that the culture of HE is ‘unreal’ for young people from ‘non-traditional’ backgrounds (see also Ball, Macrae, and Maguire (2013). Major and Banerjee (2019, p. 9) indicate that, ‘Universities need to embrace a cultural shift in the support provided for students from disadvantaged backgrounds’. This aspect of supercomplexity is even more pressing as the effects of Covid-19 may widen the attainment gap for less affluent families. Concerns of ‘accessibility’ and ‘equity’ and the nature of universities have been raised by Altbach (2008) and by the UK’s Office for Students (2019). Supplying ‘laptops’ to students is not a panacea and internet connection and ‘bandwidth deficiency’ may be a problem even in affluent communities. Although internet connectivity may be considered a human right (Berners-Lee, 2020) there are potential problems for students requiring internet access from some areas of the world (Daskal & Sherman, 2020).

‘Supercomplexity’, lies within consequences of a ‘ubiquitously connected and pervasively proximate’ (UCaPP) world that encapsulates the 4IR: ‘a world of entangled, complex processes, [where] the greatest skill is that of making sense and discovering emergent meaning . . . in which truth, and therefore authority, is never static, never absolute, and not always true (Federman, 2005, p. 11). These aspects of authority and knowledge base are becoming part of the information space of the HE sector and bring ethics and philosophy (Pigliucci, 2010) into supercomplexity. Hence, universities need to encompass VUCA – Volatility, Uncertainty, Complexity, Ambiguity in looking forward. Originally a term from the US military, a VUCA suggests that, ‘We live in a world that’s

constantly changing, becoming more unstable each day, where changes big and small are becoming more unpredictable' (VUCA, 2020).

The victorian educational system

The Victorian Educational System (VES) is shorthand for a system that was, and in many respects still is, epitomised by the aphorism, 'pile em in deep, lecture 'em long and examine 'em hard'. As Mentkowski (2000, pp. 259–260) amplifies, 'knowledge was a commodity' but 'given this complexity, we can understand why increased information and complex ideas about student learning seldom lead directly to practice'. Information can be commodified and traded (Buckland, 1991) and, with its own philosophy, returns us to AI (Floridi, 2011) and the 'Fourth Revolution' (Floridi, 2014). Indeed, commodification of knowledge is the currency of undergraduate degrees that Covid-19 is currently disrupting. Students and HEs expect examinations, how is assessment best transacted and, taking one example, what is to be done about library access in an on-line environment?

The Conventional-Direct-Recitation (CDR) teaching methodology (Gage, 2009) for compulsory level education in the US still dominates in the UK. As Gibbs (2019, p. 22) indicates, 'Students are strategic as never before, and . . . focus their attention on what they believe will be assessed and what they believe will gain good grades'. CDR epitomizes the VES in 'teaching to the test' as Burns (2015) shows. Conversely, Progressive-Discover-Constructivist (PDC) approaches tend to promote active learning. However, we need to account for issues raised by Hamilton (2018) 'how can universities respond to the rise of the robots?' that fit in with 'wisdom' and ethics. Pedagogies need to adapt to the disruptive influences of Covid-19 and 4IR via PDC approaches. Hamilton (2018) posits, 'how can universities respond to the rise of the robots?'. The consequences of using social media and AI in face recognition are already with us (Gururaj, Swathi, & Ramesh, 2018). In a Covid-19 world, not all agree with virus-tracking apps and issues are raised about individual's data protection which will continue in the 4IR. Students and their tutors need to be able to discuss these issues.

Further concerns relate to students with specific learning difficulties (SpLD) – better subsumed under 'neurodiversity' (Walker, 2014) – and problems of mental health, exacerbated by Covid-19. Most often, institutions have specialist professional staff in these fields who act as consultants for students. The possible effects of financial and social pressures on students 'learning online' are only just being realised. How students will inter-react online with professional staff, such as librarians and teaching/tutorial assistants still needs exploration on an institutional basis in a transition from the VES towards the *Future Educational System*.

The future educational system and teaching quality

Institutions might help to monitor and support quality education by having an explicit and transparent education/teaching policy (Whalley, 2019). Such a policy has pedagogy at the heart of quality measures and, to become more agile, **HEIs need continuing professional development**. HEIs should move from the rigidity of the VES towards Progressive-Discover-Constructivist (PDC) approaches of the FES. 'Active learning', a term in use for many years should come to the fore in PDC. Whalley's (2019) quality schema has 'active learning' and the ideas of Chickering and Gamson

(1987) as its focus. Adekola, Dale, and Gardiner (2017) provide a holistic framework to, 'support effective institutional transitions into enhanced blended learning' (Adekola et al., 2017, Figures 1 and 2) although an overall institutional policy needs to have more than 'blended learning' at its centre.

Several issues related to Artificial Intelligence in education are discussed by Holmes, Bialik, and Fadel (2019) and as well as 'AI', [figure 1](#) suggests the **importance of data and analytics**. The latter are often considered aspects of the HE sector, particularly with respect to recent developments in assessment and distance learning (Buckingham Shum & Crick, 2016). Mass communication and its social-web additions require wisdom from knowledge; the need to challenge 'false news' and fact verification are key elements. Knowledge manipulations; MMR vaccination, 'rewilding', climate change, '5 G causes Covid-19', and 'mutant-algorithms' show where online discussion should cross disciplinary boundaries and beyond 'traditional' students in HE to 'the neglected' and the wider population.

Where does 'wisdom', as opposed to **knowledge accretion, come from in the VES? Possibly through face-to-face tutoring but also in projects, collaborations and discussions**. In the FES these need to be more accessible and online as they are increasingly becoming in research. 'Authentic' and 'real world' learning in the affective domain (Herrington, Reeves, & Oliver, 2014) also need to be online for, as Covid-19 has shown, this is the way much of the world already works (Spinks, 2015). Fernando (2018) considers a variety of aspects, especially with relevance to developing countries, and the role of information and communications technology (ICT) to educate the next generation by way of *active online learning* for schools in Sri Lanka. Active learning has been shown to be effective even within the VES (for example, Beetham, 2020; Healey, Pawson, & Solem, 2013; Krol, Haselager, & Zander, 2020) and lectures *can* be active and involved (Whalley, 2016). Out of classroom education, such as in fieldwork, has traditionally involved active learning (France et al., 2015). A sympathetic approach to personal networked learning has been compiled by Stephen Downes (2017) we align towards the FES in the next two sections.

Towards personalizing HE systems of the future

Rather than trying to make the VES 'electronic' with online lectures, post-Covid-19 we should now assess and develop all the recent experiences gleaned, tested and particularly *shared* by 'going online'. The FES should be able to present and discuss VUCA as applied to each student of the future. Data protection and security, perhaps including lecture materials and resources to confirm authenticity, is just one aspect. Blockchain technology already figures in this discussion, for example Chen, Xu, Lu, and Chen (2018) give a general consideration and include aspects such as transcripts and reducing fraud. Grech and Camilleri (2017) provide a substantial education orientation overview including aspects of trust and verification (Sharples & Domingue, 2016). Competency-based education is a potentially important part of subverting the VES degree structure. For example, a blockchain might contain a student's educational transcript with formative information and achievements rather than a single-valued degree result. This may become particularly significant for mobile applications and the concept of bring your own device (BYOD). Williams (2019) considers the significance of blockchains in the

area of assessment, probably continuing to be important institutionally, despite criticism (Buckingham Shum & Crick, 2016). Information systems and networking, digital and face-to-face, will be pivotal in tutor-learner relationships. Learning, or education analytics are increasingly in evidence via VLEs and in the 4IR (figure 1 and, for example Gasevic, Dawson, Mirriahi, & Long, 2015). However, they do not in themselves promote personalised learning as would be engendered by online student-tutor interactions. Francis, Broughan, Foster, and Wilson (2020) also consider analytics into future educational research agendas and student agency have recently been discussed by Tsai, Perrotta, and Gašević (2020) who point out that, ‘the current approach to learning analytics presents tensions between increasing student agency in making learning-related decisions and “datafying” students’ (Tsai et al., 2020, p. 554).

Networked learning and delivery systems in the FES

All HEIs have wired/wifi computer connectivity. Along this go e-mails and communications with Virtual Learning Environments (VLE, or Learning/Course Management Systems) that are much used as part of ‘e-learning’ (Sharpe, Beetham, & De Freitas, 2010). In networks however, connections matter as much as content:

- Sharing knowledge produces network effects such as knowledge co-creation.
- Nodes gain respect and trust from their activities, not their hierarchical position.
- Cooperation is as important as collaboration and teamwork.
- Being interconnected, networking is learning.

These aspects are encompassed by consideration of ‘e-learning’ and ‘blended learning’ (although both terms should now be deprecated; we just have various ways to ‘learn’). New technologies can bring personal interactions into learning without the VLE. An example of this, non-traditional practical work (NTPW) in the context of 4IR is being explored by Drysdale et al. (2019). Such 4IR research has a direct link with Covid-19. The common usage of the term ‘social distancing’ is incorrect. With respect to the Sars-CoV-2 virus, *physical distancing* is required, social interactions should be enhanced by promoting well-being using VoIP – Voice (and video) over Internet Protocol. By ‘delivery’ we mean the main ways in which university staff (from governing bodies to library and ICT staff to tutors and lecturers) engage and interact with students to engender a key part of students’ ‘personal learning’. The FES should examine existing learning opportunities and practitioners should enhance traditional formats to become ‘ubiquitously connected and pervasively proximate’ (UCA PP). For example, not reiterating lectures by recordings but by making them interactive. Many forms of ‘enlightened education’ based on connectivist innovations exist: flipped classrooms, Just-in-time (JiT) teaching (Simkins & Maier, 2010), varieties of problem-based learning (PBL) (Savin-Baden & Wilkie, 2006) and assessment methods (Boud & Falchikov, 2007). Active delivery-assessment will be an important part of attuning students to the 4IR by developing connectivized pedagogies of the FES. Degree structures might include measures of competence and attainment rather than explicit award systems that promote ‘grade inflation’. Williams (2014a, 2014b)) has contributed some thoughts as to what assessment might be like, especially regarding the knowledge economy. Williams (2014a) makes radical recommendations, ‘for universities

to embrace radically different assessment priorities and practices. Instead of centring assessment on the personal, academic achievements’.

There are ways in which assessment can be better integrated into digital systems but going beyond the examination/essay debate or indeed ordinary/honours degrees of the VES. We need to consider aspects such as ‘competency’, which does not mean ‘not demanding’ (Holmboe, Sherbino, Long, Swing, & Frank, 2010; Johnstone & Soares, 2014; Leung, 2002) and its possible manifestation in the 4IR (Williams, 2019). How such ideas can reduce stress on students as well as making them more fitted and adapted for future education as part of the FES requires further investigation.

Newman’s view of the university (Newman, 1858 (1996)) still evokes the ‘us’ – who can afford it – and ‘them’ – who cannot and know their place. Most UK universities are dependent on full-time student attendance and hence the importance placed on student ‘retention’ and has implications for non-UK students and the funding model for UK HEIs as noted previously. Many more institutions now offer a variety of residential and online (and distance) courses, such as xMOOCs (eXtended MOOCs based on traditional university courses) and SPOCs (Small Private Online Course), which often cater for apprentices, continued professional development (CPD) and undergraduates. With student connectivity they present suitable models to enhance teaching innovation. In the UK, participation in the VES by attendance at lectures and tutorials is seen as an indication of student ‘engagement’. However, better online connectivity and the development of Personal Learning Environments (PLE) in the FES allow student-centred methods of engagement (see for example Gourlay, 2015; Gourlay & Stevenson, 2017) particularly with connectivist cMOOCs (distinct from xMOOCs) using social media (Saadatmand & Kumpulainen, 2014). This might be seen as a move towards the Ruskin-inspired ‘university settlement’ movement (Hill, 2019). However, substituting MOOC technology as online equivalent to lectures – the ‘new normal’ is not the answer as Reich (2020) has discussed.

Open discussions about these ideas will be essential for institutions to develop their responses to connected teaching in the FES alongside modern assessment practices (Bryan & Klegg, 2019). The traditional undergraduate degree in the UK is residential with terms/semesters. Whyte (2019), in a critique of residential student accommodation, considers that, ‘We have tended to ignore the 50% of teenagers who do not attend university and have disregarded the one-in-five students who do not leave home’. In this paper we refer to them as being ‘the neglected’. Special attention will need to be given these and non-residential students of the future.

The individual in mass teaching

Mass teaching can be improved by developing ‘personalised learning’ (Beetham & Sharpe, 2020) that (as one university has it), ‘allows participants to take ownership of their personal, professional and academic development and to demonstrate acquired knowledge and skills to enhance their practice within the workplace’. Another way is via digital marketing (DMI, 2019) that provides a suitable strategy implementing personalized learning in the FES – referring to the ‘customer services’ of a 4IR approach. One of the consequences of Rose’s Taylorian education (Rose, 2016, p. 49 ff) is the problem of a single valued function (such as a ‘First Class degree’) being representative of a student’s attainment (Rose, 2016, p. 81 ff). These aspects of HE are the traditional, and current, VES. How might attainment be improved

in a FES? We might consider the ‘old’ ordinary-honours degree system. Predominantly ‘online’ approaches might be used for a two-year modular degree achieved with only pass/fail similar to an Open University arrangement but at minimal cost to the student. This might be very attractive to those students, such as the neglected, who do not consider university to be ‘for them’. Such a scheme would provide cost incentives with no need to travel; distance learning with social *inclusion*. An Honours degree might be more like a masters programme, perhaps charged at a higher rate. This could be developed as suggested by the World Economic Forum (2018). Harari (2016, p. 381) considers that, ‘the traditional model will become totally obsolete, and the only way for humans to stay in the game will be to keep learning throughout their lives, and to reinvent themselves repeatedly’. One way to encourage more personalised education is by using ‘old fashioned’ tutoring but using interactive online techniques akin to telemedicine now becoming part of ‘virtual’ medical education (Uscher-Pines et al., 2020) and with mobile (iPad) devices (Ponce et al., 2016).

Modifications to the present system

Academics generally pay allegiance to their subject areas. Understandably, because this is where they developed educationally and into which undergraduates are recruited. This also applies to the UK’s Research Excellence Framework (REF) and the subject-based Teaching Excellence Framework (TEF, that monitors ‘educational quality’). Much is made of undergraduate employment and recent indications in the UK suggest that funding be directed to STEM subjects rather than ‘arts’. Views to the future – 2030 – indicate that national needs will become more skills-based, even in knowledge economies (Störmer et al., 2014). Further, that as professions change in the 4IR so will academic subject ‘gatekeepers’ need to change (Susskind, 2020; Susskind & Susskind, 2015). Prensky (2017) give a radical view of paradigm change. However, subject-centredness perpetuates the inertia of the VES. In Finland, secondary education, has become less subject-focussed and more-problem-orientated (Spiller, 2017). In a university context, multi- and inter-disciplinarity may become points of dispute. Evidence of good practice related to education (Donaldson, Ward, & Bradley, 2010), links to evidence-based policy (Cartwright & Hardie, 2012) and ethics (Bucciarelli, 2008) suggesting subject restructuring and adapting to the 4IR are opportune following Prensky’s formulation.

In the UK the Covid-19 pandemic has seen suggestions that doctor (general practitioner) consultations should primarily be via video links. Yet telemedicine is already widespread and popular diagnostic apps (using simple AI) exist for doctors as well as lay people and has existing security, privacy and accountability rules. Such areas of online and application development in the 4IR are likely to be cross disciplinary; software engineers, social scientists, psychologists, nurses, actors, graphic designers and ethicists as well as health professionals. This is just one area (gaming is another) where ‘subject mixing’ in HE will better fit the population for the 4IR and where Covid-19 makes moves towards the FES urgent.

Small and agile modifications could be reconfigured from existing structures. Restructuring needs to be transparent from the students’ point of view as well as tutors and discussed with the Office for Students to show the benefits. What should these benefits be and how might they be implemented? At an individual (or group) level, students need to facilitate communication, between tutors and tutor group members.

Online tutoring might mitigate disruption by illness, physical and mental, or financial difficulties for example which requires something of a holistic view of tutoring rather than purely academic (Lochtie, McIntosh, Stork, & Walker, 2018).

However, this may be not radical enough. The way for the future needs better connectivist systems as part of critical scrutiny and understanding of the ‘digital university’ (Johnston, Macneil, & Smyth, 2019). Ideas such as venture creation programmes (Lackeus & Middleton, 2015), the *London Interdisciplinary School* and *Edinburgh Futures Institute* are existing novel ways of looking towards the 4IR.

Personalization technologies in the future educational system

The Future Educational System (FES) considered here is for higher education, although Beard (2020) has recently suggested something similar for compulsory education. To accommodate the manifold problems facing HEIs, considerable modifications of educational systems will be needed. It will be necessary to promote discussion, both nationally and especially, institutionally to accomplish change, although government policy may force the issue. Being responsive to change is the best way to progress towards the 4IR and can be accomplished by building upon a stated, quality-directed policy such that the *whole institution* responds. The VES in the UK needs to look at educational and pedagogic models already in use internationally, for example learner-centered paradigms of education (Herodotou et al., 2019; Reigeluth, Beatty, & Myers, 2017).

We suggest that academic reconfiguration requires incorporating flexible active learning to allow for the needs of non-traditional students such as those who are part-time (Maguire, 2013) as well as the ‘neglected’. Such changes should look well beyond the marketing tool of the virtual learning environment (VLE) towards better implementations of personal learning. This is rather far from the personal learning environment (PLE) on the VLE (e.g. Sire, Bogdanov, Gillet, Palmer, & Wild, 2011) and the use of video-recorded lectures which tend to reinforce the VES. Some principles for personalised integrated educational system (PIES) and constructivist approaches have been discussed by Watson and Watson (2017). The book ‘Emergence and Innovation in Digital Learning’ (Veletsianos, 2016) discusses the context of re-alignment from VLE to PLE. Video-on-demand (VoD) systems, using high bandwidth internet, allow access to *YouTube*, *Apple iTunes U*, *Khan Academy* etc. and allow free educational courses involving MOOCs and SPOCS, especially for specialised learning possibilities (Drysdale et al., 2019). Udall, Forrest, and Stewart (2015) have presented case studies of mixed discipline, ‘engaged teaching’ that offer possibilities to break down traditional boundaries. Covid-19 has shown us the working from home is not only possible but can, with care, be advantageous. Rather than ‘printing-on-demand’ for textbooks, there are increasing opportunities for subscription (‘Netflix’) formats that might be organised via institutional libraries.

Cochrane, Sissons, and Mulrennan (2018) show that assessment in journalism needs to be debated and implemented *beyond* the level discussed in educational textbooks. The ‘one fits all’ approach of most examinations needs to be challenged, especially for those entering higher education via non-traditional routes direct from compulsory education and do we really need examinations? (Whalley, 2010). Discussion on alternative assessment models (Williams, 2014b) and competency-based assessment (Gonczi, 2013; Johnstone & Soares, 2014; Williams, 2019) are needed to go beyond the ‘examination + essay’ mode of conventional

VES practices to be able to cope with varied needs of diverse students and connectivist learning in the FES.

There are views of the 4IR world as being dystopian, involving AI, nano-technology and gene-editing technologies as well as climate and environmental challenges. HEIs are involved by looking at the carbon footprints of buildings, staff and student travel for example. As outlined above, and as part of the 4IR, there are responsibilities to students not only in terms of ‘inclusivity’ but also what, where and how students are educated. To do this effectively, universities will need to change, probably away from the traditional ‘subject centres’ and departments and towards considering generation Z students. This will require going beyond ‘Reshaping the University’ (Barnett, 2005) and developing e-learning strategies (Cochrane, 2010) in the development of an educational quality policy (Whalley, 2019), although Cochrane (2013) does suggest using m(obile)-learning as a catalyst for change. In line with the view of Harari above, Brown (2019) considers the 4IR ‘at the end of the day isn’t about machines but about humans – *the way we live, learn, earn and play* ... and that ... workers prepare for the future in an age of unprecedented and ever accelerating change? The answer: *continuous education, learning and training*’. Personalization, in terms of technologies and pedagogies, will be at the heart of these changes. Some of these issues are included in Reigeluth et al. (2017) on structural design and presented in the free online publication by Beatty (2019) and brought together by Kelly (2020) as hybrid-flexible course design (‘HyFlex’) with four core values:

- (1) Learner Choice: *Provide meaningful alternative participation modes to enable students to choose between participation modes in space and time.*
- (2) Equivalency: *Provide learning activities in all participation modes which lead to equivalent learning outcomes and diverse assessment.*
- (3) Reusability: *Utilize artefacts from learning activities in each participation mode as “learning objects” for all student and between institutions as required.*
- (4) Accessibility: *Equip students with technology skills and equitable access to all participation modes with no discrimination, economic or social.*

We now show how technology can promote these values in higher education.

Mobile devices in the future educational system

The Covid-19 pandemic has shown the importance of broadband communication to improve social contacts not least by moves towards ‘working from home’. Universities often provide extensive, and expensive, ‘computer suites’ for students on campus. Mobile learning has the potential to make these largely redundant, especially for students who cannot easily get to a campus site. Crompton, Burke, Gregory, and Gräbe (2016) have reviewed mobile learning devices and their role in education. Smart phones and tablets as Bring Your Own Devices (BYOD) enable the internet to be used effectively (Welsh et al., 2018) for communication and to enhance memory, as a *vade mecum* (Whalley, France, Mauchline, Welsh, & Park, 2016). Significantly, smart devices will develop with technologies to be true adaptational, companion devices for students (Whalley, France, Park, Mauchline, & Welsh, 2020). Although there is concern about inequality issues, have and have-not, with mobile devices and broadband

access, Covid-19 has shown how important they are for social and educational interaction. If cost is an issue then institutional subsidies may be required. But, as suggested above, institutional computer suites may become a thing of the past. Student (and tutor) support lies in the broadband capabilities especially in its availability nation-wide. A further problem may lie with insufficient institutional support for tutors to use mobile devices as part of their educational procedures and thus incorporate connectivity in the Future Educational System.

When Apple's iPad was released in 2010 it followed the iPhone of 2007 as a 'disruptive' device. We have been working on the utility of smart devices in fieldwork (France et al., 2015) especially with BYOD (Clark et al., 2020; Welsh et al., 2018). Smart devices can be used in the field or indeed any learning space as part of what is generally called mobile learning (JISC, 2015; Whalley, Mauchline, France, Park, & Welsh, 2018), but their inclusion needs to be purposeful and have the potential to improve the student experience (France, Lee, Maclachlan, & McPhee, 2020). Yet the use of technology in education is highly variable and is rarely fully integrated into personalised learning. It is generally accepted that teaching staff need more experience and practice of using technologies, hardware and software, via professional development. Thus, training needs to go beyond knowledge of mobile technologies and into pedagogies looking towards the 4IR via flexible personalized learning (Kukulska-Hulme & Traxler, 2020). Connectivist approaches can be viewed as a networked class, tutor group or with points of information (Wikipedia, YouTube, iTunes U for example) via rhizomatic learning (Cormier, 2008, 2011). These approaches should be linked to design principles (Kukulska-Hulme & Traxler, 2020) and the core values of HyFlex as listed above.

Towards the FES with future research

The Victorian Educational System *can* become the Future Educational System. The present educational system already uses internet communication structures, developing technologies and pedagogic devices outlined above. The FES needs to incorporate it, together with diverse mobile technologies bound together in a student-centred outlook and pedagogy. Covid-19 is forcing changes to education but loose concepts such as 'distance' or 'blended' learning' need pedagogic grounding. Barber, Donnelly, Rizvi, and Summers (2013) advocate MOOCs, although this can all too often be a VES lecture distributed electronically (xMOOC). We suggest that a focus on students' needs via online/remote learning using connectivist cMOOCs is necessary: 'connection not content'. A typical response to Covid-19 strictures of physical distancing is to open social linkages with the use of VoIP such as Zoom, Teams, Collaborate and Hangouts. This suggests that a connectivist and personal learning approach is perfectly feasible and moves to competencies rather than being examined in the competitive manner of the VES. For institutions to move towards a Future Educational System educational research to redesign systems and pedagogies based around active and connected learning is necessary. Considerable thought has already been given to design principles (Beetham & Sharpe, 2020; Laurillard, 2012; Sharpe et al., 2010) but they need to be implemented fully by institutions not just haphazardly by academic departments. We should use pedagogically-sound implementations that are cross- and multi-discipline to match the requirements of 4IR and demands of Covid-19. In fact, much of this work is readily available from a wide range of educational practitioners and developers.

Tutors and Tutoring have been mentioned several times previously and conventionally (in the VES) this means that students are individually assisted to pass examinations. This ‘achievement’ exists within the time domain (length of tutoring, number of lectures, time limited examination). In the 1960s J. B. Carroll and later Benjamin Bloom suggested that students needed ‘mastery’ of a topic before moving on (Guskey, 2010). There are good indications that mastery techniques can be used to avoid ‘teaching to the test’ and avoid stress in high-stakes testing (Zimmerman & Dibeneditto, 2008) across the educational spectrum. Sales and Pane (2019) for example have started to explore intelligent tutoring and mastery learning. Anywhere-anytime tutoring on mobile devices is now practical Grant Sanderson’s 3blue1brown ‘lockdown math’ being a good example via a YouTube channel.

The Hy-flex approach is well established in the United States. It aims to allow students to sit a module either online or face to face or as a combination. Students who feel they want a campus experience can receive it, those who want or need to participate online can do so. However, this duality is somewhat restrictive in developing the FES. The four core values (as above) should still hold but attention should be given to developing skills in situated and ‘authentic’ learning with students communicating amongst themselves or with tutors as needed, on campus or online. The capabilities of smart mobile devices (sometimes called m-learning) now makes this possible. We have shown this to be the case with fieldwork and should be developed more generally. From the perspective of the lecturer (teacher, tutor or instructor) in HE the ‘guide on the side’ can become the guide online with digital (or e-) democracy.

Figure 2 suggests that moving towards Future Educational Systems should incorporate the issues raised above and be at the heart of institutional policies, in particular in developing ubiquitous quality higher education.

Conclusions

Covid-19 has been a disruptive influence on individuals and communities as well as all forms of education and will continue to do so. In the HE sector, the immediate response has been to ‘put lectures online’ and then consider what to do about assessment. However, as Knight and Drysdale (2020) point out, the future of HE hangs on innovating assessment. As yet unknown effects apply to the number of returning and new students, their fees, income for institutions but also socio-economic backgrounds. Instead of perpetuating the existing Victorian Educational System, the sector needs to look forward to the 4IR where the educational needs of populations will be very different from 2020 – beyond VUCA. The Volatility, Uncertainty, Complexity and Ambiguity produced by Covid-19 is an opportunity to evolve a Future Educational System (FES). The late Sir David Watson suggested that, ‘UK higher education is going through one of its more “manic” periods’ with respect to aspirations and funding models’ (Watson, 2013). With Covid-19 this phase continues. The education and pedagogic aspirations of HE should now start to re-organize by developing the future educational system.

Adaptations to teaching and learning in the HE sector can be used to develop and deliver student-directed pedagogic opportunities for the FES. If these opportunities are developed in a flexible (or agile) manner, then students should benefit as we move towards the 4IR. Adaptive responses to Covid-19 provide a focus for improving teaching and online learning systems. Mobile technologies already exist to provide students with more freedom and

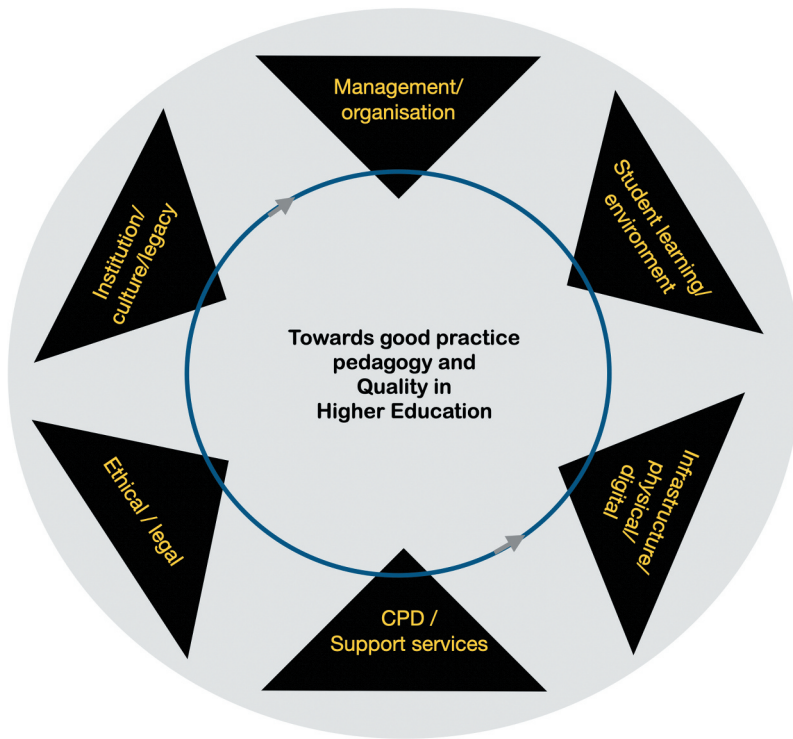


Figure 2. Overall structure for producing an institutional pedagogy for the 4IR, modified from Adekola et al. (2017, Figure 2). The pedagogy is placed central to the educational aim of the institution operating within external pressures – such the 4IR.

flexibility to develop their own capabilities, wherever they live and study. Smart mobile devices also offer a wide variety of features that aid accessibility. Hybrid-flexible course design can bring tertiary sector education to a much wider community and to help redress the imbalances of economic and social deprivation. Personal Learning Environments on smart devices help the flexibility from a student perspective by accentuating connectivist (rhizomatic) learning. Anywhere-anytime tutoring with smart mobile devices already allows much greater flexibility for students and tutors. Realigning structures and associated pedagogic foundations are not simple, but opportunities should now be seized such from ‘co-creation’ of learning and teaching (Bovill, 2020). Its implementation is a matter of management, not the traditional top-down, but ‘middle-up-down’. This approach would use the existing base of practitioners whose direct concerns are students in higher education. Not least, lecturers should become better tutors (or mentors) aided by development and practices in metacognition (Weinstein & Sumeracki, 2019) by understanding how we learn (Bransford, Brown, & Cocking, 2000) and by using student-pacing using mastery ideas. The sector could then become a ‘knowledge-creating and skills using’ community after Nonaka and Takeuchi (1995). In particular, the future educational system should develop structures that welcome students from the widest possible of backgrounds.

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