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 and include ‘digital poverty’ for
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](https://shockoe.com/people/)

**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/](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 1and 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’ (UCaPP). 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 nade 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. Carrol 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 & Dibenedetto, 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
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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References

Adekola, J., Dale, V.H., & Gardiner, K. (2017). Development of an institutional framework to guide transitions into enhanced blended learning in higher education. Research in Learning Technology, 25. doi:10.25304/rlt.v25.

Albrecht, D.E., & Albrecht, S.G. (2009). Economic restructuring, the educational income gap, and overall income inequality. Sociological Spectrum, 29(4), 519–547. doi:10.1080/02732170902904822

Altbach, P.G. (2008). The complex roles of universities in the period of globalization. Higher Education in the World - Global University Network for Innovation 3, 5–14.

Arum, R., & Roksa, J. (2011). Academically adrift: Limited learning on college campuses. Chicago: University of Chicago Press.

Augar, P. (2019). Review of Post-18 Education and Funding. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805127/Review_of_post_18_education_and_funding.pdf

Ball, S., Macrae, S., & Maguire, M. (2013). Choice, pathways and transitions post-16: New youth, new economies in the global city. Abingdon: Routledge.

Barber, M., Donnelly, K., Rizvi, S., & Summers, L. (2013). An avalanche is coming: Higher education and the revolution ahead. The Institute of Public Policy Research. Retrieved from https://www.ippr.org/publications/an-avalanche-is-coming-higher-education-and-the-revolution-ahead

Barnett, R. (2000). Supercomplexity and the curriculum. Studies in Higher Education, 25(3), 255–265. doi:10.1080/713696156

Barnett, R. (2005). Rethinking the university: New relationships between research, scholarship and teaching. Maidenhead: Open University Press/McGraw-Hill Education (UK).

Beard, A. (2020). The Learning Revolution. BBC. Retrieved from https://www.bbc.co.uk/programmes/m000h93b

Beatty, B.J. (Ed.). (2019). Hybrid-Flexible Course Design: Implementing student-directed Hybrid Classes. EdTechBooks.org

Beetham, H. (2020). Learning activities and activity systems. In H. Beetham & R. Sharpe (Eds.), Rethinking pedagogy for a digital age (3rd ed ed., pp. 32–48). Abingdon: Routledge.

Beetham, H., & Sharpe, R. (Eds.). (2020). Rethinking pedagogy for a digital age: Principles and Practices of Designing, 3rd edition. Abingdon: Routledge.

Berners-Lee, T. (2020). It’s time to recognise internet access as a human right. Retrieved from https://webfoundation.org/2020/10/its-time-to-recognise-internet-access-as-a-human-right/

Boud, D., & Falchikov, N. (2007). Rethinking assessment in Higher Education. Abingdon: Routledge.

Bovill, C. (2020). Co-creating Learning and Teaching: Towards relational pedagogy in higher education. St Albans: Critical Publishing.

Bransford, J.D., Brown, A.L., & Cocking, R.R. (2000). How People Learn: Brain, Mind, Experience, and School. Washington DC: National Academies Press.

Brown, A. (2019). Charting your own pathway to professional success in the 4th Industrial Revolution. Medium.com. Retrieved from https://medium.com/predict/charting-your-own-pathway-to-professional-success-in-the-4th-industrial-revolution-ec5287a1b242

Bryan, C., & Klegg, K. (2019). Innovative Assessment in Higher Education. Second Edition), Abingdon: Routledge.

Bucciarelli, L.L. (2008). Ethics and engineering education. European Journal of Engineering Education, 33(2), 141–149. doi:10.1080/03043790801979856

Buckingham Shum, S., & Crick, R.D. (2016). Learning Analytics for 21st Century Competencies. Journal of Learning Analytics, 3(2), 6–21. doi:10.18608/jla.2016.32.2

Buckland, M.K. (1991). Information as thing. Journal of the American Society for Information Science (1986-1998), 42(5), 351. doi:10.1002/(SICI)1097-4571(199106)42:5<351::AID-ASI5>3.0.CO;2-3
Burns, J. (2015). Student fury over ‘impossible’ economics exam. BBC. Retrieved from https://www.bbc.co.uk/news/education-31057005

Carey, K. (2016). The end of college: Creating the future of learning and the university of everywhere. New York: Riverhead Books.

Cartwright, N., & Hardie, J. (2012). Evidence-based Policy. A practical guide to doing it better. Oxford: Oxford University Press.

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

Chickering, A.W., & Gamson, Z.F. (1987). Seven principles for good practice in undergraduate education. AAHE Bulletin, 39(7), 3–7. Retrieved from: teaching.uncc.edu/learning-resources/articles-books/best-practice/education-philosophy/seven-principles

Clark, K.A., Welsh, K.E., Mauchline, A.L., France, D., Whalley, W.B., & Park, J.R. (2020). Do educators realise the value of Bring Your Own Device (BYOD) in fieldwork learning? Journal of Geography in Higher Education, 44(3), 1–24. doi:10.1080/03098265.2020.1808880

Cochrane, T. (2010). Beyond the yellow brick road: Mobile Web 2.0 informing a new institutional e-learning strategy. ALT-J, 18(3), 221–231.

Cochrane, T. (2013). M-Learning as a catalyst for pedagogical change. Handbook of Mobile Learning (pp. 247–258). New York, NY: Routledge.

Cochrane, T.D., Sissons, H.A., & Mulrennan, D.L. (2018). Mainstreaming mobile learning in journalism education. In H. Crompton & J. Traxler (Eds.), Mobile Learning and Higher Education (pp. 19–30). Abingdon: Routledge.

Collini, S. (2012). What are Universities For? London: Penguin.

Cormier, D. (2008). Rhizomatic education: Community as curriculum. Innovate: Journal of Online Education, 4(5), n5. Retrieved from: https://nsuworks.nova.edu/innovate/vol4/iss5/2/

Cormier, D. 2011. Rhizomatic Learning – Why we teach? Dave’s Educational Blog, retrieved from http://davecormier.com/edblog/2011/11/05/rhizomatic-learning-why-learn/

Crompton, H., Burke, D., Gregory, K.H., & Gräbe, C. (2016). The use of mobile learning in science: A systematic review. Journal of Science Education and Technology, 25(2), 149–160. doi:10.1007/s10956-015-9597-x

Daskal, J., & Sherman, J. (2020). Data nationalism on the rise. Data Analyst. Retrieved from https://datacatalyst.org/reports/border-control-the-rise-of-data-nationalism/

Department for Business Energy and Industrial Strategy. (2019). Policy paper, Regulation for the Fourth Industrial Revolution Department for Business, Energy and Industrial Strategy, CP111. Retrieved from: https://www.gov.uk/government/publications/regulation-for-the-fourth-industrial-revolution/regulation-for-the-fourth-industrial-revolution#contents

DMI. (2019). How to drive personalized learning in Higher Education. Digital Marketing Institute. Retrieved from https://digitalmarketinginstitute.com/en-gb/blog/how-to-drive-personalized-learning-in-higher-education

Donaldson, A., Ward, N., & Bradley, S. (2010). Mess among disciplines: Interdisciplinarity in environmental research. Environment and Planning A, 42(7), 1521–1536. doi:10.1068/a42483

Donnelly, M., & Gamsu, S. (2018). Home and Away. Social, ethnic and spatial inequalities in student mobility. Retrieved from https://www.suttontrust.com/wp-content/uploads/2019/12/Home_and_Away_FINAL.pdf

Downes, S. (2017). Toward personal learning. Reclaiming a role for humanity in a world of commercialism and automation. Retrieved from https://www.downes.ca/files/books/Toward%20Personal%20Learning%20v09.pdf

Drysdale, T., Simon, K., Anne-Marie, S., Victoria, D., Jenny, S., Andrew, W., … Watts, S. (2019). Post-humanistic/practices of community for non-traditional laboratory work. Proceedings of the SEFI 47th Annual Conference. Budapest, HU. Retrieved from http://orca.cf.ac.uk/126446/1/2019-07-22_sefi_drysdale_et_al_final.pdf

Federman, M. (2005). Why Johnny and Janey can’t read, and why Mr. and Ms. Smith can’t teach: The challenge of multiple media literacies in a tumultuous time. University of Toronto Senior Alumni Association Lecture Series, Toronto, Canada. Retrieved from http://www.individual.utoronto.ca/markfederman/WhyJohnnyandJaneyCantRead.pdf
Fernando, M. (2018). Pedagogical and E-Learning Techniques for Quality Improvement of ICT Education. Advanced Learning and Teaching Environments: Innovation, Contents and Methods, Intech Open, 3–22. Retrieved from https://www.intechopen.com/books/advanced-learning-and-teaching-environments-innovation-contents-and-methods/pedagogical-and-e-learning-techniques-for-quality-improvement-of-ict-education

Floridi, L. (2011). The Philosophy of Information. Oxford: Oxford University Press.

Floridi, L. (2014). The Fourth Revolution. How the infosphere is reshaping human reality. Oxford: Oxford University Press.

Forum, W.E. (2018). The Future of Jobs Report 2018. World Economic Forum. Retrieved from http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf

France, L. (2014). The Fourth Industrial Revolution: The future of work: What will jobs look like in 2025? Random House.

Friedman, T.L. (2006). The world is flat: A brief history of the 21st century. Vintage.

Gage, N.L. (2009). A conception of teaching. Dordrecht: Springer.

Gasevic, D., Dawson, S., Mirriahi, N., & Long, P.D. (2015). Learning analytics—A growing field and community engagement. Journal of Learning Analytics, 2(1), 1–6. doi:10.18608/jla.2015.21.1

Gibbs, G. (2019). How assessment frames student learning. In C. Bryan & K. Clegg (Eds.), Innovative Assessment in Higher Education: A Handbook for Academic Practitioners (pp. 22–35). Abingdon: Routledge.

Gonczi, A. (2013). Competency-Based Approaches: Linking theory and practice in professional education with particular reference to health education. Educational Philosophy and Theory, 45(12), 1290–1306. doi:10.1080/00131857.2013.763590

Gourlay, L. (2015). ‘Student engagement and the tyranny of participation. Teaching in Higher Education, 20(4), 402–411. doi:10.1080/13562517.2015.1020784

Gourlay, L., & Stevenson, J. (2017). Teaching excellence in higher education: Critical perspectives. Teaching in Higher Education, 22(4), 391–395. doi:10.1080/13562517.2017.1304632

Grech, A., & Camilleri, A.F. (2017). JRC Science for Policy Report. Centre. Luxembourg: Luxembourg: Publications Office of the European Union. Blockchain in Education. doi:10.2760/60649

Gururaj, H., Swathi, B., & Ramesh, B. (2018). Threats, consequences and issues of various attacks on online social networks. International Journal of Education Management Engineering (IJEAME), 8(4), 50–60.

Guskey, T. R. (2010). Lessons of mastery learning. Educational Leadership, 68(2), 52

Hamilton, M. (2018). The fourth industrial revolution: How can universities respond to the rise of the robots? Jisc. Retrieved from https://www.jisc.ac.uk/blog/the-fourth-industrial-revolution-how-can-universities-respond-to-the-rise-of-the-robots-11-apr

Harari, Y.N. (2016). Homo Deus: A brief history of tomorrow. London: Random House.

Healey, M., Pawson, E., & Solem, M. (2013). Active learning and student engagement: International perspectives and practices in geography in higher education. Abingdon: Routledge.

Herodotou, C., Sharples, M., Gaved, M., Kukulska-Hulme, A., Rientes, B., Scanlon, E., & Whitelock, D. (2019). Innovative pedagogies of the future: An evidence-based selection. Frontiers in Education, 4(Article), 113. doi:10.3389/feduc.2019.00113

Herrington J., Reeves T.C., & Oliver R. (2014) Authentic Learning Environments. In J. Spector, M. Merrill, J. Elen, M. Bishop. (Eds.), Handbook of Research on Educational Communications and Technology. New York, NY: Springer, 401-402.

Hill, A. (2019). Ruskinland. How John Ruskin Shapes our World. London: Pallas Athene.

Holmboe, E.S., Shérbino, J., Long, D.M., Swing, S.R., & Frank, J.R. (2010). The role of assessment in competency-based medical education. Medical Teacher, 32(8), 676–682. doi:10.3109/0142159X.2010.500704
Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence In Education. Promises and Implications for Teaching and Learning. Boston, MA: Center for Curriculum Redesign.

Jack, A.A. (2019). The Privileged Poor: How Elite Colleges Are Failing Disadvantaged Students. Cambridge, MA: Harvard University Press.

JISC. (2015). Mobile technology and m-learning. Available at: www.jisc.ac.uk/full-guide/developing-organisational-approaches-to-digital-capability

Johnston, B., Macneil, S., & Smyth, K. (2019). Conceptualising the Digital University: The Intersection of Policy, Pedagogy and Practice. Basingstoke: Palgrave.

Johnstone, S.M., & Soares, L. (2014). Principles for developing competency-based education programs. Change: The Magazine of Higher Learning, 46(2), 12–19. doi:10.1080/00091383.2014.896705

Kelly, K. (2020). COVID-19 Planning for Fall 2020: A Closer Look at Hybrid-Flexible Course Design. Phil on Tech, 7 May 2020. Retrieved from https://philonedtech.com/covid-19-planning-for-fall-2020-a-closer-look-at-hybrid-flexible-course-design/

Knight, G.L., & Drysdale, T.D. (2020). The future of higher education (HE) hangs on innovating our assessment – But are we ready, willing and able? Higher Education Pedagogies, 5(1), 57–60. doi:10.1080/23752696.2020.1771610

Krol, L.R., Haselager, P., & Zander, T.O. (2020). Cognitive and affective probing: A tutorial and review of active learning for neuroadaptive technology. Journal of Neural Technology, 17(1), 012001. doi:10.1088/1741-2552/ab5b5

Kukulska-Hulme, A., & Traxler, J. (2020). Design principles for learning with mobile devices. In H. Beetham & R. Sharpe (Eds.), Rethinking pedagogy for a digital age (3rd ed ed., pp. pp. 181–196). Abingdon: Routledge.

Lackéus, M., & Middleton, K.W. (2015). Venture creation programs: Bridging entrepreneurship education and technology transfer. Education + Training, 57(1), 48–73. doi:10.1108/ET-02-2013-0013

Laurillard, D. (2012). Teaching as a design science: Building pedagogical patterns for learning and technology. Abingdon: Routledge.

Leung, W.-C. (2002). Competency based medical training: Review * Commentary: The baby is thrown out with the bathwater. BMJ, 325(7366), 693. doi:10.1136/bmj.325.7366.693

Lochtie, D., McIntosh, E., Stork, A., & Walker, B. (2018). Effective personal tutoring in higher education. St Albans: Critical Publishing.

Machin, S., & Vignoles, A. (2004). Educational inequality: The widening socio-economic gap. Fiscal Studies, 25(2), 107–128. doi:10.1111/j.1475-5890.2004.tb00099.x

Maguire, D. (2013). Flexible Learning: Wrapping Higher Education around the Needs of Part-Time Students. Oxford: Higher Education Policy Institute.

Major, L.E., & Banerjee, P.A. (2019). Social mobility and elite universities. HEPI Policy Note 20. Retrieved from https://www.hepi.ac.uk/wp-content/uploads/2019/12/HEPI-Policy-Note-20-Social-Mobility-Challenge-FINAL.pdf

Associates; Mentkowski, M. (2000). Learning that lasts: Integrating learning, development and performance in college and beyond. San Francisco: Jossey-Bass.

Montacute, R. (2020). Social mobility and Covid-19. Implications of the Covid-19 crisis for educational inequality. Retrieved from https://www.suttontrust.com/wp-content/uploads/2020/04/COVID-19-and-Social-Mobility-1.pdf

Newman, J.H. (1858 (1996)). The idea of a university. New Haven, CT: Yale University Press.

Nonaka, I., & Takeuchi, H. (1995). The knowledge-creating company. Oxford: Oxford University Press.

Office for Students. (2019). Beyond the bare minimum. Author. Retrieved from https://www.officeforsstudents.org.uk/media/1a263fd6-b20a-4ac7-b268-0bbaa0c153a2/beyond-the-bare-minimum-are-universities-and-colleges-doing-enough-for-disabled-students.pdf

Pigliucci, M. (2010). Nonsense on stilts: How to tell science from bunk. Chicago: University of Chicago Press.

Ponce, B.A., Brabston, E.W., Zu, S., Watson, S.L., Baker, D., Winn, D., … Shenai, M.B. (2016). Telemedicine with mobile devices and augmented reality for early postoperative care. 38th annual international conference of the IEEE engineering in medicine and biology society (EMBC), Orlando, FL. Retrieved from https://www.semanticscholar.org/paper/Telemedicine-
with mobile devices and augmented for Ponce-Brabston

Prensky, M. (2017). A new paradigm of curriculum. In C.M. Reigeluth, B.J. Beatty, & R.D. Myers (Eds.), Instructional design theories and models Vol IV (pp. 121–140). Abingdon: Routledge.

Raphael, D. (2020). Failure to disrupt: Why technology alone can’t transform education. Cambridge, MA: Harvard University Press.

Reigeluth, C.M., Beatty, B.J., & Myers, R.M. (2017). Instructional-Design Theories and Models, Volume IV: The Learner-Centered Paradigm of Education. New York/Abingdon: Routledge.

Rose, T. (2016). The end of average. London: Allen Lane.

Saadatmand, M., & Kumpulainen, K. (2014). Participants’ Perceptions of Learning and Networking in Connectivist MOOCs. MERLOT Journal of Online Learning and Teaching, 10(1), 16–30.

Sales, A.C., & Pane, J.F. (2019). The role of mastery learning in an intelligent tutoring system: Principal stratification on a latent variable. The Annals of Applied Statistics, 13(1), 420–443. doi:10.1214/18-AOAS1196

Savin-Baden, M., & Wilkie, K. (Eds.). (2006). Problem-based learning online. Maidenhead: Open University Press.

Schwab, K. (2019). Shaping the Future of the Fourth Industrial Revolution: A guide to building a better world. New York: Portfolio Penguin.

Sharpe, R., Beetham, H., & De Freitas, S. (Eds.). (2010). Rethinking Learning for a Digital Age: How Learners are Shaping their own Experiences. Abingdon: Routledge.

Sharples, M., & Domingue, J. (2016). The blockchain and kudos: A distributed system for educational record, reputation and reward. In). K. Verbert, M.Sharples & T. Klobučar (Eds.), European Conference on Technology Enhanced Learning, Verbert et al (pp. 490–496). Eds). Cham: Springer.

Simkins, S., & Maier, M. (2010). Just-in-time teaching: Across the disciplines, across the academy. Sterling, VA: Stylus Publishing.

Sire, S., Bogdanov, E., Gillet, D., Palmer, M., & Wild, F. (2011). Introducing qualitative dimensions to analyse the usefulness of Web 2.0 platforms as PLEs. International Journal of Technology Enhanced Learning, 3(1), 40–60. doi:10.1504/IJTEL.2011.039063

Spiller, P. (2017). Could subjects soon be a thing of the past in Finland? BBC. Retrieved from https://www.bbc.co.uk/news/world/europe–39889523

Spinks, R. (2015). Smartphones area lifeline for homeless people.Retrieved from https://www.theguardian.com/sustainable-business/2015/oct/01/smartphones-are-lifeline-for-homeless-people

Störmer, P., Patscha, C., Prendergast, J., Daheim, C., Rhisiar, M., Glover, P., & Beck, H. (2014). The Future of Work, Jobs and Skills in 2030. UK Commission for Employment and Skills. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/303334/er84-the-future-of-work-evidence-report.pdf

Susskind, D. (2020). A World Without Work: Technology, Automation and How We Should Respond. London: Allen Lane.

Susskind, R.E., & Susskind, D. (2015). The future of the professions: How technology will transform the work of human experts. Oxford: Oxford University Press.

Tsai, Y.-S., Perrotta, C., & Gašević, D. (2020). Empowering learners with personalised learning approaches? Agency, equity and transparency in the context of learning analytics. Assessment & Evaluation in Higher Education, 45(4), 554–567. doi:10.1080/02602938.2019.1676396

Udall, J., Forrest, D., & Stewart, K. (2015). Locating and building knowledges outside of the academy: Approaches to engaged teaching at the University of Sheffield. Teaching in Higher Education, 20(2), 158–170. doi:10.1080/13562517.2014.966237
Uscher-Pines, L., Sousa, J., Raja, P., Mehrotra, A., Barnett, M.L., & Huskamp, H.A. (2020). Suddenly becoming a “virtual doctor”: Experiences of psychiatrists transitioning to telementicine during the COVID-19 pandemic. Psychiatric Services, 71(11), 1143–1150. doi:10.1176/appi.ps.202000250

Vaatr, R.V.D., & Heijnen, A. (2018). Places of Engagement. Amsterdam: Amsterdam University Press.

Veletsianos, G. (Eds.). (2016). Emergence and Innovation in Digital Learning. Edmonton: AU Press.

Vignoles, A. (2013) Widening participation and social mobility. In Callender, C. & P. Scott (Eds.), Browne and Beyond: Modernizing English higher education. London: Institute of Education, University of London, 112–129

VUCAG. (2020). VUCAG world. Leadership Skills & Strategies. Retrieved from https://www.vuca-world.org/

Walker, N. (2014). Neurodiversity: Some basic terms & definitions. Retrieved from https://neurocosmopolitanism.com/neurodiversity-some-basic-terms-definitions/

Watson, D. (2013). Leading the British University today: Your fate in whose hands? In Callender & P (Eds.), Browne and Beyond: Modernizing English higher education, (pp. 194–205). London: Institute of Education, University of London.

Watson, W.R., & Watson, S.L. (2017). Principles for personalized instruction. In C.M. Reigeluth, B.J. Beatty, & R.D. Myers (Eds.), Instructional design theories and models (Vol. IV, pp. 93–120). Abingdon: Routledge.

Weinstein, Y., & Sumeracki, M. (2019). Understanding how we learn: A visual guide. Abingdon: Routledge.

Welsh, K.E., Mauchline, A.L., France, D., Powell, V., Whalley, W.B., & Park, J. (2018). Would Bring Your Own Device (BYOD) be welcomed by undergraduate students to support their learning during fieldwork? Journal of Geography in Higher Education, 42(3), 1–16. doi:10.1080/03098265.2018.1437396

Whalley, B., France, D., Park, J., Mauchline, A., & Welsh, K. (2020). Developing Active Personal Learning Environments on Smart Mobile Devices. In K. Arai, R. Bhatia, & S. Kapoor (Eds.), Proceedings of the Future Technologies Conference (FTC) 2019 (Vol. 2, pp. 871–889). Cham Switzerland: Springer Nature.

Whalley, W.B. (2010). Marks, remarks and feedback. Do we really need examinations? Planet, 23(1), 34–39. doi:10.11120/plan.2010.00230034

Whalley, W.B., France, D., Mauchline, A.L., Welsh, K.E., & Park, J. (2016). Everyday student use of iPads: A vade mecum for students’ active learning. In B. Baab, J. Bansavich, N. Souleles, F. Loizides, & A. Mavri (Eds.), Proceedings of the 2nd International Conference on the use of iPads in Higher Education (ihe2016), San Francisco (pp. 43–61). Cambridge: Cambridge Scholars Publishing.

Whalley, W.B. (2016). Lecture discussion tasks: Pedagogic and technological approaches to help break down barriers in lectures. In P. Kapranos (Ed.), Sixth International Symposium for Engineering Education (pp. 93–100). Manchester: University of Manchester.

Whalley, W.B., Mauchline, A.L., France, D., Park, J., & Welsh, K. (2018). The iPad six years on: progress and problems for enhancing mobile learning with special reference to fieldwork education. In H. Crompton & J. Traxler (Eds.), Mobile Learning and Higher Education (pp. 8–18). Abingdon: Routledge.

Whalley, W.B. (2019). Towards institutional ‘quality education’ policies in higher education: A schema for their implementation. Quality in Higher Education, 25, 340–358. doi:10.1080/13538322.2019

Whyte, W. (2019). Somewhere to live: Why British students study away from home _ and why it matters. HEPI Report 121. Retrieved from https://www.hepi.ac.uk/wp-content/uploads/2019/11/HEPI_Somewhere-to-live_Report-121-FINAL.pdf

Williams, P. (2014a). Rethinking university assessment. International Journal of Technology and Inclusive Education, 3(1), 257–264. doi:10.20533/ijtie.2014.0533.2014.0033

Williams, P. (2014b). Squaring the circle: A new alternative to alternative-assessment. Teaching in Higher Education, 19(5), 565–577. doi:10.1080/13562517.2014.882894
Williams, P. (2019). Does competency-based education with blockchain signal a new mission for universities? *Journal of Higher Education Policy and Management, 41*(1), 104–117. doi:10.1080/1360080X.2018.1520491

Zimmerman, B.J., & Dibenedetto, M.K. (2008). Mastery learning and assessment: Implications for students and teachers in an era of high-stakes testing. *Psychology in the Schools, 45*(3), 206–216. doi:10.1002/pits.20291

Zwaan, B.V.D. (2017). *Higher education in 2040: A global approach*. Amsterdam: Amsterdam University Press.