Higher Education's Digitalisation: Past, Present, and Future

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Abstract: Following COVID-19 there has been discussion in the media of a digital revolution as across the world universities have been forced to teach at a distance. However, rather than being something entirely new, the move to technology enhanced learning (TEL) is a trend that has been observed for decades. In this chapter the authors present example projects from the Open University's OpenTEL research group that highlight some of the advances that have been made in terms of lifelong learning, open education, and science education supported by TEL. The chapter ends with discussion on what the digitalisation of higher education could mean post COVID-19. The role of universities is likely to change as society develops different needs and expectations of education. The newly acquired expertise of many higher educational institutes in TEL is likely to create opportunities for entrepreneurial universities, although due consideration must be given to the accessibility-related needs of an increasingly diverse student base.

Key Words: Accessibility, Citizen Science, Distance Education, Life-long Learning, MOOC, OER, Science Education, Self-regulated Learning, Technology Enhanced Learning, Workplace Learning.

Introduction

The events following COVID-19 catalysed a transformation in the higher education sector, with many institutions forced to rapidly embrace the digital domain. However, as discussed in the opening chapter, this can be viewed as the acceleration of trends that have been observed for several decades (Weller 2020). It could even be argued that the development of distance learning supported by technology has been occurring for centuries, since the invention of the printing press (Kaplan and Haenlein 2016). Research in Technology Enhanced Learning (TEL) has explored how technological affordances can aid learners when judiciously introduced to learning settings. Examples include TEL being used to aid learners in regulating their learning (Zhang and Quintana 2012) and scaffolding dialogue (Murphy, Coiro and Kiili 2019). Due to these affordances, higher educational institutes have for many years been increasing their use of TEL. Nevertheless, the pace at which universities across the world introduced technology to enable distance and blended learning was unprecedented following COVID-19, and there is a need to consider whether and how it is likely to have changed the landscape of higher education forever. As universities embrace TEL, there are many lessons that can be learnt from past attempts at innovation. This chapter discusses three pressing topics that represent continuing debates in the TEL research community. We will use projects from OpenTEL (an Open University strategic research initiative) to illustrate state-of-the-art approaches to these topics. The chapter concludes with reflections on the relationship between universities and TEL post-COVID.

The Open University and OpenTEL

The sections below will detail projects from the OpenTEL research group. For context, a short introduction is provided here to the Open University (OU) and OpenTEL. The OU was founded in 1969 and has a mission to be 'open to people, places, methods and ideas'. In line with this mission, there are no minimum academic qualifications needed to start a degree with the OU. Since its inception, the OU has taken learning to learners, wherever they are using an evolving range of technologies, supporting learners from across the UK and, more recently, across the globe (Cross et al. 2019). The university has pioneered new approaches to teaching in response to the needs of its diverse set of students who are learning at a distance. This has been especially prevalent in Science, Technology, Engineering and Maths (STEM) subjects, where learners have not had access to a traditional laboratory. A range of technologies are used to support learners, ranging from broadcasting information via the BBC, to using augmented reality to

practice presentations (McFaul and FitzGerald 2020). At the start of 2021, courses at the OU predominantly used a blended approach, combining online study and, where appropriate, posted materials. Prior to COVID-19 it was the practice of the OU to also support learners by organising in-person and online tutorials held by hundreds of associate lecturers across the UK. During COVID-19 these tutorials were all moved to an online format.

Within the OU, OpenTEL has a unique position as a research group dedicated to the use of TEL in a manner befitting the OU's mission. Researchers have argued that TEL as a field is inherently applied and multidisciplinary (see e.g. Scanlon and Conole 2018). Increasingly the complex cross-disciplinary difficulties presented by technological and pedagogical challenges demand new approaches, a rich set of theoretical perspectives, and innovative research methodologies. In response to the complexities of effectively using TEL to support learners, OpenTEL is an interdisciplinary group of researchers with backgrounds including educational technology, STEM, social science, and organisational studies. The wide diversity of group members' backgrounds allows the exploration of openness and TEL in ways that can feed into the OU's teaching.

In 2021 OpenTEL had six main research areas:

1. learning in an open, connected world and at scale,
2. design and analytics in learning,
3. language learning landscapes,
4. citizen science,
5. inclusion,
6. and professional and digital learning.

These areas represent aspects of TEL that are central to how the OU provides distance education.

The following sections present three questions that span these research areas. Example OpenTEL projects are used to demonstrate current thinking related to each question. The questions are:

1. What role will universities play in supporting life-long learning in the future?
2. How inclusive is open learning?
3. What do technological and pedagogical innovations promise for science education?

What Role will Universities Play in Supporting Life-long Learning in the Future?

A Google Scholar search for articles on 'life-long learning' published in 1990 returns around 3,000 results. The same search for articles published in 2020 returns around 41,000 results. In the 30 years between 1990 and 2020, learning technology has truly transformed. The development of search engines, video hosting platforms, and Massive Open Online Courses (MOOCs) have made knowledge more accessible to anyone with a stable internet connection. At the same time, the pace of technological change has meant that workplaces are constantly adapting, as new software and hardware is introduced to help employees perform tasks more effectively. In order to remain competitive, workplaces have needed to engage their employees in professional development, often involving TEL. The expansion of academic research on life-long learning is a reflection of changed societal views, in other words, increased expectations for people to continue growing their skills and knowledge throughout their lifespan. As demonstrated by standalone business-oriented courses offered by higher educational institutes (e.g., https://business.edx.org/), universities are starting to use TEL to offer professional qualifications along-side more traditional degrees. In 2021 microcredentials are increasingly being offered by higher educational institutes (e.g., https://www.futurelearn.com/programs). The European MOOC Consortium - Labour Market (EMC-LM) examplifies higher educational institutes engaging with MOOCs in the labour market, either by developing MOOCs that are aligned with continuing professional development or by carrying out research in this area (Farrow 2020).

TEL is also starting to be used to tackle global workplace issues, going beyond the sphere of formal learning. The Learning From Incidents and Implementing Action (LFIA) project examined how companies in the energy sector used TEL to learn after incidents and prevent major disasters. After an incident investigation, energy companies leverage TEL to allow individual workers to learn using a summary of an incident, reflecting on how that incident is relevant to their own work practices (Littlejohn et al. 2017). Teams of workers are guided through the events of an incident and its implications by a team leader. For these 'learning sessions' to result in safer behaviour, the way in which workers are guided through the material must be based on pedagogically sound principles (Murphy 2020). While research suggests it is not currently playing this role, TEL could be used to provide structure and underpinning pedagogy to these learning sessions. As with all settings, LFIA demonstrates the need to judiciously consider what affordances of TEL can help learners to achieve their goals.

The Fleming Fund: Tackling Antimicrobial Resistance (TAMR) is another example of an Open University research project that examines how TEL can be utilised to educate a large population and change workplace behaviour. Antimicrobial resistance is one of the world's current biggest threats. Tackling this issue requires co-operation and exchange of knowledge across multiple professions and at local, national, and global levels (Charitonos and Littlejohn 2021). In the energy sector, technology was used to support learning through the creation and distribution of learning materials, with the greatest opportunities relating to embedding effective pedagogy. In contrast, TAMR aims to use TEL to educate professionals in low-to-middle income countries and the biggest value of TEL could be seen as delivering a consistent experience across diverse settings. There are many barriers to successful implementation of TEL in such a varied context, such as internet access (Charitonos and Littlejohn 2021). TEL can provide a flexible learning environment that allows the same material to be presented in multiple ways, allowing learners to make use of whatever is available at the time. A full-blown learning management system could be supplemented by a mobile text-message based system to deliver the same content. Both LFIA and TAMR highlight the potential for TEL to contribute to educating workforces to address issues of global importance. However, the purpose of TEL in workplaces varies greatly, and consideration must be given to how the cultural and social norms of diverse groups of people will influence its use (Cole and Engeström 1993). Universities are uniquely placed to provide guidance and support on how to use TEL in a pedagogically effective manner with adult learners.

Outside of the workplace, TEL is evolving to support life-long learning for those who need to learn new skills quickly, especially for those who have limited resources. Mobile phones in particular have the power to transform and empower disadvantaged sections of society due to their ubiquitous nature in many countries. For example, research projects conducted at the OU have provided evidence that carefully designed smartphone apps can aid migrants in learning languages, succeeding in social situations, and navigating a new city (Kukulska-Hulme 2020). Similarly, OpenTEL's MAZI project (mazi means together in Greek) demonstrated the power of mobile technologies, even when disconnected from the Internet. The MAZI project team piloted the use of local networks hosted by Raspberry Pi computers that created learning resources which could be accessed by anyone in the surrounding geographical area, without the need for a stable internet connection (Gaved et al. 2019). A follow-up project (ARCLIGHT, Action Research Community Led Initiative Guyana Health Team) is currently using the technology as a tool to build community mental health resilience in Guyana.

Following COVID-19, higher educational institutes must consider what role they will take beyond providing degrees. While there has been a mixed reaction to the online migration, universities have quickly developed knowledge on how to educate using technology, something that will likely become increasingly important in life-long learning. Professionally oriented short courses and microcredentials are avenues that institutions are already exploring, but there is the potential for universities to use their new-found expertise in even more enterprising ways (Farrow 2020). For example, while guidance on TEL implementation in workplaces is currently mostly managed by large specialist firms, there is scope for universities to provide consultancy on how to effectively use TEL to support adult learning. There is also an abundance of opportunities for universities to use their knowledge and materials for social justice, supporting those in less privileged positions in developing the skills that could allow them to thrive. However higher educational institutes choose to support lifelong learning, technology is likely to be at the core and require flexibility to cater to diverse learners.

How Inclusive is Open Learning?

Perhaps in response to the potential for contributing to social justice mentioned in the previous section, higher educational institutions from across the world are showing increasing dedication to creating educational resources that are open to all. As previously discussed, the OU is a forerunner in that regard, providing education with no barriers to entry. Open education, however, has come to take on several meanings in the higher educational sector other than providing qualifications without barriers, incorporating many ways to expand existing approaches to knowledge construction, citizenship models and theories of identity. Taking advantage of technology, open forms of education could achieve scale and bring benefits to learners, teachers and organisations through diverse media in a wide range of social, cultural and disciplinary settings (Scanlon, McAndrew and O'Shea 2015).

The different ways that education can be ‘opened up’ are demonstrated through the work of the Global OER Graduate Network (GO-GN). GO-GN is a network of PhD candidates from around the world whose research projects include a focus on open education, open educational resources (OERs) and open educational practices. The network connects PhD students, experts, supervisors, mentors and interested parties to form an international community of practice (Weller, Farrow and Pitt. 2019). Many participants in the network examine how learning content and practices can be made open, for example through the creation of OERs, MOOCs or open textbooks (Pitt et al. 2020). Universities are already creating an abundance of high-

quality content that is freely available online. As this trend continues post COVID-19, universities will need to carefully consider how the content that they create adds value to what already exists or whether it is better to engage in reusing content with public copyright licenses supported by OERs.

However, open education goes beyond an ability to access a resource, and increasingly researchers are considering the accessibility of OERs and what values underpin their creation. Central to all open education initiatives are the values of diversity, equity and inclusion (Bossu et al. 2019). This means considering how resources might be used by diverse cultures, including recognising intergenerational barriers and historical legacies. For example, the language in which an OER is written has implications for its openness. Research has found that OERS are sometimes written in a relatively complex way, making them only accessible and useful to those who have a grasp of academic English (Rets et al. 2020). In response to these needs, tools are being created to empower learners in navigating the ever-increasing pool of OERs. YourMOOC4all, for example, is a MOOC aggregator which allows learners to evaluate and discuss the accessibility of a course in an open environment, following principles of universal design for learning (Iniesto and Rodrigo 2019). There are numerous reasons for universities to invest in creating OERs, from promoting their brand to addressing societal inequalities. As universities look at the possibilities of open digital education, they will need to consider not only what content they are creating, but how that content is accessed and used for learning. Consideration of accessibility should be explicitly incorporated into the design process of OERs (Iniesto 2020).

Another example of a barrier that can prevent education from being open is a frequent task of contemporary life: form filling. The need to fill in online forms and complete administrative processes is ubiquitous and particularly an issue for learners with accessibility needs. Forms are commonly required before learners with accessibility requirements can access the support that they need and are entitled to. However, navigating complex paperwork can be a near-impossible task for some of these learners without any help or support. This can prevent formal education from being ‘open’ to learners who would otherwise be able to succeed. The ADMINS (Assistants to the Disclosure and Management of Information about Needs and Support) project is creating a virtual assistant to tackle this issue. The virtual assistant can talk learners through the disability disclosure process, offering generic advice and guidance, and obtain more nuanced and relevant data from the learner. There is untapped potential for

adaptable and accessible chatbots to reduce the burden of having to fill in forms and other administrative tasks (Lister et al. 2020).

The move to digital technologies following COVID-19 is in some senses making education more open, offering opportunities to integrate accessibility-related tools and start discussions on the experiences of learners. While the ADMINS project tackles a well-defined accessibility context, Our Journey (Coughlan, Lister and Freear 2019) is a tool that opens education by providing visibility into learners' journeys in education, using novel interfaces to provide insights into learners' mental health and wellbeing. Our Journey is a digital tool where learners can enter different events from their educational experiences and visualise their emotional journey in a boardgame style display. Not only does this allow learners to consider their emotional expressions and see their progress, but the feedback can be used to inform educational design and learning pathways (Edwards and Gaved 2020). An increasingly digitised higher education offers opportunities to collect data in different ways that are meaningful to learners and useful to institutions (Coughlan et al. 2019).

What do Technological and Pedagogical Innovations Promise for Science Education?

Whilst many parts of higher education have moved online, there could be an argument made that some subjects, especially STEM, will always be primarily face-to-face due to the need for laboratory work. However, in this section of the chapter, we make the argument that fifty years of Open University experience, together with several recent prospects, show that science education could be taken to learners wherever they are with due pedagogical consideration. We can identify a number of trends in contemporary pedagogy which have had and will continue to have an impact on science education. These include the realisation that we need to consider both formal and informal learning, and to consider journeys between formal and informal learning as part of the learning process. In addition, there is also increasing recognition of collaborative work as important for STEM. The importance of facilitating remote collaborative learning, particularly through accessing remote laboratories, has been developing over the last twenty years.

One project that highlights the potential for universities who choose to invest in online facilities for science, is the openSTEM Labs project. The openSTEM Labs project is changing the way scientists and engineers of the future are educated by making authentic online laboratory

experiences possible (Jones et al. 2020). The Labs give STEM learners in any location access to a potentially unlimited range of cutting-edge scientific equipment and data through collaborative robots, electron microscopes, engineering workstations, particle detector cameras, and more. All activities are underpinned by pedagogic research. From a learning perspective, lab work is essential for two reasons: it can offer learners immediate feedback on whether they understand fundamental principles and it develops practical skills that will be needed after university. OpenSTEM Labs provides opportunities for learners to benefit from these types of experiences, without the need to be physically in the same location as equipment. As STEM workplaces move to incorporate new technologies, online laboratories offer learners the chance to develop practical skills by using software, remote equipment, and simulations. From the perspective of receiving immediate feedback on whether underpinning theoretical concepts have been understood and can be applied, the Labs offers a similar experience to in-person laboratory experiments. A number of openTEL research studies have contributed to the development and evaluation of the laboratory for this purpose. For example, studies have evaluated the use of virtual microscopes (Herodotou, Sharples and Scanlon 2018), virtual field trips (Minocha, Tudor and Tilling 2017) and inquiry tools to support experiments (Herodotou et al. 2015).

With regards to the second pedagogical aim of STEM labs, developing the skills to collect accurate data, one option that is becoming increasingly popular is utilising mobile devices to contribute to citizen science projects. Citizen science platforms provide learners with the ability to collect and analyse data, contributing to large scale projects (Scanlon et al. 2020). Building on studies of inquiry tools, research by members of the OpenTEL group led to the development of nQuire, a platform which was built to support personal inquiry learning among schoolchildren (Sharples et al. 2014) and then extended to work in different settings. The platform allows learners to engage with and contribute to ongoing scientific inquiry. One example of an activity using this approach is an exercise developed for the openSTEM lab, where postgraduate students accessed and studied moonrocks (Villasclaras et al. 2013). Developments on the nQuire platform have contributed to supporting the design and implementation of personally meaningful investigations outside the classroom, by young people but also citizens of all ages. With support from the BBC OU partnership, a version of the BBC's 'Tomorrow's World nQuire' platform has been developed to host multiple types of citizen science projects. Awareness about contemporary issues has increased in thousands of nQuire participants, including on the protection of pollinators and climate change. Citizen

science allows learners to plan experiments and collect accurate data, skills which are key to STEM. Furthermore, it allows learners to begin to engage in a large collaborative scientific network.

Discussion and Conclusion

While the press has talked about the acceleration of the digital revolution brought about by COVID-19 (Times Higher Education 2020), the reality is that higher education has been making increasing use of TEL for decades. COVID-19 has catalysed this, highlighting both opportunities and potential stumbling blocks for the future. The global experiment of most universities moving to online over the course of a few months has been a baptism of fire for many in the sector. There have, nevertheless, been success stories which are likely to leave many learners questioning whether they really need to physically relocate to receive a quality higher education. On the other hand, others will have had a suboptimal experience of online learning, leading them to question its value. The increased availability of OERs and the development of platforms, such as nQuire and OpenSTEM Labs, means that there is the potential for a revolution in terms of how universities provide degrees. While many learners will see the value of physically attending a prestigious university to establish social networks that will be a resource for life, others will perhaps question if the cost is too high amongst discussions of grade inflation and the decreased value of a degree (Bachan 2017). However, on a more optimistic note, embracing the digital has led to universities gaining valuable expertise and knowledge that will create many more opportunities for different modes of study.

One of the biggest opportunities comes with the developing notion of education being something for everyone throughout their life, wherever they are. Our discussion of the potential of citizen science demonstrates an interactive way of engaging learners with science, making use of the pedagogical benefits of inquiry-based learning at a large scale. Science is brought closer to the everyday life of learners, helping them understand and appreciate its value by developing bridges between formal and informal education. In this approach science and education are not something that are done by experts in a bounded geographical location, rather knowledge is created collaboratively and geographical dispersion becomes an advantage rather than a limitation. OERs are similarly leading to open and high-quality resources that individuals can take advantage of depending on their needs and interests. Both citizen science and OERs emphasise the importance of learning across settings, supporting self-regulated learning with the help of technology and social interactions, and promoting lifelong learning

aspirations. While universities have traditionally been seen as gatekeepers that guarantee the standard of formal skills associated with a qualification, their role is changing to be enablers of learning for people in both formal and informal settings. This evolving place in society means that there are many opportunities for universities, such as becoming consultants for workplaces on how to effectively integrate TEL.

However, as universities embrace the possibilities for supporting both formal and informal life-long learning enabled by digital technologies, there must also be caution. As the OU has long been aware, diverse learners have diverse needs. TEL can tear down barriers to education, but equally can create others. How technology is used to enhance any kind of education requires careful consideration of not only pedagogical principles but accessibility.

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