Teaching Practicals in the Time of Physical Distancing: Advances, Challenges and Recommendations for Higher Education

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Abstract

The last two decades have seen a rise in the demand for e-learning platforms for remote teaching. These technologies offer novel opportunities and tools for educators, including those in the humanities and social sciences, to develop new materials, rethink curricula, and teach more effectively and creatively, even when contact with students is limited or not possible. To salvage what is left of the 2019-2020 academic year, this will have to form part of the higher education sector's response to the coronavirus disease 2019 pandemic and lockdown challenges. While significant advances have been made in the use of e-learning technologies for teaching practicals, some challenges still need to be addressed. By drawing on examples from various developing and developed parts of the world, we identified the advances, challenges and recommend-dations associated with teaching practicals remotely. The chapter focuses on the review of current virtual platforms and digital tools. Additionally, it offers some commentary on the preparedness of lecturers and learners in the higher education sector to embrace e-learning technologies for teaching practicals. Finally, recommendations are forwarded on how these remote teaching and

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learning tools can help students acquire and practise essential manipulative and process skills, and help teachers move concepts from an abstract into a concrete setting.

Keywords: COVID-19 pandemic, emergency remote teaching, higher education, online learning, teaching practicals, virtual fieldwork, virtual laboratories

1 Introduction

We are in a state of emergency/disaster worldwide in terms of the coronavirus 2019 (COVID-19) pandemic. The effective management of pandemics requires the adaptation of systems across several sectors, including higher education (Uscher-Pines, Omer, Barnett, Burke & Balicer 2006). The World Health Organization (WHO) has encouraged all countries to develop or maintain a current national influenza preparedness plan and guided the content of such strategies (WHO 2005). While these guidelines focus on a variety of issues, ranging from surveillance and communications to prioritisation of vaccines, they do not deal explicitly with issues such as teaching and learning. This may explain why despite very recent pandemic influenza events, as of 2020, very few developing countries have come up with strategies for managing educational needs during a state emergency, more specifically during a pandemic. Sinelnikov-Murylev (2020) argues that the progress of the COVID-19 pandemic cannot be predicted with any certainty at this stage; therefore, educational institutions have been forced to prepare for two possible scenarios in their attempts to adapt. The first scenario is dependent upon the pandemic ending this year, allowing the educational process or at least part of it to recommence; this refers mainly to direct contact between teachers and students. The second scenario arising as a continuation of the pandemic is far more challenging and will require remote learning methods for at least part of this school year (ibid 2020).

The figures released by the United Nations Educational, Scientific and Cultural Organization (UNESCO 2020) show that 1.5 billion students (from pre-primary to higher education) around the world were unable to attend school or university (due to quarantines, lockdowns, and school closures) as of mid-April 2020. Although this figure is declining, the education community has

been struck by COVID-19. In Africa, 9.8 million students are experiencing disruptions to their studies due to the closure of higher education institutions (Tamrat & Teferra 2020). The numbers of affected higher education students in developing countries outside Africa are also high (e.g. 250 000 in Serbia [Statistical Office of the Republic of Serbia 2019]). Governments across the world are taking drastic measures to curb the spread of infection during the current pandemic, which in most cases involved closing all schools and universities. This has brought to an end the conventional 'in-person' lecturing and learning experience. Universities have subsequently been hard-pressed to take steps to ensure that teaching and learning continue remotely via a transition to online learning. Lecturers have adopted tools and methods that have emerged over the last few decades, and have been guided by standards such as those set by the International Society for Technology in Education (Fuller 2020).

There is a wealth of literature on the relationship between technology and human capital development (Choudhury & Pattnaik 2020) that has emboldened governments and higher education institutions around the world to invest financially, infrastructurally and intellectually in developing digital citizens. The COVID-19 pandemic has fast-tracked the emergence of what we term here 4th-generation universities, i.e. online and digital universities. In parts of the developed world such as America (Marsicano, Felten, Toledo & Buitendorp 2020), this transition to emergency online learning has been very rapid (days to weeks). However, in many countries lecturers and students are neither prepared nor familiar with teaching/learning virtually, which has resulted in some unwanted effects, such as social isolation, inequity, and reduced learning and quality (Hammond, Watson, Brumbelow, Fields, Shryock, Chamberland, Barroso, De Miranda, Johnson, Alexander, Childs, Ray, White, Cherian, Dunn & Herbert 2020), particularly concerning practical components of curricula. This is mainly due to lecturers having days to take up or develop innovations in academia and higher education, which would usually have taken years to master. Administrative regulations and processes, and the lack of infrastructure and budgetary allocations have exacerbated these challenges for lecturers and students, hampering their transition to fully functional and operational online tuition.

Many university-level courses require laboratory, field or practical components of students' training (Kennepohl 2010; Potkonjak, Gardner, Callaghan, Mattila, Guetl, Petrović & Jovanović 2016). The literature offers

several software solutions and tools for teaching/learning practicals in a blended/distance education setting. These have been presented and evaluated in detail by various authors (Andújar, Mejías & Márquez 2011; Bower, Dalgarno, Kennedy, Lee & Kenney 2014; Ip, Li, Leoni, Chen, Ma, Wong & Li 2019; Madathil, Frady, Hartley, Bertrand, Alfred & Gramopadhye 2017; Potkonjak *et al.* 2016). However, as alluded to above, implementing practical activities into online courses is very challenging (Sinelnikov-Murylev 2020), especially for institutions with low-budget and digitally low-skilled teachers who in many cases have to use personal resources and equipment to teach and support students. This chapter presents the benefits and challenges associated with the use of currently available virtual platforms and digital tools for teaching practicals (crucial manipulative and process skills). We also offer some preliminary commentary on the preparedness of teachers and learners in the higher education sector to embrace e-learning technologies for practicals and forward recommendations on how to address challenges faced in emergency online learning in general.

2 Teaching Practicals Online

Online teaching has its roots in more than a century-old tradition of correspondence courses (Ghilay 2017). It is not a novelty in higher education, since tertiary institutions started offering online courses almost three decades ago and nowadays entirely online undergraduate and graduate programmes have a global presence (Palvia, Aeron, Gupta, Mahapatra, Parida, Rosner & Sindhi 2018). Also, many universities and other higher education institutions are involved in the development/offering of massive open online courses (MOOCs) (De Freitas, Morgan & Gibson 2015; Olsson 2019). Even before the COVID-19 pandemic, completely offline classes (only face-to-face teaching with printed learning materials) were rare, due to the widespread use of learning management systems (LMSs) (Daniela & Rūdolfa 2019; Fındık-Coşkunçay *et al.* 2018; Mtebe 2015), digital learning materials (learning objects) (Georgieva, Gueorguiev, Kadirova, Evstatiev & Mihailov 2018; Mei, Aas & Medgard 2019), the bring-your-own-device (BYOD) initiative (Ruxwana, Msibi & Mahlangu 2018; Vasant 2015), flipped classroom teaching strategies (Bognar, Sablić & Škugor 2019; Koh 2019; Uskoković 2018), online student (audience) response systems (Licorish, Owen, Daniel & George 2018; Lim 2017), and the use of social media as an educational tool

(Lytras, Visvizi, Daniela, Sarirete & Ordonez De Pablos 2018; Tess 2013). However, Hodges, Moore, Lockee, Trust and Bond (2020) point out the need for a clear distinction between regular online/blended education and emergency remote instructional delivery due to the COVID-19 crisis, that is otherwise delivered face to face; calling this instruction emergency remote teaching (ERT). ERT involves the use of online teaching platforms and tools, but it has emerged in a hurry with a minimum of resources and time, and cannot be evaluated with the same standards for high-quality fully online courses which were well planned and usually developed over the span of six to nine months (ibid 2020). Also, while e-learning is a common and popular mode of instructional delivery, very little has been established with regard to its effectiveness in teaching practical skills (Preston, Ada, Dean, Stanton, Waddington & Canning 2012). In many disciplines, and hence professions (e.g. healthcare), effective performance of practical skills is essential. Practical skills required in specific disciplines incorporate a wide range of manual techniques (e.g. physiotherapy, dentistry, hospitality, culinary and other arts) and knowledge of procedures/protocols (e.g. chemistry, archaeology, sociology and psychology). In the sections that follow, we describe virtual platforms and digital tools commonly used for practical teaching, focusing on two established modes of online practical teaching: (a) virtual laboratories and simulations; and (b) virtual field trips.

2.1 Online Teaching Possibilities

For some time now, digital technologies have been an indispensable element of students' way of life and a significant part of their higher education experience (Henderson, Selwyn & Aston 2017). The rapid increase in ownership of mobile devices (such as laptops, tablets and smartphones) among students provided opportunities for using those devices in both physical and online higher education learning environments (Milošević, Živković, Manasijević & Nikolić 2015; Santos 2013). The current situation has forced teachers to utilise both synchronous and asynchronous approaches (using different learning platforms and tools) in their ERT (Alvarez 2020; Bozkurt & Sharma 2020; Huang, Liu, Amelina, Yang, Zhuang, Chang & Cheng 2020).

For formal online and blended education, LMSs are the most widely used solution (Fındık-Coşkunçay *et al.* 2018; Kakasevski, Mihajlov,

Arsenovski & Chungurski 2008) that is already implemented at many higher education institutions, including those in developing countries (Mtebe 2015). According to Ghilay (2017:5), a typical 'LMS is a web-based platform designed for management, documentation, monitoring, reporting and delivery of courses in both higher education and other educational systems'. In other words, LMSs are sites that provide online learning and assessment opportunities, as well as options for tracking student progress and statistics regarding learning outcomes. They are based on the idea that teachers can create (or modify existing) learning materials to meet their students' needs (Daniela & Rūdolfa 2019). However, LMSs are often used only as an electronic repository of learning materials, since many teachers neglect advanced options of those systems and use them only to upload text files for students to download (Daniela & Rūdolfa 2019; Mtebe 2015; Vovides, Sanchez-Alonso, Mitropoulou & Nickmans 2007). Similar behaviours can be expected with ERT, given the circumstances that have led to their use, especially in instances where there was a dramatic shift to online teaching due to COVID-19 (Alvarez 2020; Bozkurt & Sharma 2020; Natwi & Boateng 2020). The most popular LMSs are Moodle, Blackboard, Canvas, Edmodo and Google Classroom (Aditya, Nurhas & Pawlowski 2019; Aldiab, Chowdhury, Kootsookos, Alam & Allhibi 2019; Daniela & Rūdolfa 2019; Huang *et al.* 2020; Kakasevski *et al.* 2008). All indicated LMSs include numerous options for presenting lectures, delivering learning materials, communication and assessment. Still, sometimes they do not cover all teaching/learning needs (such as certain aspects of practical teaching) or do not provide sufficient stability when a large number of students use them at the same time. Therefore, teachers need to be able to connect additional digital tools to LMSs and/or to use them separately. In this regard, there are a variety of options available (Ghilay 2017). Some of the most popular and free online tools currently being used are G Suite for Education (including Gmail, Drive, Calendar, Google Docs, Sheets, Slides and Forms and other apps), YouTube, Office 365 Education (including Outlook, OneDrive, Word, Excel, PowerPoint, OneNote, Teams, Sway and additional classroom tools), Skype, Zoom, Padlet and many others.

In the context of practical teaching specifically, which requires a higher level of engagement/interaction, cloud-based tools (such as Google Apps for Education, Padlet, OneNote and others) can be useful for students' remote collaboration, cooperative, and project-based learning activities.

YouTube can be particularly useful for hosting recordings of practical demonstrations by lecturers and protocols (e.g. teaching students how to make and administer an online survey) that can be easily shared (via links or QR codes). SoundCloud and Audiomack can be utilised for hosting lectures (in sound format) and podcasts. Zoom can be a good option for online synchronous teaching sessions as students can see and communicate with each other as a group. Teachers should also consider using social media (e.g. Facebook) and popular instant communication services (such as Viber, WhatsApp and Skype) for delivering learning materials and facilitating communication among students and lecturers when the practicals involve groupwork or project-based learning. However, it must be noted that some of these platforms can be bandwidth-intensive, and connectivity to stable and affordable internet access is essential. In this regard, higher education teachers should try to provide practical lectures and learning materials in different formats (e.g. text, video, audio, and multimedia) and aim to foster students' self-regulation skills (see Huang *et al.* 2020), as well as cater for students who might be experiencing hardware, software and connectivity-related challenges.

Practical sessions usually involve some preparation by the students and in most cases a post-practical assessment, typically in the form of a written report. Also, effective online education requires an ecosystem of learner supports (Hodges *et al.* 2020). Therefore, it is also vital that students have off-campus library access. A significant number of university/college libraries worldwide offer students online access to their digital resources (such as academic e-books, journals, theses and dissertations and datasets). Some university and public libraries (mainly in the USA) offer additional services for streaming films and other video content (e.g. Kanopy and Hoopla; which is important for media and film students), and taking on-demand online courses (e.g. Lynda.com/ LinkedIn Learning) for free. Several universities have also provided students with free remote access to EBSCO databases during the coronavirus lockdown as an additional resource for writing reports, seminar papers, and theses.

In most cases, learning practical skills requires observation of the skill combined with physical practice (Shea, Wright, Wulf & Whitacre 2000). Many STEM (science, technology, engineering and mathematics), social science and humanities programmes include intense laboratory (hand-on)

activities or fieldwork; therefore, we presented virtual laboratories (and simulations) and virtual field trips in dedicated sections.

2.2 Virtual Laboratories and Simulations

Kennepohl (2010) lists several options as substitutes for in-person laboratory activities: (a) remote access laboratories; (b) video demonstrations; (c) laboratory kits for home study; and (d) virtual computer simulations (virtual laboratories). Remote access laboratories were developed in the early 1990s to enable students and teachers to do experiments using real substances and equipment via the internet, regardless of time and location (ibid 2010; Ku, Ahfock & Yusaf 2011). The most crucial advantage of remote laboratories is that the process of preparing and performing the experiment is similar to in-person laboratory experience (Andújar *et al.* 2011). Higher education institutions widely use them as alternatives when the physical equipment is not available in the laboratory, or for distance learning courses, especially in disciplines such as physics, chemistry, biology, medicine and engineering (Zapata Rivera & Larrondo-Petrie 2016). In the last two decades, a significant number of remote laboratories have been set up by universities in the USA, Canada, Australia, and Europe (Ku *et al.* 2011). However, due to high costs for a single academic institution, universities in developing countries rarely use them. Also, open, free, and fully functional options are limited (Kennepohl 2010).

More practical solutions, in the time of social distancing and the COVID-19 pandemic, are virtual laboratories (or simulations), and video demonstrations, since the equipment in remote laboratories needs maintenance and cannot be used by multiple users simultaneously. Remote and virtual laboratories are often categorised together as 'online laboratories', but virtual laboratories can be described as simulations that mimic the behaviours of real laboratory equipment using calculations, mathematical formulas and data of experiments done in the real laboratories (Zapata Rivera & Larrondo-Petrie 2016). Virtual laboratories are especially crucial for online distance learning of STEM disciplines, since these fields require intensive hands-on laboratory experiences for effective skills acquisition (Potkonjak *et al.* 2016). There are many commercial and open-source solutions for virtual laboratories (appropriate for different academic areas) or simulations made for specific procedures, situations or skill practice. In recent years, the usage of commercial solutions such as Labster's virtual laboratory simulations (available for

anatomy and physiology, biology, ecology, chemistry, engineering, medicine and physics) and Minecraft: Education Edition platform (available lesson plans for various STEM and humanities fields) have increased significantly in formal education settings worldwide (Stojšić, Ivkov-Džigurski & Maričić 2019a).

According to Merchant, Goetz, Cifuentes, Keeney-Kennicutt & Davis (2014: 30), 'Simulations are interactive digital learning environments that imitate a real-life process or situation'. The same authors conducted a meta-analysis in which they included 29 studies in the category of simulations. The results indicated that simulations were effective in improving learning outcomes in K-12 (Kindergarten to 12th grade) and higher education and provide cost-effective practice solution for medical scenarios, animal dissections, and many situations that impose a financial burden, danger, high risk, or have ethical issues if practised physically in a laboratory (ibid 2014). Nowadays, simulations are also accessible as free/low-cost Android and iOS apps; for example, several apps (e.g. Complete Anatomy Platform 2020) are now available for learning about the human anatomy, and some of them support augmented reality (AR) as well.

Potkonjak *et al.* (2016) point out that virtual worlds (e.g. Second Life, OpenSimulator) can be used for developing virtual laboratories since those platforms can create authentic ambiences that enable realistic communication among users (through avatars). The same authors also indicate some advantages (e.g. multi-user approach, resistance to damage, highly configurable and flexible, and can make invisible visible) and disadvantages (e.g. very heavy on computer resources and can be appropriate only as an initial sep in students' training) of virtual laboratories. Also, they emphasise the utility of virtual laboratories for distance education and a head-mounted display (HMD)-based immersive virtual reality (VR) learning (ibid 2016). For example, Izard, Juanes, García Peñalvo, Gonçalvez Estella, Sánchez Ledesma and Ruisoto (2018) and Cochrane, Cook, Aiello, Christie, Sinfield, Steagall and Aguayo (2017) indicate that 360° video and interactive VR content could be useful for remote practical training of medical and paramedical students.

2.3 Virtual Field Trips and Fieldwork

Field trips and fieldwork are often a mandatory requirement in disciplines such as geography, geosciences, biology, history, archaeology, cultural heritage, architecture and tourism. Specific physical, cultural, ecological and

structural characteristics, orientation skills or gathering information (by using scientific instruments) can be fully understood and appreciated only in authentic environments outside classrooms or lecture halls (Wallgrün, Chang, Zhao, Sajjadi, Oprean, Murphy, Baka & Klippel 2019). According to Bailenson (2018:232), 'The field trip is the perfect metaphor for VR learning'. Using virtual trips as a substitution for actual field trips or fieldwork is not a novelty, since researchers have investigated these possibilities for more than two decades (Wallgrün *et al.* 2019). Due to the COVID-19 pandemic, higher education institutions worldwide cancelled or postponed all trips and field-related practical activities. Therefore, virtual trips may be the only alternatives for this mode of practical teaching for the months ahead. Recent studies on this approach have mainly used HMDs (such as Oculus Rift, HTC Vive and Google Cardboard) and shown mostly positive results regarding knowledge and/or skills transfer and students' motivation (Bailenson 2018; Ip *et al.* 2019; Markowitz, Laha, Perone, Pea & Bailenson 2018; Vert & Andone 2019; Wallgrün *et al.* 2019). However, Vert and Andone (2019) point out that VR-based learning materials should be available through various device/medium distribution channels (e.g. web, Android, iOS, VR HMDs, or a combination of these). A possible solution for this issue can be a WebVR approach (Stojšić, Maričić, Ivkov Džigurski & Višnić 2018; Stojšić, Ivkov-Džigurski & Maričić 2019b).

Virtual trips can be successfully integrated into online courses (Ip *et al.* 2019), and vast collections of pre-made VR applications and other materials (e.g. 360° panoramas and videos) are available (Daniela 2020; Stojšić, Ivkov Džigurski, Maričić, Ivanović Bibić & Đukičin Vučković 2016; Stojšić *et al.* 2018). Also, higher education teachers can use free/low-cost authoring tools to tailor the virtual trips to their students' needs. Popular authoring tools are CoSpaces Edu, Uptale Studio, InstaVR, WondaVR, Fieldscapes (Vert & Andone 2019), and Tour Creator (Stojšić *et al.* 2018; 2019a) among others.

3 Challenges and Recommendations

According to Olsson (2019), all teaching methods used in contemporary higher education have at least some IT elements, since university/college teachers are required to embrace information and communication technologies (ICTs) in their teaching practice. While this chapter and others have identified some

online tools and platforms that can be useful for practical teaching, their eventual uptake in ERT is uncertain since the level of student and lecturer e-learning preparedness and actual usage vary significantly worldwide (Baran & AlZoubi 2020; Palvia *et al.* 2018). Variations within regions and countries are also noted (Alvarez 2020; Nantwi & Boateng 2020). Mtebe (2015) notes that levels of investment in and the uptake of e-learning depend on institutional decisions and policies, and teachers' digital competence and choices. Even though conversations around higher education teaching, learning and curriculum in the time of the fourth industrial revolution started before the pandemic (Gleason 2018), regions and countries are at different stages of digital transformation, and a significant number of universities in the developing world have just started this process. However, the state of emergency demands that countries like Serbia and South Africa embrace digital technologies and fasttrack their migration to remote teaching and learning systems. Many countries may therefore need to conduct skills and infrastructure audits of each university in order to inform their online teaching/learning strategy.

While the danger of COVID-19 contamination has triggered institutions to move their courses online, transitioning to online learning is not that simple where only a small proportion of the population has access to the internet, and poor connectivity, exorbitant costs, and frequent power interruptions are serious challenges, as in South Africa (Tamrat & Teferra 2020). Many developing countries may have to follow the example of South Africa in offering students and lecturers internet connectivity at reduced prices through collaborations with private service providers.

Lack of awareness around the use of e-learning tools for practical teaching is probably one of the most significant challenges. If higher education teachers are not aware of LMSs and other digital tools' existence, they are not going to use them (Mtebe 2015); therefore, in some developing countries, lecturers will have to be upskilled. There may also be a need for higher education teachers to evaluate their digital skills and preparedness for online instruction and conduct usability evaluations of the platforms, tools and digital resources that they want to use for teaching practicals. Additionally, copyright issues, quality of pre-made applications/software for virtual trips or virtual laboratories and mechanisms to foster student's self-regulation skills (Huang *et al.* 2020) are essential considerations. Universities must also put mechanisms in place to provide students and lecturers with adequate support

for remedying issues related to the hardware, software and slow and/or limited internet connectivity.

Reports suggest that online learning providers and practitioners have not prioritised security (Chen & He 2013), but we believe that in the months ahead, prevention of network security threats (for example, 'Zoombombing') are going to become increasingly important. Administrators of online learning systems must also pay careful attention to the privacy and safety of users, which include digital footprint issues and cyberbullying.

According to Vert and Andone (2019: 2), 'A big challenge for adaption of VR in education is the skills required for educators to design and develop VR-based instruction'. Universities, therefore, need to create platforms for ICT engineers and programmers to collaborate with lecturers in adapting VR for different online learning applications. While students usually can download VR experiences, it should also be noted that they are often bandwidth-heavy (Vert & Andone 2019), which could limit their utility.

Despite the value that many of these tools and platforms could bring to ERT, the most significant barriers to uptake are likely to be financial rather than attitudinal or cultural. Current costs of up-to-date IT equipment (Sinelnikov-Murylev 2020) and licences place these out of the reach of many higher education institutions. Furthermore, many institutions in developing regions have either outdated policies or do not have regulations regarding online teaching (Mtebe 2015), making it difficult for universities/colleges to convince governments to redirect funds towards e-learning. Lecturers in many parts of the world will, therefore, have to find innovative ways of adapting current infrastructure and adopting free/low-cost tools for e-learning, while dealing with the challenges associated with fostering student's self-regulation skills and their own personal skills inadequacies.

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