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simulations are extensively used as well, for various educational goals, and they are becoming more and more human. The social media is increasingly recognized as another important educational tool in clinical practices. This is used to share and develop knowledge, including via creating virtual communities of practice. Other forms of teaching technologies were also reported in literature as successful, such as digital games and the Google Glass, which were recently incorporated into medical curricula as essential teaching clinical tools.

Challenges of technology in clinical education

The challenges for universities in developing and implementing the kind of technologies described above in classes are, beyond the traditional challenges of added cost: the digital literacy and equity, integrating formal and informal learning, the very fast changing technology, or the risk of dependence, such as on mobiles. Special to the clinical education, challenges relate to the need for convinced and motivated faculty members. Reluctance by faculty members can be the result of three main concerns:

i. While the use of handheld devices increases practitioners' access to resources, it may also reduce their connectivity with people or lead to what could be considered 'unprofessional'. The use of such devices among patients and co-workers needs to be sensible and within what is perceived as good manners. Also, the fact that devices have cameras and recorders, including access to social media, promotes worries by faculty members about trust and confidentiality with students.

ii. With the online-based activities, learning is more and more being steered by the student, with the educator being now more of a guide. In clinical education, many argue that self-learning about a clinical condition cannot substitute the magic of hearing about it from experienced faculty members and practitioners, who hands-on managed it. It is therefore common in schools of clinical education that the online activities are mostly to augment class activities or to replace parts of the learning activities, but not to substitute them completely. Significant is the concern that online activities can be limited against the need for the increasingly important inter-professional education in health disciplines.

iii. Faculty members in medical colleges are relatively highly busy, especially if in research universities. Assistant professors are rewarded on their teaching, publications,

and funds. Full professors are expected to increasingly also add university and community services. This is all added to being active practitioners in clinical settings. It is highly likely, therefore, that faculty members will not find or risk time to lead or implement new technologies into their classes.

Deans and academic administrators, therefore, need to push their colleges forward by inspiring faculty members and adjusting rewards to those who leap forward. In the College of Pharmacy at Qatar University, for example, a special Technology and Teaching Committee was organized. This initially worked to create an archive of teaching technologies, before it was expanded to facilitate the use of several non-didactic methods and technology tools, organize development sessions of recent technologies and methods, and conduct research to assess and share experiences about the use and outcomes of different technologies used, such as learning management systems and the virtual reality lab.

Overall, despite challenges, the traditional higher clinical education is being disrupted, and institutions are aggressively adjusting their curricula. While the value of this depends on content and drive, technology is surely not only altering how to administer medicine, but it is also altering how to learn it. This, nonetheless, is in infancy still, with the best utilization of the technology varying upon how it is combined with other learning approaches.

11 Digital research design

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Research is one of the central missions of Higher Education Institutions (HEIs). In fact, it is widely believed today, through notions such as 'publish or perish', that research improves other missions of HEIs such as education, knowledge transfer, and internationalisation. Such four missions have, in turn, been influenced by two major trends in recent decades: globalisation and digitalisation. Globalisation resulted in increased exchange of students, faculty and staff across borders as well as in new foreign-owned HEIs. It was thus primarily related with rising flows of people and capital, facilitated by transportation technology and infrastructure such as low cost aviation and modern airports.

Digitalisation, by contrast, is primarily concerned with knowledge flows across borders, enhanced by information and communication technologies (ICTs) such as personal computers and videoconferencing as well as infrastructure such as the

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Internet. The impact of digitalisation on HEIs is illustrated by the way research is conducted. Instead of physically searching for a journal article in the shelves of a library, researchers now look for the same article online by digitally browsing webpages in the hope of finding it available for free. The walls of physical space have thus been replaced by those of digital space. The former were geographic, whereas the latter are economic and only when open access is unavailable.

Searching for a journal article, however, is just one of the many tasks researchers can perform digitally. Nowadays, there are even research projects entirely devoted to the listing of the vast amount of digital research tools available online and offline (e.g. https://101innovations.wordpress.com/). Such a listing is in itself an ambitious endeavour since new research software is created daily. An equally relevant question is, therefore, what research tasks are not yet digitalised. One can think of isolated field work, but most likely researchers will carry their smart phones with them; or face-to-face interactions in HEIs, but most likely tablets and the Internet will also attend the meetings.

Such ubiquitous role of ICTs has inspired new concepts such as 'digital immigrants' and 'digital natives', depending on whether digital skills were acquired in adulthood or childhood. For HEIs, it means that digital literacy creates new generational gaps, namely between faculty and students, reversing once taken for granted hierarchies of knowledge.

In such a context, it is relevant to ask what digital research design means, in contrast to traditional research design, and what are the implications for HEIs. For the purposes of this paper, digital research design is defined as the process by which research software is used to conceive academic research. Such a definition emphasises the role of software rather than paper to think, and of screens rather than human eyes to interact. A cognitive and relational revolution that disrupts traditional ways of learning, teaching and supervising research in HEIs.

Such a revolution affects primarily doctoral researchers, given their corner stone role in the four missions of HEIs. In particular, they tend to contribute to education by teaching younger generations of students as well as to research by publishing with their supervisors. In addition, they may participate in knowledge transfer projects as well as in international exchange programmes. It is not surprising, therefore, that international higher education organisations such as the European University Association have recently created a Council for Doctoral Education, nor that its

10th Annual Meeting was entitled 'Digitalisation' (http://www.eua.be/activities-services/events/event/2017/06/15/default-calendar/10th-eua-cde-annual-meeting).

At the doctoral level, digital research design increasingly implies the use of online rather offline research tools. Such web-based tools assist doctoral researchers in the design of a research project either as content providers or collaborative platforms. Content providers disseminate theoretical frameworks and related knowledge to help researchers think through a research project. Idea Puzzle (https://www.ideapuzzle.com/) and Sage Research Methods Project Planner (http://methods.sagepub.com/project-planner) illustrate this first approach to digital research design. Collaborative platforms, by contrast, are primarily interested in creating opportunities for networking and sharing online. Doctoral Net (https://www.doctoralnet.com/) and Form@doct (https://formadoct.u-bretagneloire.fr/) illustrate this second approach to digital research design.

The adoption of such tools in HEIs can nevertheless be problematic due to conflicting goals. In particular, digital research tools may question the legitimacy of HEIs to be the sole providers of knowledge, especially for academic research design. In this respect, it is important to ensure that such tools complement rather than replace traditional face-to-face classes of research methods and research skills as well as supervision sessions. One possible way to address this issue is to consider them as an opportunity for collective blended learning in HEIs rather than individual e-learning elsewhere.

In sum, digital research design is another reminder that digitalisation is a disruptive revolution which may lead to the creation of new positions in HEIs such as vice-rector for digitalisation, in addition to education, research, knowledge-transfer, and internationalisation. In other words, digitalisation may well be the fifth mission of HEIs.