

# Cybersecurity in the Post-COVID Digital Classroom: Implication for Emerging Policy, Pedagogy and Practice

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# **Cybersecurity in the Post-COVID Digital Classroom: Implication for Emerging Policy, Pedagogy and Practice**

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## **Introduction and Context**

The educational environment has changed radically — and will continue to do so — since the start of the COVID-19 global pandemic and the subsequent lockdown measures in every country and jurisdiction [1,2,3,4,28]. Combined with the demands of an increasingly digital, data-driven and computational world, there is a growing impetus for the evolution of the digital classroom, and especially digital pedagogy and practice [2,5]. Pre-COVID-19, UNESCO identified the need back in 2008 that it is essential that teachers have the competencies to integrate digital technologies effectively in the curriculum [6], to help learners develop the skills required for the 21st century, such as critical thinking, problem-solving, and the ability to collaborate [7]. Alongside this wider “21<sup>st</sup> century skills” imperative is the need to be aware of digital and cyber security threats from a societal, cultural and economic perspective [8], linking to wider national and international shifts in computer science education [9] and digital skills reforms [10].

In this chapter, we pull together these key themes to look at the cybersecurity concerns associated with the modern digital classroom, the challenges (and opportunities) associated with developing the environment for a safe online teaching environment, and the cyber skills now required of both students and educators. In addition, we will explore the increasing value of academic records and student/institutional data to cybercriminals, as well as discussing the underlying motivations for why cybercriminals access educational systems. Whilst the emerging online classroom might appear to be a benign environment and be of little value to cybercriminals, we will discuss how online or cyber classroom environments can be exploited to become gateways to other institutional systems and educational data.

Tertiary education institutions (universities and colleges) across the world now find themselves rapidly moving into major programmes of digital transformation, both student-facing, as well as for their own systems, processes and infrastructure [1,5]. Digital transformation is the process of adopting and using digital technology and data to deliver value and drive change [11]; in higher education, the emphasis is not necessarily on the use of specific digital technologies, but on the application of those technologies to support high-quality, pedagogically-driven learning, teaching and assessment practice, as well as enabling wider transformational operational and organisational change. With the potential opportunities to embrace new ways of working as a result of the COVID-19 pandemic [2], especially from the rapid shift to online/hybrid approaches [5,12,13], this has exacerbated the potential vulnerabilities in the new digital or cyber classroom [14,15].

Educational environments globally have been transformed as a result of COVID-19 [16]. In March 2020, as countries across the world went into various levels of lockdown and social isolation measures, higher education institutions moved quickly to find a solution to giving all students continued access to practitioners, learning materials and resources – the answer was “emergency remote teaching”, rapidly moving to an online or blended provision. Overwhelmingly, the speed of “flipping to online” was clear, with faculty, tutors and professional services support staff rapidly redesigning learning,

teaching and assessment (as well as implementing new systems, processes and infrastructure) to enable students to continue with their education [1,2,3,17,28]. A further consideration because of the lockdown environment is the fact that academics and students have been setting up and engaging with learning environments at home, away from the established systems and processes that would normally be in place in an institutional setting [5,12,13].

Recent cybersecurity education literature has focused on developments in cybersecurity curricula [19,26], qualifications and accreditation [20,23], pedagogy and practice [18,22] to increase the number of cybersecurity professionals, in both the UK and internationally [21,24]. There has been little research published to date on the online learning, teaching and assessment environment as a cyber target in its own right. In this chapter, we will illustrate the dangers in using online environments, discuss emerging threats, and suggest steps and mitigation that can be taken by practitioners and learners to make it more difficult for cybercriminals to attack educational institutions.

## **A Short History of Cybersecurity in Educational Environments**

In recent years — and certainly since the start of impacts resulting from the COVID-19 pandemic from March 2020 onwards — the use and application of computing technology and computer systems has experienced dramatic growth, particularly in education [27, 6, 2]. The growth in the number of systems and the advances in the scale, functionality and usability of these systems has provided significant opportunities for malicious users to exploit insecure and non-robust systems [18]. The pace at which education providers and students have embraced technologies such as virtual learning environments, online/blended learning and the use of smart devices, mobile technologies, and the Internet of Things (IoT) has rapidly increased the visibility and accessibility of digital educational environments, creating an education ecosystem that is changing faster than learners, organisations and indeed legislators can often manage [1]. It is not only the software and systems that are changing; the way in which students and faculty use the systems, with expectations of speed and convenience means that cybersecurity can often be overlooked or secondary in importance to availability and interconnectivity. Allied to this growth in educational technologies is the growth in the amount of data that is generated at the individual and institutional level, and the variety of ways in which data is collected, stored, aggregated and manipulated.

The ways in which educational technology can be used in a university or college setting will vary depending on the learners, level, subjects and disciplines, and the approaches that are used in designing and delivering courses. Typically, there will be universal access to a virtual learning environment (VLE), managed by the university's security systems. However, the need for flexibility for both learners and faculty means that there will often be add-ins to enable a range of functionality and features, including:

- editing of educational materials;
- links to video capture systems;
- embedding of third-party resources (including images, audio and video);
- access to library resources;
- submission of formative and summative student work in a range of formats; and
- provision of online feedback.

All of the above are increasingly viewed as core features for a modern virtual learning environment, enhancing the range and accessibility of learning materials that can be developed for diverse student needs across a wide range of courses. However, all of the above features listed above are also

potential weak points and vectors for attack in terms of cybersecurity and could be exploited by bad actors.

The wide range of software, systems and technologies — and the speed of their adoption and implementation — provide significant new opportunities for cybercriminals to exploit. In addition to taking advantage of existing vulnerabilities in systems, the advances in technology also provide the opportunity for cybercriminals to conceal their activities, to cover their tracks and attempt to destroy evidence of their actions. The ability to prevent or mitigate cybercrime attacks and cybersecurity breaches in the classroom has always been a challenge, but the speed of growth and the volume of activity mean that this challenge is escalating.

The nature of the diverse systems being used at universities and colleges means that there is a requirement for them to be interlinked and interconnected; for example the need to link the virtual learning environment (VLE) to the student administration systems and human resources systems in order to facilitate online learning and teaching operations. Whilst this enables online learning to be accessed by learners and faculty, connecting these disparate systems potentially creates cybersecurity vulnerabilities; we will revisit this later in the chapter.

Every institution has a wide range of system functions; some used directly in the digital classroom, some to facilitate independent learning for students, and others to enable the “business as usual” functionality of the institution. Many of these systems will be linked by function, but also linked by technical architecture. There is a potential tension between accessing full functionality of the systems against the cybersecurity associated with the systems. In normal times, this would be considered a vulnerability from a cybersecurity perspective; but in times when there has been a significant amount of rapid change with the adoption and use of digital technologies to allow learners and faculty to participate remotely with online learning, teaching and assessment, the vulnerabilities are potentially exacerbated.

The changing educational technology environment and the growth in both explicit and potential threats means that the role of cybersecurity in the classroom is increasing in importance. As educational providers globally become more reliant on utilising educational technology to deliver education, what we teach and how we teach it become key considerations. Similarly, there is a need to consider the learners themselves, what they need and want to learn as well as how they learn about key cybersecurity principles in the classroom, irrespective of the subject that they are studying online [30].

## **An Emerging Threat Landscape**

There are extensive and diverse sources of cyber threat in the digital environment and many of these threat sources could potentially relate to the emerging cyber classroom [35,37]. The education sector, across all settings and contexts [31], is increasingly being targeted by cybercriminals due to the huge amount of sensitive data and in many instances relatively weak security infrastructure and implementations [29]. Attacks can be both random or targeted – and it is targeted attacks on educational institutions that have increased in recent years, with the range educational institutions largely perceived as “soft” targets [32]. Although the focus of this chapter is on cybersecurity issues in the classroom, and in particular, the emerging threats since the start of COVID-19, attacks on universities are certainly not new. These were early examples of motivation for cybercriminals to attack university systems: even during the early 1990s, a number of cyber attacks on universities were documented [33]. Universities had huge computer processing power (for the time), integrated and interconnected systems, and external network links which provided direct access to a wide range of

military and government systems. As well as access to processing power and gateways to external systems, the motivation for cybercriminals to attack these institutions includes access to other key systems, for example finance, payroll, human resources, student data and the opportunity to catastrophically disrupt core institutional business e.g. using the disruption to deny legitimate access and facilitate “ransomware”. It is difficult to put accurate financial figures to the cost to educational institutions on these types of attack, but it is easy to see the wider impact to the UK economy from the annual Cyber Security Breaches Survey [34], led by the UK Government’s Department of Digital, Culture, Media & Sport.

Cyber attacks can come from a variety of different sources, with the nature of the attack and the attack vector varying depending on the attack type. Whilst the severity and impact of an attack will clearly vary depending on the specific circumstances and context, any cyber attack on an educational institution is going to cause immediate disruption to core learning and teaching activities, potential (digital) damage, and likely have a longer-term financial and reputational impact [36].

There are a variety of different threat vectors ranging from “advanced persistent threats” typically funded by governments and nation states, through to hacktivists (often ideologically motivated) to nuisance threats (often attacking from their own homes) [32,35,36]. Of course, there are also threats from organised cybercriminal groups who will exploit opportunities afforded by cybercrime and vulnerabilities in computer systems [31,35,36]. These attacks can be both computer dependent or computer enabled. A final group often identified in categories of attack vectors is often the most overlooked: the insider threat – these are unscrupulous, and often disgruntled, employees who will seek to cause disruption to their employer or find a way to make some personal gain [31,34].

There are a number of points in educational systems that could potentially be vulnerabilities for attackers to exploit, including, but not limited to:

- Hardware and infrastructure;
- Software and integrated systems;
- Connected university systems (e.g. finance, HR, etc);
- Virtual learning environments;
- Email, instant messaging, and connections to social networking;
- Data storage (both personal and academic); and
- Users.

Perhaps one of the most challenging threats to classroom security is human error. As institutions have rushed to provide high-quality and comprehensive online and virtual learning experienced for their students, it is easy to overlook the demands of robust, adaptable and verifiable security considerations. Especially as we try put in place simple, accessible and usable solutions for diverse student groups. This is further exacerbated by academics and professional services staff working remotely from home and not having the standard university security systems and protocols in place, as well as the need for students to have frequent access to tutors, learning materials and online classes [1,2,4,28].

As well as the requirements to facilitate high-quality and flexible online learning, teaching and assessment being a new domain for educators and institutions, it also provides a new set of opportunities for attackers. Furthermore, cybercriminals have shown that they can be highly innovative and creative whilst identifying targets to exploit [34,31].

One current example of cyber criminal creativity is the use of ransomware attacks [34]. Essentially, the attacks will utilise an attack vector to lock or encrypt so that the legitimate users will not be able

to access systems or data. In order to obtain the “key” to get access to systems and data, the attackers hold the education provider to ransom, hence the term ransomware [37]. Of course this would be disruptive at any point in the academic year, for example in blocking access to online classrooms or learning resources, but can be particularly problematic in disrupting institutional business at key periods, such as enrolment or examination boards.

All of the high-level examples given in this section are potentially disruptive to the educational operations and core business of an institution, with associated financial and/or productivity loss; however, there is a further implication as a result of any cyber attack, system breach or data loss: reputational damage [31,34].

## **A New (Ab)Normal for Education?**

As we have indicated earlier in this chapter, COVID-19 has likely irrevocably changed educational environment and ecosystem [1,2,5]. There has always been a digital aspect to education, especially since a diverse range of software and systems were systematically introduced to various levels of education from the late 1980s onwards. However, since March 2020, the speed of the shift to, and adoption of, various models of online learning, teaching and assessment has increased significantly [2,6,30].

The widespread impacts of the COVID-19 pandemic, and especially the various “lockdown” measures experienced in the majority of educational jurisdictions meant that there was a rapid move to facilitate online delivery to ensure that students in all settings could continue to learn. Students expected to have immediate access to online learning and teaching, and to the full range of institutional software and systems [5]. The uncertainty of working protocols at the start of the short initial lockdown — and to which groups of society they applied — alongside preventing access to campuses with very little notice, meant that the infrastructure, architecture, access for the remote use of educational systems happened extremely quickly. There was a pragmatic requirement to ensure ease of access and minimal disruption to these systems for broad groups of academics, professional staff and students, giving rise to a particular set of challenges from a cyber security perspective.

The rapid move to online delivery meant that staff and students were routinely working from home or other locations outside of the standard institutional environment and access protocols. This led to a number of low-level security issues, including staff with a lack of IT expertise not going through appropriate checks and processes, and misconfiguring hardware and software (including downloading unapproved or potentially unsafe software) to access core institutional systems and specialist facilities to facilitate learning for students, with a marked increase in vulnerabilities and potential for attack [29,30,32].

Furthermore, with the rapid shift to online delivery came major institutional purchases and licensing of new software, hardware and infrastructure [1,5,28,30]. This meant rapid integration with existing institutional systems and data, providing remote authentication and access, largely without time to analyse wider security considerations or new threat exposure. The increase in the number of points of contact from staff and students meant that it was and increasingly complex threat landscape to monitor and to manage [14]. Finally, whilst the majority of these were no doubt legitimate and credible, it also provided an opportunity for potentially unscrupulous hardware and software vendors to provide insecure or untested systems and create attack vectors in an educational enterprise-scale setting [29,31].

At the time of the first COVID-19 lockdown, during the “emergency remote teaching” phase of the 2019/2020 academic year, there was concern about the ability to recruit new students for the 2020/21 academic year. Many UK higher education institutions reviewed their financial positions and reduced expenditure, for example major capital investments delayed, new posts being put on hold, promotions cycles were postponed, pay increments were delayed (indeed, staff were asked to take pay cuts in some institutions to avoid any redundancies), and all non-staffing costs were reviewed [1,3]. While there were immediate savings on travel costs and other types of routine expenditure, this did not offset the wider concerns about potential loss of income from student numbers, and especially international students coming to the UK [1,3,28]. The core institutional spend on cybersecurity, often an area for debate before COVID-19 [37], came under increased scrutiny [34]. This was in the context of significant government and policy focus on the cyber resilience of UK higher education institutions from the National Cyber Security Centre (NCSC), especially to protect strategic research and innovation investments and associated intellectual property, but also from a critical national infrastructure and economic perspective [31].

### **Understanding the Value of Student Data**

At first glance it may appear that student data may not have any immediate or exploitable value to cybercriminals. However, as with any sensitive personal data there is a requirement to protect and safeguard that data, especially under the requirements of UK data protection legislation. As highlighted earlier, educational institutions are increasingly subject to ransomware attacks; withholding access to or corruption of student and/or academic data would likely be a component of these types of attacks [14]. Additionally, student personal data breaches may lead to various types of fraud, including identity theft; indeed, student data can be as valuable as financial data, used as a basis for obtaining false documentation and credentials and facilitating serious organised crime [15,34].

As highlighted earlier, obtaining unauthorised access to student administration systems (required for online classrooms) can often be a gateway to obtaining privileged credentials for other institutional systems, for example finance, payroll, procurement, HR, etc. One of the factors that make student data systems attractive to cybercriminals is that it is often difficult to detect when these systems have been compromised [15,37]. This means that attackers can have unrestricted access to the student data and related systems before institution or indeed student becomes aware of any issue. The problem can be further exacerbated if the educational establishment is not up to date in maintaining student records; for example if a student withdraws from their course but the details are not updated it may be possible for the attack to “cuckoo” and take over these records, continuing to receive student finance, etc [14,15,30]. Similarly if a student applies to an institution and is accepted, but does not turn up to university to take up their position on a course, and never formally contacts the institution, a student record is created, which can be exploited for a range of benefits [14,15,30].

### **Cybersecurity in the Emerging Digital Classroom**

There are a number of cybersecurity issues in both online classrooms and indeed the traditional face-to-face classroom environments. As well as installing and implementing secure systems to enable the use of educational technology in the classroom [27], collecting incredibly rich personal data on students [38], there are various other factors which should be taken into account when considering cybersecurity in the classroom. All participants in the classroom learning environment, academic staff, professional services staff and students, should be aware of the increasing need for robust and adaptable cybersecurity in the classroom.

In order to embed effective cybersecurity in the classroom there is an expectation that the lecturer has a level of expertise and understanding of cybersecurity both in terms of the teaching environment and the context of the subject being taught [19,20,21,23]. In order for teaching to be effective it is important that the lecturer understands the level that students are at in their learning and also appreciate what it is students know about cybersecurity [15,18,22,25]. The tutor needs to be aware of the cybersecurity needs and the potential threats of attack in the classroom, as well as outside of the classroom. The question then becomes how much cybersecurity knowledge is required before using commonplace educational technology in a teaching environment. We also need to ask whether it is fair to expect academics and tutors to understand the diverse range of cybersecurity risks in a classroom environment, especially if they are not from a technical background or discipline.

Evidence suggests that many students consider the use of digital software, systems and online services as a positive environment, often without considering the explicit flaws or risks [39]. Whilst this may be broadly helpful in facilitating learning and teaching, it often means that they do not think about wider security consideration, or how their student data could be compromised. It is important that all academics and professional services staff, irrespective of discipline or role, understand their responsibility in ensuring both themselves and students understand the need for cybersecurity to be taken seriously in the online learning environments and settings.

Interestingly, a new online phenomenon was observed at the start of the emergency remote teaching phase in 2020: “Zoom-bombing”. This involved attackers who were not meant to be participants in an online classroom entering the classroom as unauthorised users and causing disruption, from sharing memes to sexist, racist and homophobic abuse [14,15,37]. There were widespread reported instances of these interruptions, both in the UK and internationally, leading to increased security settings and configurations for entry to online classrooms and the need for active management of online teaching sessions [14]. Thus, to increase student awareness of the risks in the online classroom it is important for students to appreciate and understand:

- the need to be responsible digital users;
- the value of student data and their digital footprint;
- the wide range of potential threats and vulnerabilities;
- the need to recognise and validate trusted digital resources;
- the need to protect their digital devices; and
- the expectation as students to actively develop positive and ethical use of academic software and systems.

## **Balancing Educational Needs and Security Requirements**

In this closing section of the chapter, we indicate a number of key steps that can be taken to avoid online classrooms being easily compromised. As we have highlighted, it is important to get the balance right between ease of access to and use of the online classroom, as well as having in place the appropriate and necessary security measures.

There are a number of steps that can be taken to make it more difficult for attackers, including:

- Use high-strength encryption as much as possible (acknowledging it is not always feasible when running certain online classroom environments or activities);
- Utilise multi-factor authentication for entry into the classroom; whilst this might slow things down a little in terms of access to the classroom it is a very powerful technique in minimising unauthorised access;



- Apply the principle of least privilege: only enabling access to the online classroom when it is required, for specific roles and activities, and only for those academics and learners who need access. Least privilege also means that access should be removed when access to the online classroom is not required;
- Related to this principle of least privilege, ensure there is an end of life plan to manage access when students and staff leave (progression, graduation, or otherwise), managing student records and ensuring that obsolete and unprotected equipment is decommissioned and removed; and
- Constant vigilance (and do not be afraid to question or challenge): both tutors and students need to be aware of the environmental conditions and anticipated users in the online classroom, and when something does not look right then should be empowered to flag an issue or raise the alarm.

Although not directly linked to the online classroom, care should be taken when using official institutional email or messaging systems, as there are a number of classic exploits that cybercriminals will attempt to utilise. The main and well-known issue is “phishing” and the closely-related “spear phishing”. Phishing is when a cybercriminal tries to get a legitimate user to either pass information to the cybercriminal or get the legitimate user to click on an online resource that is controlled by the cybercriminal. In times of crisis, criminals often increase low-level phishing activity to target people as often their guard is lowered [14,37]. Common guidelines to staff and students at institutions to help protect against phishing scams may include:

- *Are you expecting the email? If the answer is no, then please take additional care in opening or responding to the email;*
- *Is the language used in keeping with what is usual from the sender? If the answer is no, please take additional care and do not be afraid to contact the “sender” via another route to confirm authenticity;*
- *Hover over hyperlinks; do they link back to websites and email addresses that you recognise? If not, do not click them;*
- *If an email has an enticing offer associated with it and the offer seems too good to be true then it most likely is;*
- *Lookout for hard to notice misspellings in URLs and hyperlinks, particularly if these are close to legitimate ones e.g. [www.sunderland.ac.uk](http://www.sunderland.ac.uk) is authentic, whereas [www.sundreland.ac.uk](http://www.sundreland.ac.uk) is not.*

Earlier in the chapter, we highlighted the multitude of issues emerging from the rapid move to online learning, teaching and assessment. In trying to find solutions to enabling a useful, usable and manageable online classroom environment, tutors should avoid signing up to “free” services. Many of the free services which are frequently advertised are often restricted in functionality and customisation compared to the premium services (and are therefore not suitable for enterprise-scale installations), or often do not conform to UK data protection requirements and may potentially expose the institution to an unmanaged level of risk. It should also be noted that cybercriminals may use free software and services as a vector for collecting credentials so as to obtain privileged access to staff or student data. It is safer to use hardware and software that is institutionally approved and supported, meaning that due diligence and security checks will have taken place, adhering to the institution’s security policies and processes.

## **Conclusions and Future Challenges**

Cybersecurity — and indeed cyber resilience — is a domain of growing interest and influence across all of our lives: across society, culture, the economy, and clearly from an educational perspective. In this chapter, we have highlighted and explored a number of key cybersecurity issues, concerns and threats with particular reference to the evolving online classroom, especially as a consequence of the rapid (and perhaps permanent, in some instances) shift to online learning, teaching and assessment. We have identified a series of potential threat vectors and modes and attack, and considered the reasons educational institutions, academics, professional services staff and students could easily become the targets of cybercriminals and cyber attacks.

In a similar way to health and safety, cybersecurity is the responsibility of everyone; educational institutions, staff and students absolutely need to take explicit ownership for staying safe online. As we have shown in this chapter, cybersecurity is an emerging and evolving challenge in education. and ensuring sure that people, data and systems remain secure and resilient will require constant attention and strategic investment. We all need to be vigilant, work together and do all we can to avoid the diverse landscape of vulnerabilities, exploits and attacks. Furthermore, we anticipate this becoming a key future area for research, policy and practice, as well as influencing learning, teaching and assessment as all educational levels.

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