Ed-Tech Within Limits: anticipating educational technology in times of environmental crisis

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ABSTRACT: Despite climate heating and rising ecological instability, environmental issues feature rarely in discussions of educational technology. Most commentators presume the continued unfettered use of digital education resources bolstered by occasional claims that emerging technologies might support the 'greening' of school and university provision. In contrast to such business-as-usual complacency, this article anticipates ongoing environmental degradation of the planet as radically up-ending the continued expansion of digital technologies in education. On one hand, depletion of natural resources and energy curtailments might put paid to established 'abundant' forms of digital technology use. On the other hand, more frequent climate-related disasters might necessitate emergency forms of education for displaced and unsettled populations. As such, the article argues for a new paradigm of educational technology that is both wholly sustainable and targeted toward displaced and disadvantaged populations. The article considers a number of ways that such an 'EdTech within Limits' might be pursued – outlining fundamental shifts in thinking necessary to reorient educational technology along environmentally-concerned lines.

Ed-Tech Within Limits: anticipating educational technology in times of environmental crisis

INTRODUCTION

We live in times of successive crises and upheavals on a global scale. The opening months of 2020 saw devastating bushfires in Australia, followed by the rapid global shutdown resulting from the COVID-19 pandemic. This was accompanied by significant civil unrest around the 'Black Lives Matter' movement, followed by equally devastating 'megafires' stretching from the US west coast to the Pantanal wetlands of Brazil and Bolivia. These were just a few prominent instances of what many commentators see as an inexorable unravelling of the world's environmental, economic, political, societal and health fortunes over the 2020s and beyond.

So, amid these global upheavals what needs to be said (if at all) about the future of educational technology? While hardly the most pressing issue to be tackled in times of crises, the educational technology community still needs to consider its place, its actions, and general relevance to contemporary conditions. After all, what we have come to refer to as 'ed-tech' takes up considerable amounts of time, effort, resources and attention that might be better directed elsewhere. As such, this article anticipates the fundamental refocusing of digital technology use in education in light of the changing global conditions that our planet and its populations face. Put bluntly, it makes little sense to presume that current assumptions about the continued abundance of digital education resources and technology-driven practices are in any way sustainable. At the same time, it also cannot be presumed that face-to-face schooling and higher education will continue on a wholly un-interrupted basis. If not, what forms might educational technology usefully take for the next few decades? By the usual standards of ed-tech scholarship, some radical rethinking is required.

THINKING BEYOND ED-TECH AS A POSITIVE PROJECT

The use of digital technology in education (both in terms of practice and scholarship) has always been an inherently forward-looking and optimistically-minded endeavour. Most people are motivated to work in this area by ambitions to make use of technology to improve learning, teaching and/or other aspects of education provision. Over time, this has proven to be both a strength and a weakness. On one hand, educational technology continues to be an area where people engage with questions of education innovation and change - actively seeking to resolve

challenges and improve education. In this sense, ed-tech might be described as an essentially 'positive project', coloured by "an underlying belief that digital technologies are—in some way—capable of improving education" (Selwyn 2011, p.713). While concerns have been raised regularly over the epistemic limitations of this approach (e.g. Noble 1998, Kerr 1996, Cuban 2009), the past 40 years has seen educational technology and digital education prosper as forward-looking optimistic areas of practice.

Even during our recent chaotic times, educational technology remains a field of work driven by twin assumptions that: (i) emerging technologies will continue to be developed with ever-increasing capabilities, and, (ii) these technologies can be 'harnessed' to improve learning, teaching and other aspects of education. While strong differences of opinion persist regarding the nature and form of these technologies, most ed-tech endeavours are rooted in a shared sense of continuing progress, with digital tools and practices placed firmly at the centre.

Of course, ed-tech is not unique in its forward-looking perspective and ambitions to constantly enhance and improve. Most areas of education research share a 'redemptive' commitment to improving the lives of learners and teachers, or else righting perceived wrongs in the provision of education (Ball 2020). Similarly, many technology disciplines are focused primarily on the engineering of new innovations to address problems. Even ostensibly 'critical' areas of social study are bound with implicit orientations toward some sort of progress. As Joe Davidson (2021) notes, a belief in progress underpins most founding social theoretical accounts of the world – from the writings of Karl Marx to Max Weber. Moreover, most contemporary critical thinkers continue to be driven by an implicit 'social hope' – i.e. for "the realisation of a social world better than the present" (Davidson 2021, n.p).

Yet, what if the essentially hopeful epistemological framing of educational technology is no longer fit for purpose in terms of making sense of the contemporary world? This paper will develop the argument that there is fast-diminishing reason for hope, certainty and a presumed progress in any area of society over the next few decades – let alone educational technology. So, what if the fundamental logics of progress and positivity implicit in the use of digital technology in education are no longer justified? In light of recent world events, these are challenges that need to be acknowledged and acted upon.

COVID: A WARNING AGAINST COMPLACENCY

Any faith that one might have in the predicable progression of educational technology was surely confounded by the global COVID-19 pandemic at the beginning of the 2020s. The prospect of a major pandemic had been considered previously by a few specialist educational futurists (see, for example, Alexander 2020). Yet, to the best of my knowledge, no instance of 'future-scoping' or 'horizon-scanning' within mainstream ed-tech circles during the 1990s, 2000s or 2010s imagined a global pandemic shutting down entire continents and forcing nearly 85

percent of the world's students into emergency remote schooling. The ramifications of what actually unfolded during the opening years of the 2020s point to the limitations of how the future has been approached and anticipated within the field of educational technology. This sentiment was acknowledged by the author of a set of ed-tech futures scenarios published at the very start of 2020 (a few weeks before the pandemic came to the world's attention):

> "We wrote a paper imagining three futures of ed-tech, and in none of these scenarios did we imagine some sort of crisis. I look back now and think, how did we not think about some sort of rupture? Instead, we had three possible futures that flowed in different directions from what we have today … [so COVID showed us that] crises are what make change. Maybe the [COVID] pandemic was just one crises. So we can imagine a future where further crises are coming – ecological crises, other crises – and each crises is going to have its own unexpected leap" (Macgilchrist 2020).

As Macgilchrist acknowledges, COVID proved a harsh reminder that we live in uncertain and vulnerable times, with the fortunes of different countries and regions around the world inexorably interconnected and dependent upon each other. At the same time, COVID was also a reminder that exceptional shifts in the status quo can take place. As Steve Matthewman (2020) put it, COVID was an instance when "the unthinkable happened". Governments temporarily suspended entire economies and education systems, global travel was halted, non-workers were paid basic state incomes and homeless populations housed in hotels. As Matthewman (2020, n.p) reasons: "disasters are social laboratories. They give us the opportunity to think the world anew. The Coronavirus pandemic t[old] us that the impossible happens, and that other ways of living are within our grasp". Refocusing these thoughts toward the specifics of educational technology, then, it makes little sense to be envisaging our possible futures simply in terms of a return to a 'new normal' involving slightly altered versions of status quos from pre-pandemic times. Instead, COVID prompts us into radically reassessing how we engage with thinking about the future of ed-tech along lines of continued crises – incorporating what is unforeseeable alongside what is foreseeable.

ANTICIPATING UNKNOWABLE FUTURES

Of course, these are not unprecedented concerns. The past forty years has seen the establishment of a rich tradition within the social sciences of viewing the future in fundamentally uncertain, volatile and unknowable terms. Indeed, some COVID commentaries were quick to reinvigorate thinking around the 'risk society', and make use of ideas developed by sociologists such as Ulrich Beck during the 1980s and 1990s detailing how societies were confronting the insecurities and hazards associated with industrial modernity.

The risk society thesis reasons that modern industrial era is defined by how societies confront ecological and techno-scientific risks that stem from the techno-economic 'progress'. During the 1980s, industrial modernity was seen to throw-up many such risks – from the threat of nuclear disasters and genetic mutations, to ozone depletion and greenhouse gases. While the COVID virus might have been 'natural' in origins, the global spread and sustenance of the virus was fuelled by international travel, global supply chains, rise of online misinformation and popularist politics, and other decidedly human accelerants. Unlike the natural risks faced by pre-industrial societies (which were *relatively* calculable, controllable and avoidable), the risk society of the 2020s continues to face novel kinds of threats, dangers and uncertainties that are fundamentally uncertain and incalculable. In some cases these risks are literally unknowable, reflecting Beck's (2009) talk of 'non-knowledge' (nichtwissen). As Blok & Selchow (2017, p.4) observe, contemporary observers are therefore well-advised to focus their attention on "potentially catastrophic consequences that stand and remain beyond knowledge".

The risk society thesis therefore provides a useful signpost in reorienting our thinking around ideas of indeterminability and uncertainty of ed-tech. For example, this requires accepting that it is impossible to predict (let alone plan for and/or control) future outcomes associated with the technological, environmental, political and economic systems that we have created. Instead, anticipating 'risk' requires imagining what might be, and then "creat[ing] the means for acting as though it were" (Reith 2004, p.396). While we cannot know what *will* happen, we can anticipate future catastrophes, and use these as a basis for engaging in collective action in the present as a means of preventing that future from being realized. Beck (2015) refers to this as "emancipatory catastrophism".

This spirit of hopeful (re)imagining in the face of unknown crises is reiterated in the recent turn toward 'anticipatory' approaches in imagining education futures (see Amsler & Facer 2017). The contention here is that viewing the future of education through the lens of what seems 'probable', 'likely' and 'predictable' is an inherently repressive starting-point - foreclosing alternative ways of acting and divergent forms of knowledge. Instead, unknowable futures require responses that imagine how we would like to be living – especially in terms of recentering the perspectives of previously marginalized interests and non-powerful groups (Facer 2019). This also raises a host of challenging questions that might be asked of educational technology in the 2020s. For example, how might alternate approaches to ed-tech be established that do not presume the continuation of dominant 'Big Tech' industry, global capitalist modes of production, the 'global middle class', or other facets of neoliberal hegemony? Again, the focus here is on using these imaginations to inform 'anticipatory behaviours' – i.e. changes in our present behaviours rooted in these imagined and desired futures (Poli 2017).

ANTICIPATING EDUCATIONAL TECHNOLOGY FOR TIMES OF FUTURE CRISIS

With these ways of thinking in mind, how might we anticipate desirable forms of educational technology in light of the risks associated with future planetary crises and catastrophes? There are a number of interconnected risks here that any rethinking of ed-tech might usefully start from. For example, we might anticipate disruption caused by future pandemics, increased militarisation, and/or geopolitical destabilisation due to increasingly unpredictable dynamics of online information flows. However, from here onwards this paper will focus on the multiple, interconnected crises associated with ongoing environmental instabilities. This encompasses a range of issues: from the depletion of non-renewable natural resources through to the deleterious human and ecological consequences of anthropogenic climate change. It should be clear that this set of issues represents one of the most urgent areas of uncertain 'non-knowledge' over the forthcoming decades. As such, these are prevailing risks that must be anticipated in any talk of the 'future' of ed-tech.

i. Ed-tech as environmental solution?

Educational technology is rarely discussed in relation to issues of environmental risks. When environmental connotations *are* considered, this is usually framed in terms of possible environmental benefits of expanded digital technology use in schools, universities and other education settings. For example, we see speculation over the environmental benefits accruing from reduced paper use, video conferencing, and installing 'green tech' such as smart lighting and smart metering in a general push toward 'carbon neutral' campuses. Here, it is also reasoned that online teaching might well reduce the carbon footprint of schools and colleges, not least by lowering emissions of students otherwise travelling to classes (Versteijlen *et al*. 2017) as well as reducing on-campus power consumption (Caird *et al*. 2015).

Indeed, most forms of emerging technology in education attract occasional claims of environmental benefit. At the beginning of the 2010s, 'massive open online courses' (MOOCs) were soon being praised for supporting the 'reconceptualization' of higher education along the lines of reduced carbon emissions and low environmental impact (Lane *et al*. 2014). Elsewhere, various other educational technologies have attracted similar praise – ranging from augmented reality (Alahmari *et al*. 2019) through to the role of blended learning in "protect[ing] global environmental resources" (Caird & Roy 2019, p.107). If educational technology is considered at all in terms of its environmental impact, then, this has tended to be in beneficial terms. As Becker and Otto (2019, p.8) conclude:

> "Digital learning … it saves resources and CO_2 emissions, thus contributing to the protection of the climate and to the goal of responsible consumption and production. … it helps to connect people from different cultures by allowing for intercultural exchange among students without additional travelling … it facilitates a self-regulated learner-centred style of learning that is well-suited to empower learners to become agents of a sustainable development".

This confidence spills over into imagined future forms of environmentally sustainable forms of teaching and learning. For example, the 2020 edition of the influential 'New Horizons' report presented a 'Collapse' scenario shaped by 'climate-related catastrophes' and associated 'political destabilization'. Here, higher education systems of the late 2020s were imagined to have been 'dramatically transformed' by "two primary forces: the dangers posed by climate change and the advances in digital technology" (Educause 2020, p.36). In this scenario, digitally-driven universities are imagined as a vital element in how societies can "address the climate-related challenges". Global networks of universities are formed to "focus on online learning as a sustainable educational model". Online courses allow for "time-delimited enrolments", students paying monthly subscriptions to access learning and earn micro-credentials when needed. While the authors of this scenario acknowledge that "extreme global weather events and droughts will impact students' well-being", it was suggested that students will have personal AI companions capable of significantly decreasing "rates of depression and other markers of mental distress".

While willing to anticipate political destabilization and climate catastrophes, these scenarios reinforce a dominant framing of extended and intensified use of technology to overcome educational (and societal) challenges. These framings presume a continued status quo of institutionalized and credentialed education, as well as the unfettered functioning of expanded digital infrastructures. Digital technologies continue to be imagined as offering a ready response to any problems that might arise from climate catastrophe – mitigating everything from restricted geographic mobility to impacts on mental health. All told, the bottom-line is one of an assured techno-solutionism (Johnson 2018).

ii. Ed-tech as environmental burden?

The claims and scenarios just outlined all presume environmental instability as a largely knowable and containable challenge. Yet, what if this is not the case? What if environmental instability cannot be 'solved' simply through the expanded application of digital technologies, but is actually exacerbated through increased technology use? In contrast to the business-as-usual complacency outlined above, it can be argued strongly that the relationships between educational technology and environmental instability demand more diverse thinking. As such, it makes little sense to anticipate environmental change solely in terms of steady continuation of existing conditions – rather, this is something that needs to be anticipated in more catastrophic and radical terms. As such – and this is the core message of this paper - ***we need to anticipate the ongoing environmental degradation of the planet as radically up-ending existing assumptions about the continued use of digital technologies in education***.

Imagined along these lines, then, it is worth thinking how our current reliance on 'abundant' technology use might soon be curtailed by: (i) the ongoing depletion of natural resources, and (ii) increasingly unsustainable energy demands arising from the production and consumption of digital resources might soon curtail. This

suggests reassessing the ‘cornucopian’ logics (Preist et al. 2016) that have underpinned the past twenty years’ thinking about digital education as essentially limitless, infinite and replicable. Such assumptions are implicit, for example, in norms established during the 2010s that digital technologies need to be personally owned and frequently upgraded, expectations for classrooms to be full of screens, and the pressure to achieve ideal ‘one-to-one’ ratios of at least one device per student. An entitled sense of digital abundance also underpins expectations of instantaneous and continuous access, unlimited and eternal ‘cloud’ storage, high-bandwidth connections, high-definition content that is stored in multiple versions and shared repeatedly across different platforms.

All told, we need to reconsider the basic expectation that educational technology now involves significant amounts of technology. Indeed, belying previously outlined assumptions that digital technology is somehow environmentally beneficial (or at the very least environmentally neutral), the continued expansion of digital technology throughout education can in no way be rationalised as somehow off-setting the hugely detrimental nature of the full life-cycle of the digital products and processes that go to make up ‘ed-tech’. Instead, the environment costs of technology use in education need to be properly acknowledged and then challenged in a number of specific ways. First is what Toby Miller (2015, n.p) terms the “dirty material origins and processes” of digital hardware. Educational technology relies on digital devices, batteries and attendant infrastructures that are constructed from dozens of different metals – including scare metals and ‘rare earth elements’. For these reasons alone, educational technology clearly needs to pay closer attention to the non-renewable material resources and “geophysical reality that make technical media happen” (Parikkka 2015, p.13).

Aside from these material origins, the production of digital artefacts and devices is a similarly environmentally destructive process. For example, it estimated that between 70 to 80 percent of energy expended during the life-time of a laptop occurs during its initial manufacture rather than its eventual use (Greenpeace 2017). As illustrated in Crawford and Joler’s (2018, n.p) forensic insight into the lifecycle of the Amazon Echo device, the production of digital hardware “requires a vast planetary network” to facilitate the smelting, processing and mixing of raw materials which are then shipped halfway around the world to be assembled. Each of these stages involves the production (and disposal) of further toxic waste products. As Bhowmik (2019) reasons, we need to better acknowledge the ‘messy primitive’ ways in which digital technologies come into being – replete with chemicals, minerals, metals. There is nothing ‘virtual’ or ‘artificial’ about digital technology.

Further energy expenditure results from the data infrastructures that facilitate the use of these devices. Behind the ephemeral notion of ‘the cloud’ and ‘trace data’ are the material realities of data processing and data storage in the form of energy-greedy climate controlled data-centres and server farms that require substantial amounts of power and water to function (Thylstrup 2019). It is reckoned that internet usage accounts for around 8 percent of total energy consumption in the UK, with two internet searches generating equivalent amounts of carbon dioxide as boiling a kettle (Shalini & Prasanthi 2013). Similarly, training a typical machine learning model is

estimated to emit the equivalent of around 300,000 kg of carbon dioxide - comparable to the lifetime carbon emissions of five cars (Strubell et al. 2019). All told, digital education is founded on a technology industry that has an 'explosive' footprint in terms of global greenhouse gas emissions – a trend that is set to increase in an 'alarming' manner over the next few decades (Belkhir and Elmeligi 2018).

Also to be taken into consideration are the considerable environmental costs of dismantling and disposing devices and other hardware once they have outlived their usefulness. The growing problem of 'e-waste' resulting from discarded hardware has been well-noted, with the recycling (and what is often more accurately described as dumping) of devices leading to heightened levels of pollution, contamination, and toxic waste in some of the poorest regions of the world (Gabrys 2011). In stark contrast to rhetoric of 'greening' the operation of education through increased technology use, advocates of educational technology need to face the fact that "consumer electronics and other digital technologies are made in ways that cause some of the worst environmental disasters of our time" (Maxwell and Miller 2020, n.p).

REIMAGINGING ED-TECH FOR TIMES OF ENVIRONMENTAL CRISIS

So, what does it mean if we anticipate educational technology as exacerbating (rather than ameliorating) the ongoing environmental instability of the earth? Most obviously, perhaps it might be concluded that assumptions of abundant, excessive and 'always on' forms of technology use in education look wholly unsustainable. Moreover, it seems difficult to continue imagining there being sufficient natural resources to produce and sustain the use of digital technologies on the scales that we have become accustomed to. Instead, it makes sense to reimagine educational technology in ways that immediately decrease (and eventually negate) these environmental demands.

As an area of 'non-knowledge', it does not matter how convincing one personally finds these arguments to be. Put simply, we have no way of knowing how these issues will play out in the future – although this should not preclude engaging with such scenarios and anticipating their consequences. Of course, these issues are not unique to the educational use of digital technologies. Clearly, these risks relate to digital technology use across all areas of society. Yet, while not solely culpable, education can be used to lead the way for technology-readjustment in other sectors. Given the field's ambitions to act in a positive enriching manner, this is perhaps an area of societal improvement where educational technology can take a lead in facing the fact that "simply put, the technologies we want and use are part of the industrial problem that is warming and polluting the planet" (Greenwood & Hougham 2015, p.106).

So, what might now be done? In all likelihood, the most likely response is that everybody carries on as before. It is likely that most readers are already cognisant of the issues and connections raised in this article so far. More pointedly, it is likely that most readers have already tried and failed to act on these arguments before. After all, what can one *really* do? These are huge planetary issues and multi-billion-dollar geo-political flows that reach well beyond the purview of individual educators or academics. The associations between a classroom full of iPads and a 3.2 million-hectare wildfire raging across Brazil and Bolivia can understandably seem as unactionable as they are intangible.

If any response comes to mind, then it is likely to take the form of the basic practical adjustments that might be made to the ways in which digital technologies are used. For example, current good practice for any educator or institution would include adopting EPEAT (Electronic Product Environmental Assessment Tool) standards when purchasing new devices, turning devices off when not in use, reducing use of cloud-based services and data-storage, and recycling old devices. Yet, these minor actions of environmental citizenship are unlikely to make significant impacts on the issues outlined above. More significantly, it is a mistake to frame the entwined relationship between educational technology and environmental instability primarily in terms of the individual 'consumer' as a locus of change. It will take a lot more than altered individual behaviours to address these issues.

As such, perhaps more helpful in the short term to recognise that there are no 'easy wins' or 'quick fixes'. Instead, the distinction needs to be established between anticipating environmental instability as a problem and as a predicament (Greer 2008). In other words, environmental degradation associated with digital technology use in education is not a problem (that can be solved), but is a predicament (that has to be handled and that we might be able to come to live with). All of the issues just outlined cannot be simply addressed and eventually solved. In contrast to the usual ed-tech mindset, these are not challenges to which the expected answer can simply be 'more technology'. Instead, as Keri Facer (2018, n.p.) puts it, the challenge that educational technology practitioners now face "is to learn how to live differently, to live in and with climate change, to mitigate its worst effects, to experiment with the creation of new possibilities".

TOWARD A RADICAL SHIFT IN EDTECH MINDSET – 'EDTECH WITHIN LIMITS'

So, how might the area of educational technology develop alternate approaches that allow us to better manage our reliance on what may well be unsustainable forms of technology consumption? Of course, it is very difficult to raise collective consciousness over environmental dimensions of computing, let alone develop collective responses (Remy *et al.* 2018). Even when people are willing to countenance disruption to future digital technology use, this is commonly imagined in solely personal - rather than collective or societal - terms (Grandi *et al*. 2020). Yet, if

we take the idea of anticipatory futures seriously, then perhaps a wholesale realignment of collective understandings of 'ed-tech' is a wholly sensible response.

At this point, it is helpful to look to the lead being set by the 'Computing Within Limits' movement that is growing throughout academic computer science (Nardi *et al.* 2018). Of course, computing and technology are not traditionally areas of academic and policy discussion that engage with the idea of non-negotiable limits – especially with regards to the material constituents of its products and practices. As such, the idea of 'Computing Within Limits' developed during the 2010s (along with the preceding notion of 'Collapse Informatics' [Tomlinson *et al.* 2011]), to foreground discussions of how to develop modes of computing that might be fit for a resource-constrained world. Extending this approach into an 'Ed-Tech Within Limits' would therefore foreground the need to plan future education technology use with a primary aim of 'coping with finiteness' (Pargman & Wallsten 2017). This implies a complete rethinking of many of the fundamental presumptions of limitless, infinite and replicable technology use that a field such as ed-tech is built around. As just argued, these presumptions are simply not appropriate for a constrained future. Instead, we need to entertain the idea of radically leaner and ecologically-mindful approaches to rethinking how digital technologies might be best deployed (and not deployed) in education.

i) Reconfiguring ed-tech practices

Any notion of 'within limits' implies a fundamental reduction of resource usage, coupled with a renewed focus on social equity and sufficiency (O'Neill *et al.* 2018). In a practical sense, this might prompt us to reimagine patterns of resource procurement and work out ways to break the continual 'churn' cycle of regularly 'upgrading' hardware and software. For example, IT industry actors can be pushed into better durability for their products – boosting the quality of manufacturing processes, supply chains and working standards. Products can be designed on a modular and disassemblable basis. At the same time, schools, universities and educational institutions can develop cultures of procuring refurbished and reconditioned hardware, as well as developing in-house capacity to repair and refurbish technology.

This suggests breaking the cycle of 'planned' obsolescence of technologies every two to four years to an ethos of 'planned improvement' and design for efficient longevity (Satyro *et al*. 2018). Establishing local cultures of 'right to repair' and 'technological care' can extend the life-cycle of technological systems and artefacts, and assert local control over what are otherwise configured as globally-produced and corporately-controlled technologies (Houston and Jackson 2017). Imbuing ed-tech with a spirit of improvisation, maintenance and reconstruction can also extend to issues of energy and connectivity. This might involve encouraging 'DIY resilient' computing infrastructures being established and maintained within educational settings – e.g. community-based internet networks, long-range Wi-Fi and other forms of low-tech connectivity. It also makes sense to support cultures of developing and

maintaining DIY energy sources – for example, following the establishment of 'alt-energy' grids such as community power banks (Bhowmik 2019).

Such reconfigurations would certainly push us beyond the privileging of individual users, and seek to re-establish technology use in education as a shared and communal activity. In contrast to expectations of 'one-to-one' or 'bring-your-own-technologies', schools and universities might deliberately establish conditions of 'many people to one device'. This might involve a commons approach to device ownership and management – ensuring that issues such as technology procurement, usage, and eventual disposal are governed by processes of collective choice and communal decision-making (Franquesa & Navarro 2018). This spirit of democratic oversight might also extend to decisions of when technology is used and not used – ensuring that educational technologies are directed toward genuinely essential activities, or instances of clear educational 'added value'. Conversely, collective decisions can be made where technological abstinence might be a preferred pedagogic strategy (Greenwood & Hougham 2015). All told, educational technology use does not have to be an 'always on' default mode of engaging with education.

ii) Reconfiguring ed-tech priorities

Establishing cultures of sustainable and scarcity-aware technology use raises the need to properly deliberate which uses any technologies might be most appropriately put. This implies establishing modes of democratic decision-making regarding which technology uses are considered expendable and which are 'non-negotiable' – i.e. technology uses that merit continuing to be fundamental elements of contemporary education (Bates *et al*. 2015). In this sense, very few current forms of technology use in education might be considered unequivocally essential. Instead, plenty of current ed-tech practices might be judged extraneous, excessive or simply of marginal benefit. This raises an ongoing challenge of paring ed-tech back to its essentials – i.e. the elements of technology use that genuinely support forms of learning and teaching that otherwise would not be possible, or at the very least clearly 'add value'. As such, these shifts in practice require a fundamental cultural change across education in most industrialised regions. Indeed, the excessive ways that digital technologies are currently being used are part-and-parcel of a current 'amped-up' culture of learning that prevails in many education systems (Greenwood & Hougham 2015, p.98). As such, a broader shift in mindset might well involve rediscovering modes of 'simple learning' (Håkansson & Sengers 2014) or what Payne and Wattchow (2009) term 'slow pedagogy'.

The nature of these decisions depends on the catastrophic nature of the climate futures that we are anticipating. In light of the broader interconnected crises that accompanying environmental instability, it might well be that the most necessary and 'non-negotiable' forms of educational technology are those that support the most vulnerable populations for whom 'conventional' education has been disrupted (perhaps temporarily) or even completely discontinued. For example, it makes sense to anticipate the increased frequency of climate-related disasters that necessitate

emergency forms of educational provision for displaced and unsettled populations which no longer have access to their usual schools, universities and other educational institutions. These logics might increasingly shape education provision in light of climate-related crises throughout the 2020s – from extreme weather-related disasters, climate migration, food shortages, health, economic and political destabilization. As such, a new emergency paradigm of educational technology might need to be imagined that is both wholly sustainable and targeted toward the most deprived populations. Particular attention needs to be paid to concerns raised in the environmental justice literature (Bullard 2005, Taylor 2014) – for example, establishing forms of emergency ed-tech that cater for the needs of already marginalised and vulnerable social groups that are most likely to be impacted most by any disruption to basic public services such as education.

iii) Reconfiguring ed-tech values

Above and beyond any specific actions and practices, the idea of 'Ed-Tech Within Limits' implies a fundamental shift in values. In particular, it raises the question of what 'better' means in terms of educational technology over the next few decades. Here, then, it seems reasonable to expect that 'better' no longer equates with a continuation of exponential developments of previous forms of ed-tech innovation. As suggested in the examples just outlined, this might require the rehabilitation of old ideas (such as a return to DIY resiliency, and memory-constrained 'lean' programming), while also remaining open to the 'utopian imagining' of other emergent realities. Of course, this all involves making normative decisions about what we value as 'desirable', 'good' and what is 'worthy' (Amsler & Facer 2017). In this sense, the idea of an Ed-Tech Within Limits inevitably "raises questions about what kind of 'good society' and good politics, with technology, we want, and urges us to reflect further about how we want to take responsibility for it" (Coeckelbergh 2018, p.8).

So far, then, this paper has advocated implicitly for a conscious move away from seeing educational technology in terms of individual benefits, and instead toward collective engagement and responsibilities. As Hes and Du Plessis (2014, p.131) put it, this involves rethinking educational technology "in terms of systems and relationships" with "humans as coevolutionary partners with nature". This is not an easy (or natural) shift to make when thinking about digital technology. As Coeckelbergh (2018) reasons, even discussions about technology and 'social good' tend to be based around individualist approaches and assumptions. Instead, the idea of 'Ed-Tech Within Limits' involves the integration of new values when thinking about educational technology that move beyond aspirations of efficiency as our primary logic, and instead seek to integrate sustainable worldviews into ed-tech narratives and processes. These might include values of inclusivity, collectivity, mutuality, positive reciprocity, humility, and non-attachment. These might also include recognition of the integrity of wider systems, and balancing processes of recovery and regeneration with more familiar ambitions of transformation and empowerment. All told, this involves the mainstream embracing of values that hitherto have long been marginalised in ed-tech thinking.

CONCLUSIONS

Such a volte face in how we imagine and approach ed-tech might appear unrealistic, yet the educational responses to the COVID pandemic highlighted how any notion of the status quo can be disrupted and alternative arrangements be mobilised at short notice. As Steve Matthewman (2020, n.p) puts it, COVID made it clear that "current power structures are nowhere near as robust as is commonly thought". Moreover, this paper is not written as a prediction about a future that readers need to wholly agree or disagree with. Instead, in light of Beck's notion of 'non-knowledge', no-one can plausibly claim to know with any certainty what environmental impacts might result from simply carrying on with abundant forms of ed-tech. As reasoned at the beginning of this paper, we can only anticipate, and then act if this might be correct.

The main intention of this paper has simply been to provoke the field of educational technology to move beyond a residual complacency when it comes to the ongoing environmental crisis. It is important to note that the points raised in this paper are not intended to attribute any sense of blame for the increasingly harmful conations of continued educational technology use. Yet, environmental instability and the ensuing climate crisis is neither something that can be wholly ignored, or gleefully approached as a further challenge that can be 'solved' through the greening power of digital technology. Instead, this is something that demands an immediate epistemological 'reboot' of ed-tech along a number of key lines. This includes the field of educational technology being reimagined in more relational and reflexive terms – in other words, as bound up with larger forces. This also includes the field of educational technology being refocused away from the hubris of a techno-solutionist mindset, and instead approaching the future in a more humble manner as uncertain, unknowable and fundamentally unsolvable. Perhaps, most important, is the ability to reimagine educational technology as a focus for collective action rather than individual gain.

All told, this paper is primarily an initial call for those working in the area of ed-tech to broaden our ideas, assumptions and agendas regarding the future of this field. The arguments rehearsed in this paper bring educational technology into dialogue with broader ideas of 'degrowth' and 'voluntary simplicity' – issues that are beginning to be acknowledged by other education and technology commentators (e.g. Macgilchrist *et al.* 2020, Jones 2021). Some of these shifts have precedents in the practical strategies used to sustain educational technology use in resource-limited Global South contexts (see Gallagher 2019). Yet, environmental instability is a risk that is already universally encountered and shared. These are not localised issues only experienced by certain regions and specific populations.

It is important to set about any reimagining of an 'Ed-Tech Within Limits' as a positive and generative development, rather than simply a defeatist gesture of having "given up and are merely navigating to a more comfortable demise" (Mann *et al.* 2018, p.2). Fashioning 'sustainable' versions of ed-tech should not be pursued in

the hope of keeping current abundant forms going for as long as possible (i.e. preserving weak and impoverished forms of what we already have). Instead, this is a call for 'sustainability' in the regenerative sense of "co-evolving and co-creating society, where technology and eco-systems support both humanity and the natural environment … transitioning away from harmful forms [of technology development]" (Mann *et al*. 2018, p.2). In light of what are unknowable futures, this uncertainty can be used as a basis for thinking differently (but not despondently) about what to be doing at the present time. We can no longer presume technology in education to be an abundant and limitless resource. We need to be proactively limited in our ambitions for the educational use of digital technologies.

The 2020s should be a time when we become more comfortable with ideas and agendas that have previously not featured in popular ed-tech thinking. For example, these include engaging generatively with ideas of media abstention and resistance, digital disconnection, and restrained modes of digital engagement. Writers exploring these issues outside of education highlight that these need to be seen as collective - rather than individual – undertakings, and can act as a powerful basis for collective action and change (Syvertsen 2017, Steinmaurer & Atteneder 2019, Kaun & Treré 2020). Such a shift in mindset might not be as unrealistic as some readers might presume. As has been noted elsewhere, the past few years have seen a burgeoning appetite for engaging critically with hitherto dominant forms of educational technology provision and practice – building on from a wider societal 'tech-lash' driven by widely-held public suspicions of 'big tech' companies and their activities (see Selwyn 2021, Williamson 2019). With doubts now being raised about ed-tech in terms of data privacy, surveillance, commercial influence, and similar, it is important that concerns over environmental sustainability are also given due prominence as we begin to reimagine the future forms that digital technology might usefully take over the 2020s and beyond.

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