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Educational unsustainability in sub-Saharan Africa: in search of counter-narratives to policy pressures and exponential tech growth

Author

Michael Gallagher is a Lecturer in Digital Education in Development Contexts. He works on the Near Futures Teaching project, a project that explores how teaching at The University of Edinburgh unfold over the coming decades, as technology, social trends, patterns of mobility, new methods and new media continue to shift what it means to be at university. Michael works in digital education in development contexts in collaboration with INGOs and universities largely in South Asia and sub-Saharan Africa. His research focuses on educational mobilities, how technology structures and manages these mobilities, and the impact of these movements on local knowledge practices and communities. Further to work on mobile and digital education, Michael has a research and professional focus on ICT4D and is currently working on projects related to digital education and mobile learning in Cambodia, Kenya, Nepal, Nigeria, Tanzania, Turkey, and Uganda.

Dr Michael Gallagher
Centre for Research in Digital Education
2.02 Simon Laurie House
Moray House School of Education,
University of Edinburgh, UK
michael.s.gallagher@ed.ac.uk

Abstract

The educational systems of sub-Saharan Africa have become increasingly entangled in a network of global actors: supranational and national policy, non-government organisations (NGOs), funders, and commercial organizations wanting to capitalize on perceived gaps in local capacity. Education is being renegotiated through an explicit, inexorable link to technology, an explicit call to rapidly construct technological markets for education throughout sub-Saharan Africa, and an implicit erosion of local educational autonomy as a result. This research interrogates commercialised edtech policy in sub-Saharan Africa and explores its effects on how educational infrastructure is being built and imagined in higher education. This obscures local context and educational practice with a global, marketized and standardised new 'normal' which carries with it considerable ecological implications. There is an explicit need for a rethinking of local educational autonomy in face of policy pressures which are stimulating a largely unsustainable acceleration of educational technology.

This paper seeks to interrogate what methods exist for adaptation of policy targets and the creation of autonomous spaces for deliberation and adaptation consistent with horizontalism, including participatory approaches, degrowth approaches, rights to repair, and community-owned technologies. Without this, the acceleration of edtech, e-waste, and the global imaginaries of digital education are likely to continue.

Introduction

In much of sub-Saharan Africa (SSA), growth-based models of international development are increasingly at odds with sustainability and sustainable education. There is a need to revisit 'agency of non-human matter and the need to revisit questions of human subjectivity in light of ecological crisis, contemporary geopolitics and technological shift' (Bayne 2018). As discussed in Gallagher (2019 In Review), this is partly due to the increasing entanglements of supranational policy pressure (Grek 2009, p.24), the ambitious educational targets of the Sustainable Development Goals (SDGs), the work of civil society organizations, non-government organisations (NGOs), and the increasing presence and autonomy of commercial actors in shaping local educational agendas.

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Increasingly, and particularly in the Global South, national educational policy is tasked with a massive scaling of educational provision and increasingly proscriptive calls for more technology to satisfy that scaling in keeping with SDG 4[1] which calls on member states to "ensure inclusive and equitable quality education and promote lifelong opportunities for all" by the year 2030 (UN 2016). Several targets within this goal and the indicators associated with these targets are powerfully proscriptive for how digital education is realised in the Global South.

These educational contexts are becoming increasingly bound in a network of actors-policy, NGOs, INGOs, global educational actors like the Programme for International Student Assessment (PISA and PISA-D), and commercial organizations wanting to capitalize on these gaps in local capacity. Being bound in these global networks carries with it a 'massive defuturing effect, which negates places, regions, and countries the possibility of multiple futures' (Escobar 2019, p. 1). In becoming increasingly adherent to the 'global' educational economy, the 'local' of the Global South is becoming normalised and its multiple futures muted. Its emphasis shifts from local educational practice and ecologies to global compliance.

What is fueled in this negation of the local beyond an erosion of local educational practice and autonomy (Gallagher 2019 In Review) is an unsustainable and ultimately ecologically damaging educational context. The educational targets of SDG 4 accelerate a massive influx of technology and a redesigning of local pedagogy towards global indicators like PISA and other supranational policy pressures. The scale of technology influx is mirrored to some degree in local patterns of technological consumption, particularly in sub-Saharan Africa. The number of new subscribers to mobile services (largely the gateway for access to social services, including education) is expected to be 165 million by 2025; smartphone adoption is expected to rise from 36% in 2018 to 66% in that same span (GSMA 2019). Data is being consumed at dramatically increased rates throughout sub-Saharan Africa (SSA) increasing from 1.1 GB of data per subscriber per month in 2018 to an expected 8.5 in 2024.

This technological expansion has significant material implications. The material of digital education is becoming increasingly concentrated in SSA in e-waste sites like the infamous Agbogbloshie in Ghana (detailed, among other African e-waste sites in Asante et al 2019), with clear ecological and health concerns (Daum et al 2017). Paradoxically, the address of e-waste is an explicit focus of SDG Goal 3 (Good health and Well-being), Goal 6 (Clean water and Sanitation), Goal 8 (Decent Work and Economic Growth), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), and Goal 14 (Life Below Water) (ITU 2017). The waste of technological expansion makes fulfilling these goals difficult.

Rather than scaling up, technological alternatives exist for education in local contexts if development is decoupled from growth-based models. These alternatives are predicated on local educational autonomy, participatory processes, and value-based technological design, which this paper will present as a possible antidote to the accelerating ecological crisis emerging globally, and particularly in sub-Saharan Africa.

The work of education needs to focus on the impact 'of specific practices and assemblages of the human and non-human' (Edwards, 2010, p. 9) on shaping these educational contexts, how these can be redesigned to address the ecological unsustainability of technological consumption, and to present new narratives of sustainable technology use in education. This is especially critical in imagining the 'new' local that this paper purports to explore.

Ceding Local Educational Autonomy
It is important to note that this paper acknowledges that the SDGs, and their predecessors the Millennium Development Goals (MDGs), are inexorably entangled in an increasingly sophisticated landscape of educational policy, supranational policy pressures and increasingly influential global models of educational

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[1] https://sustainabledevelopment.un.org/sdg4

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governance like PISA and PISA-D. While the SDGs deserve scrutiny, and indeed this research attempts to add to a growing body of critique around them, they have merit. Although largely in its infancy (ratified in 2015), the SDGs have significantly contributed to widening participation in formal education across traditionally disadvantaged groups at primary, secondary, and tertiary levels. Their significant value, despite the critiques presented in this and further research, remains.

However, many of the targets and associated indicators of Sustainable Development Goal 4 are largely focused on mass efforts of education and serve to erode the local contexts of education through their execution. First though, we must look at the language itself. SDG 4 is designed to "ensure inclusive and equitable quality education and promote lifelong opportunities for all" by the year 2030 (UN 2016). Several targets within SDG 4 and the indicators associated with these targets are proscriptive for how education is envisioned, and how technology is increasingly positioned as a means of achieving that vision.

Massification is explicit in many of these targets ("access for all", "all learners", "substantially expand", "substantially increase" "mainstreamed" and so forth), suggesting again the need for at scale educational provisions consistent with the prior widening participation discussion. All require significant structural reconfiguration to ensure success: 4.3 requires a significant and gender equitable increase in participation; 4.7 suggests a significant curricular redesign and expansion; and 4.c suggests a significant increase in enrolments in teacher training programmes. Taken together, they represent a massification effort, and serve to contribute to the overwhelming drive to provide 'technical fixes' to the challenges of widening access to higher education (Selwyn 2016, p.37). Education becomes increasingly a digital education to satisfy these scaled efforts.

Additional non-educational actors include international policy instruments which carry with them technological targets that contribute to the tendency towards 'technical fixes' for scaled approaches to education. It is important to note that while most of these instruments have discrete (i.e. context-specific) value they further entangle local educational actors in an increasingly supranational policy system. Further examples include the Sendai Framework for Disaster Risk Reduction, whose targets include the promotion of 'real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data' (UNDRR 2015, p.15). The New Urban Framework in its call for 'encouraging urban-rural interactions and connectivity by strengthening sustainable transport and mobility, and technology and communications networks and infrastructure' (Habitat III 2017, p.15), and UNESCO even more explicitly forwarding 'the role that such technology can play to accelerate progress' towards the SDG 4 (UNESCO 2019).

Codified in the Qingdao Declaration, the links between the educational targets in SDG 4 and the role technology plays in servicing them are explicit: 'To achieve the goal of inclusive and equitable quality education and lifelong learning by 2030, ICT–including mobile learning – must be harnessed to strengthen education systems, knowledge dissemination, information access, quality and effective learning, and more efficient service provision' (UNESCO 2015, p.3. The UN itself is explicit as well: "Given the diverse, multidimensional, ambitious and absolute nature of the Sustainable Development Goals, it will be practically impossible to achieve all of them by 2030 without the development and appropriate application of science, technology and innovation" (UNCTAD 2019, p.2). Education and technology have become inexorably linked in broader policy contexts.

Education quality: a measure of economic prosperity?
The scaled targets and related international policy entanglements are linked to an accreditation and compliance global network with significant capacity for reshaping local educational agendas, curricula, and practice. There are global (largely Global North) bodies of accreditation and compliance that further cede local educational autonomy largely in the interests of international curricular and performance comparison: the Programme for International Student Assessment (PISA), the International Association for the

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Evaluation of Educational Achievement (IEA), the Trends in International Mathematics and Science Study (TIMSS), and the Programme for the International Assessment of Adult Competencies are but a few, although PISA's influence as 'as the main engine in the global accountability juggernaut' (Meyer and Benavot 2013, p.9). Despite critique around the cultural interoperability of PISA metrics (Unterhalter 2017), its explicit endorsement by the Organization for Economic Co-operation and Development (OECD) as the world's 'premier yardstick of education quality' and championing by the World Bank (Auld et al 2019) as a means of achieving some measure of economic prosperity have further reinforced the scaled educational efforts of SDG 4.

Predictably more public private partnerships are sought to achieve educational scale, particularly commercial actors: digital education platforms, mobile telecoms, internet service providers, hardware and software manufacturers, and more all are bound in an entanglement which has direct impact on the for-profit educational organisations creating and occupying the new markets created by these public private partnerships. Perhaps this is best typified by Bridge International Academies, a for-profit education company designing low-cost schooling largely in developing nations with an array of technologies and proscriptive teaching, including geolocated devices that map low-income communities, smartphones that automate administrative functions, and computer devices that perform the duties of a teacher (Riep 2017). Teachers employed through these low-cost schools such as Bridge are generally less educated and less compensated than state teachers of the respective national systems.

Beyond the significant critique received from Teachers' Unions and some civil society actors in Kenya, Liberia, and Uganda (The Economist 2018), Bridge International Academies typifies the entanglements that SDG 4 and other supranational policy pressures, accreditation and compliance regimes, and technology are rendering where 'structural power and neoliberal ideologies are glossed over in the SDGs and are being promoted in controversial ways already in developing countries' (Sultana 2018, p.189). Beyond merely shifting the configuration of education towards more 'open' (and therefore more commercially susceptible) systems, the SDGs attempt "to 'liberate' the user from social structure and hierarchy, boosting individual freedoms and reducing centralized controls over what can and what cannot be done" (Selwyn 2016, p.157). Broadly, such Public-Private Partnerships have been called into question, leading to demands for them to be accompanied by a governance framework within which private sector partnerships can be held accountable and transparent, yet technological expansion continues unabated.

Bridge International Academies stands at the intersection of policy, practice, and capital financed as it is by a group including Bill Gates, Mark Zuckerberg, and the World Bank/International Finance Corporation (IFC). The agency of local educational institutions in these technological partnerships is muted with their limited capacities to mediate supranational policy pressures associated with ambitious educational targets and the new markets being created to service them. What is critical here is that this structural power in education is being renegotiated through an explicit, inexorable link to technology, an explicit call to rapidly construct technological markets for education throughout sub-Saharan Africa (Riep 2017), and an implicit erosion of local educational autonomy as a result. Educationally this is highly problematic but ecologically much more so as the next section will attempt to evidence.

Shifts in positions of teaching

This drive linking technology to education in response to SDGs is well underway. There are quite explicit calls for greater links between technology and the SDG goals, that when listed as in the following suggests a break from local educational contexts and the technological providers that are increasingly structuring this new educational context: 'big data; the Internet of things; machine learning; artificial intelligence; robotics; blockchain; three-dimensional printing; biotechnology; nanotechnology; virtual and augmented reality; renewable energy technologies; and satellite and drone technologies' (UNCTAD 2019, p.2). Such a list is emblematic of the sociotechnical imaginaries of Silicon Valley (Weller 2015), rather than an educational approach with fidelity to the particulars of local educational practice.

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The break generated here is couched, predictably, in language pointing to compliance with the targets of the SDGs; it is not difficult to trace a path directly from this rhetoric to the types of educational economy envisioned by Bridge International Academies: 'New digital platforms, including massive open online courses, provide online courses that allow for open access and unlimited participation through the Internet…lower-cost replication of high-quality teaching, content and methods; self-paced learning; and data analytics for optimizing learning on the platform' (UNCTAD, 2019, p. 24). In this position, we see a redefinition of teaching towards a position of 'replication' and 'self-paced learning', a trend to what Biesta refers to as 'learnification', or a reduction of education to matters of learning (Biesta, 2010). It is also a position of education that makes initiatives like Bridge International Academies possible with their use of scripted teaching activities and non-certified teachers. We see many of the same instrumental positions of education that generates data which is then circulated through the global 'digital data economy, available for use by a variety of actors and agencies in ways that are often unknown to the people about whom this information relates' (Lupton and Williamson 2017, p.782).

Education in the Global South is being increasingly redrawn as a minor actor in a larger data economy, propelling further commercial interventions and claims of 'optimizing learning' and acting purportedly as 'a transparent instrument for educational export, keeping curricula, pedagogy, and educational values intact whilst they are broadcast to a global population assumed to be in deficit' (Gallagher and Knox 2019, p.226) .

The increasing ecological impact of education

Beyond these scaled positions of education is a general disassociation of the technology being used in this digital education and its ecological impact. This is an education increasingly driven by technology, suggesting a massive increase of technology to satisfy the massed educational targets of the SDGs. Such an increase generates considerable amounts of waste. Electronic waste (e-waste) or waste electronic and electrical equipment (WEEE) refers to used and end-of-life electronic and electrical products; it is an issue that disproportionately impacts the Global South. It draws further attention to the broader global entanglements of digital education in SSA.

E-waste has two core issues: the volume of computers and related e-waste improperly disposed of in landfills and the toxicity of the components themselves (Hawari and Hassan 2008) which have significant health consequences: Asante et al's (2012) investigation on e-waste recycling workers from perhaps the most notorious e-waste site in Agbogbloshie in Ghana found high levels of arsenic; lead and mercury cause severe contamination in landfills which can spread to ground water resources (Hawari and Hassan 2008). E-waste pollutants are generally not disposed of properly, or they are taken care of by an informal sector and recycled without properly protecting the workers, while emitting the toxins contained in e-waste (Balde et al 2017).

E-waste is complicated by global entanglements of policy and practice. The uptake and shorter replacement cycles of technology are contributing to the global growth of e-waste. Around 50 million tons of e-waste, is being discarded yearly, a figure that is expected to double by 2050; only 20% of e-waste is thought to be recycled (World Economic Forum 2019).

However, the increase of e-waste in SSA is largely not an indigenous issue; it is circulated through the same global entanglements of policy and practice as discussed before. For example, in 2015/2016, EU member states were the origin of around 77% of Used Electric and Electronic Equipment (UEEE) imported into Nigeria (Balde et al 2017). Africa itself produces very little; the lowest amount of e-waste per inhabitant was generated in Africa; this is a number that is set to rapidly accelerate particularly as more technology is incorporated into education, amongst other sectors.

Just as policy serves to accelerate this technological consumption in service of the educational targets of SDG 4, policy also fails to track its outputs of e-waste. A lack of available data makes surfacing these ecological impacts muted. Only 41 countries have official e-waste statistics and 80% of e-waste is largely untracked (Balde et al 2017). This remains, largely, an issue of visibility: narratives of rapidly increasing

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technological consumption are divorced from accompanying and complementary narratives of ecological impact wrought as a result.

These trends are increasingly prevalent in the technologies currently being advanced by INGOs and the commercial sector in response to educational challenges. For example, UNESCO (2019) has lauded blockchain technology as having the potential to *transform* and *innovate,* including education. The UN has incorporated blockchain into giving access for refugees to social services and education (Kshetri and Voas 2018). Yet the global mining system that blockchain technologies depend on requires a vast consumption of electricity, equivalent to that of Austria's, and establishes a significant carbon footprint, equivalent to that of Denmark in its entirety (Truby 2018). The educational potential of such technology use is held in stark contrast to the ecological impact of its materiality.

Yet within this technological consumption are faint signs of promise for a new local that defies the imaginaries of global edtech and policy pressures, particularly in SSA and in emerging economies. The carbon footprint of technology, defined as the full life cycle carbon equivalent emissions and effects from a particular product (Malmodin and Lundén 2018), is shifting away from older hardware and bespoke solutions to centralised app-based platforms and more energy efficient mobile technologies. As such, the carbon footprint of ICT itself (including hardware, telecommunications centres, data centres, enterprise centres, and more) peaked at 2010 globally and has been decreasing since then, despite increased data consumption consistent with steaming services (2018).

ICT growth overall is constrained largely as a result of a 'persistent energy crisis' in SSA where energy consumption is considerably lower than the global average (Akinyemi et al 2015). Yet this energy crisis has contributed to the growth of mobile technology adoption through SSA and sustainable technological approaches to development. This includes solar power grid installations (Mekonnen and Sarway 2017), particularly for supplying mobile technologies (Max and Berman 2018). M-Kopa Solar and other 'pay-as-you-go providers of solar home systems, catering to low-income, off-grid' (Rastogi 2018, p.93) communities are emerging across SSA. The significant penetration of mobile technologies, the natural constraints of limited energy assets, and the increasingly sustainable ingenuity around ICT as a result of these constraints has generated the potential for a new local, or a counter-narrative to exponential tech-growth.

Alternative Digital Futures: Horizontalism
Technological alternatives exist for a 'new' local but only if the local is decoupled from growth-based models of development and allowed to "radiate out" horizontalism, rather than scaling-up" (Escobar 2019). These alternatives, as this section will attempt to illustrate, are predicated on local educational autonomy, participatory processes, and value-based technological design. They are nominally bound in degrowth models of educational development, or education that services 'an equitable downscaling of production and consumption that increases human well-being and enhances ecological conditions at the local and global level' (Schneider et al, 2010, p.511).

As such, we are presented with two objectives to envision alternative (digital) educational futures. First, a resistance to normalisation that the use of the term horizontalism suggests in this context. Second a degrowth-based model for use of digital in education. Horizontalism refers to positions of society that emphasise networks rather than hierarchical societal structures. Emerging from the sociotechnical developments of the 1960s, it involved a view of society as a series of networks, where both 'networked power' and 'networked resistance' (Davies 2012) can co-exist. More recent manifestations include grassroots mobilisation efforts in Argentina where 'thousands of middle class and recently declassed urban dwellers [...] have organized themselves into neighborhood assemblies' (Sitrin 2007) as well as many of the Occupy movements (see Ancelovici 2016). Horizontalism is increasingly and predictably coalesced around the digital in both networked power and networked resistance arrangements (Chadwick and Dennis 2017). It is not without considerable critique. Wood (2010) notes that diffusion in horizontalism - the acceptance of some specific item, over time, by individuals, groups, communities - requires time and autonomy for

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deliberation and adaptation. Markus (2012) notes that horizontalism will struggle to establish spaces of autonomous deliberation if it cannot, paradoxically, 'formulate a larger vision for a society', suggesting tension between the local and the 'global.'

Horizontalism as positioned here suggests a series of diverse and dynamic spaces networked, but not necessarily normalising. That is, the local educational networks of Lagos needn't normalise with the educational practices of Kampala and neither should necessarily normalise with the 'global' indicators of PISA. Deliberation and adaptation, rather, become the hallmarks of radiating an educational horizontalism. Such approaches explicitly foreground participatory approaches, explicitly foreground diversity in evaluating educational systems, and explicitly foreground resistance to 'standardized definitions of worthwhile skills and knowledge that are measurable and common for developing countries' that PISA-D purports to advance as '"benchmarks" and objective measures of quality by both donors and national authorities' (Sjøberg 2015, p.124). Without this autonomy to diversify, deliberate, adapt, and ultimately resist, many of the participatory processes described in the following sections are immediately compromised.

Alternative Digital Futures: Degrowth
The second objective to envision alternative educational futures is a degrowth-based adoption and adaptation approach of the digital for education. Some have argued that degrowth requires limits to technologies (Samerski 2018) while other degrowth communities define themselves around particular technologies (Kerschner et al 2018): the Fairphone (Haucke 2018), makerspaces and fab labs (Kostakis et al 2018) and even the recycling and reuse communities emerging around the e-waste discussed prior (Vallauri 2009). What a degrowth position provides here is an alternative to the growth-based targets of the SDGs and the entanglements of global actors positioning themselves to meet these targets.

Technologically, it is instructive in that it allows for scrutiny and selectivity by local educational systems in regards their technological acquisition; selectivity and scrutiny that is largely absent from the directives of policy and strategy documents and their assertions that 'information and communication technologies (ICTs) *must* be harnessed to strengthen education systems, knowledge dissemination, information access, quality and effective learning, and more effective service provision' (UNESCO 2015, p.8). 'Must' becomes 'might' in a degrowth model dedicated to a 'voluntary societal shrinking of production and consumption aimed at social and ecological sustainability' (Demaria et al 2013, p.192). Again, without autonomy, the possibility of digital educational degrowth is severely compromised.

Radiating out Horizontalism: Local practices
Controls on technological acquisition alone is not enough for a degrowth model; 'agencies' take shape in the social and that is largely where I draw your attention in this paper.

> [...] agency is always contained within practices, and that being so, agencies take shape, and are shaped by, social practices. It is important to note here that change to a degrowth society must also reside in social practices rather than merely in the structures or values of agents. What counts is the change in practice' (Heikkurinen 2018, p.1657).

I would argue, however, that the agencies taking shape in the current educational systems outlined in this paper are largely structural (from SDGs to national educational policy to INGO reports to commercial technological intrusion) and largely disadvantageous to the agencies of the local educational environment. Without a decoupling from the constraints of these supranational policy pressures, the agency of the local will remain impoverished. Yet, Heikkurinen's position remains true; that there is a parallel need to change (educational) practice, to build in time and space for deliberation and adaptation that suggest the increasing importance of participatory models of technological and educational design.

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Despite the advantages of participatory technological and educational approaches in realising this horizontalism, their use in technological design is not unproblematic; 'participatory researchers are perhaps traumatized by the constant battle to confront technological deterministic views… and may choose to deemphasize the role of ICT' (Bentley et al 2019, p. 491). The commercial and policy imaginaries of technology use in education often travel far ahead of the collective and participatory imagination rooted in local application. How technology is used in education in Dar es Salaam or Dhaka is at least partially framed in Washington, D.C.; London, Paris, Silicon Valley, and increasingly Beijing. For many, this will lend itself, as Bentley et al suggest, to de-emphasise technology in their design processes.

Yet diverse participatory practices remain, and they are at the heart of what is being proposed as an alternative to ceding of local educational autonomy to supranational actors. Okon (2014) in research on rural Nigerian communities and their use of technology suggests a context-driven approach to enable communities to define the parameters of use and meaning of ICT themselves. Yoon (2003 and 2006) interrogates the processes of deliberation and adaptation in South Korea as technology is 'retraditionalised' in ways that often defies the global attempts to 'liberate' the user from social structure and hierarchy' (Selwyn 2016, p. 157). As Yoon suggests in the South Korean context, quite the opposite is true; the technology is remade and imbued with local practices.

Tenhunen (2018, p.155) explores mobile phone use in rural India, drawing particular attention to the diversity of practices between rural and urban communities; this diversity is instruction for horizontalism as well in establishing how the 'local' might represent a composite of networks. Tenhunen also notes that 'purchasing digital technology has become a significant symbolic act through which people can seek to improve their position and challenge hierarchies', particularly for disadvantaged caste groups. The act of acquiring the technology becomes a social practice itself.

King et al (2019, p.286) explore the specific ICT practices of Timor and how they intersect (and are partly produced by) the influences of infrastructure, family, literacies and the colonial legacy to denote 'individual's engagement within the particular forms of constraint and opportunity that exemplify life for many in countries of the Global South.' Technological agency and horizontalism exists, however constrained, defying and disrupting the normalising rhetoric of global digital education discourse.

Might this agency and horizontalism be fostered through the creation of autonomous spaces of deliberation, adaptation, and design? Might technology be 'reoriented towards convivial societies through deglobalizing and re-futuring co-design transition strategies" (Escobar 2019, p.3) consistent with the degrowth approaches suggested in this paper, ones countering the technological acceleration that policy pressures stimulate? The answer to these questions is a qualified yes. Escobar's *re-futuring* in this context is dependent on some measure of *release* from policy pressure along with participatory models of deliberation and adaptation.

Participatory Design Models
Participatory design models are critical to this process for a variety of reasons. First, they are explicit about the autonomy of the locales participating to define challenges and enact responses. These models provide capacity to deliberate and adapt in locally appropriate ways without normalising to a globalised imaginary. Typifying this participatory technological space are Dearden and Haider Rizvi (2015) exploring participatory design in the ICT4D context; Sultana et al (2018) for designing technology for women in Bangladesh; and Arevian et al (2018) exploration of participatory design models for co-creating mobile health applications. Nemer (2015), and Bentley et al's (2017) use of photography to stimulate participatory exploration of the technological practices of favela residents in Brazil is instructive here in providing capacity to surface both existing technological practices of the favela residents and the technological installations themselves (mesh networks, for example). Such participatory methods surface technologies and contextually specific practices which begin to define the local in response to the global.

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Participatory design models are not free from critique, suffering as they do from promoting 'functional or instrumental values' and failing to directly address values of 'moral import, such as privacy or autonomy' (Manders-Huits and van den Hoven 2009, p.55), yet they are values-based, because of their commitment to a collective shaping of a particular future (Van der Velden and Mortberg 2015, p.1).

Moreover, participatory design models through this collective shaping of a particular future are advancing counter-narratives to global largely homogenized edtech imaginaries. They provide a design narrative capturing accounts of 'the history and evolution of a design over time, including the research context, the tools and activities designed and the results of users' interactions with these' as well as 'the path leading to educational innovation, not just its final form' (Mor et al 2012, p.164). The collective memory is sustained in the design narrative. Beyond merely employing participatory models in both education and technology towards functional objectives or responses to challenges of local importance, this research suggests that participatory design models provide the narratives that locally responsive models of digital education are sustained, both rhetorically (resisting global edtech discourse and calls for increasingly scaled targets), and ecologically (providing space to deliberate and adapt in locally meaningful ways).

Okon (2014) call for a context-driven approach to allow communities to define the parameters of use and meaning of ICTs for themselves through some approximation of participatory design is instructive here. We should note how this approach stands in contrast to the deliberate narratives around Open Educational Resources (OER) (Ferreira and Lemgruber 2019) and Massive Online Open Courses (MOOCs) (Adams 2019) and their capacity to end a worldwide 'crisis' in education by broadcasting to a 'global population assumed to be in deficit' (Gallagher and Knox 2019). Indeed, as Wolfenden and Adinolfi (2019) suggest, the local educational agency that might exist in OER use sits in their deliberation and adaptation by local educational actors. In the horizontalist positions advanced in this paper, communities define their own digital education parameters through participatory design.

The right to repair
The right to repair is critical to both participatory design, adaptation, and deliberation. Repair in this context refers to 'the creative, resourceful, and improvisational work of getting technological systems and artifacts working and keeping them going long beyond their initial points of adoption' (Houston and Jackson 2017, p.200). Research has shown how repair cultures contribute to the building of appropriate and resilient infrastructures particularly important in resource-constrained and ecologically fragile contexts (Ahmed et al 2015 exploring Bangladeshi repair workers and Jackson et al 2012 work on Namibian repair workers are representative here). Broadly, repair studies draw attention to larger processes of valuation, breakdown, and e-waste.

It also surfaces practices of care and repair that sit comfortably within these new locals of digital education. 'Care as an object of study draws our focus beyond the functional, toward a range of affective connections, attachments, and commitments that may shape and give meaning to the work of providing for, protecting, and maintaining sociomaterial worlds' (Houston and Jackson 2017, p.201). The participatory design models presented earlier surface these connections of care and repair and foreground their importance to creating localised responses to the accelerating import of 'global' technologies. The general lack of rights to repair merely protects 'the power and prestige of (distant) global manufacturers over the interests of (local) users, extending proprietary privilege and control well beyond the point of sale' (Houston and Jackson 2017, p.210). The right to deliberation and adaptation are bound in these rights to repair, as are the implications for transitions into 'green technologies' (Suh et al 2017) and their promotion of circular economy models that seek to mitigate the effects of e-waste: recycling and reuse of technology are core to these movements (Balde et al 2017).

Trans-national arrays and grass-root driven transitions
Ultimately, participatory models; rights to and cultures of repair; providing autonomous spaces for deliberation and adaptation; and the surfacing of local educational and technological practices on which to

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rest new imaginaries of digital education provide a framework on which to explore horizontalism. Yet they are constrained by the same supranational policy pressures and subsequent global edtech acceleration explored in this paper, suggesting an additional need for a *release* from or *reinterpretation* of global educational policy targets through deliberation and adaptation. Yet this *release* is unlikely in the current geopolitical climate; global policy pressures leading to an acceleration of 'global' edtech acquisition (and subsequent e-waste) continues unabated fueled in part by the imaginaries of scaled education and edtech's role in servicing that scale.

Yet horizontalism offers an alternative to that imaginary. 'If the world is a web of radical interdependence, it follows that all local, place-based, and communal struggles are already interconnected, even if they might not know it. There is no "scaling up" to be achieved because there is no "up" to be found. We need to imagine a different politics consistent with this deeply relational vantage point' (Escobar 2019, p.00). We need to do this in ways 'framed not only within oppositional pairings such as 'global' versus 'local', but which elucidate how binaries themselves are constituted through far-flung trans-national arrays of sociomaterial practice' (Henry et al 2019). These 'trans-national arrays', and new spatial constructs like glocalism (the centering of global civic engagement in the local community, see Hartman 2017) are helpful for imagining 'grassroots-driven local and regional transitions' (Escobar 2019, p.3), particularly for digital education. Indeed, technology is critical to reimagining these new locales and the horizontalism that connects them: 'many technologies can be reoriented towards convivial societies through deglobalizing and re-futuring co-design' (Escobar 2019, p.1). Deliberation, reorientation, adaptation, and re-futuring become the hallmarks of these approaches.

There are further technological implementations that can be reoriented to support this horizontalism, including community-owned internet networks (CN) in sub-Saharan Africa like the Kondoa Community Network in Tanzania, which has connected four rural educational institutions (Matogoro 2018); the Zaria Community Network and Culture Hub in Nigeria, which has provided Internet access for students and researchers and to locally hosted teaching and learning resources via wireless hotspots on campuses and in public locations (Metri 2019); and BOSCO Uganda, which has developed solar-powered community networks in rural Uganda and provides entrepreneurial education on opportunities provided by these community networks (APC 2019). Locally owned and local facing, these networks and the communities and cohorts they stimulate are critical in creating autonomous educational space to deliberate, adapt, design through participatory models and to 'radiate out horizontalism.'

There is an explicit need here for further research that critiques how policy pressures are stimulating a largely unsustainable acceleration of edtech acquisition, and what methods exist for adaptation or a release from policy pressure coupled with autonomous spaces for deliberation and adaptation consistent with horizontalism. Without this, the acceleration of edtech (and e-waste) and the global imaginaries of digital education is likely to continue apace.

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