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Published online: 19 Jun 2019.

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Global-local divides and ontological politics: feminist STS perspectives on mobile learning for community health workers in Kenya

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ABSTRACT

This theoretical paper argues that Feminist Science and Technology Studies (FSTS) can help advance the emancipatory project in critical Ed Tech research. To support this claim, we deploy Tsing's concept of 'scale-making projects' (2005. *Friction: An Ethnography of Global Connection*. Princeton, NJ: Princeton University Press) to connect 'global' narratives to 'local' users in a mobile learning project for Kenyan health workers. Drawing from this exemplar case, we discuss more broadly how FSTS provides useful theory and methods for tracing the trans-national power relations of digital technologies 'on the ground'. The paper concludes by advocating for new forms of emancipatory Ed Tech research – ones 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.

Introduction

Drawing from Critical Theory, Friesen has suggested that 'Ed Tech' research can potentially generate three types of knowledge: instrumental, pragmatic, and emancipatory (2009). Whereas instrumental research yields positivist means/ends analyses of 'what works?' and pragmatic studies generate interpretive, user-oriented accounts asking 'how does it work?', emancipatory research engages more comprehensively with relations of power, and with questions of 'who benefits?' in the design, production, and deployment of educational technology. We contend that additional forms of emancipatory scholarship are now required to better-understand the trans-national politics, controversies, and socio-economic disparities associated with educational technologies 'on the ground'. Our aim is to show how Feminist Science and Technology Studies (FSTS) offers rich resources for pursuing this line of academic work.

In the next section, we present a brief overview of the literature on educational technology to establish the need for new forms of emancipatory scholarship. The tradition of Feminist Science and Technology Studies (FSTS) is then introduced as a useful resource for carrying out this research. We continue with an exemplar, drawing on data from a mobile learning intervention for Kenyan health workers to deploy Tsing's concept of 'scale-making projects' (2005). Based on this empirical

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case, we discuss more broadly how FSTS provides useful theory and methods for problematizing the trans-national power relations of educational technology deployments in low and middle income nations. The paper concludes by advocating for additional emancipatory studies of educational technology which help elucidate how other oppositional pairings, such as design/use, Western/Indigenous, or macro/micro are themselves constituted through far-flung, trans-national arrays of embodied sociomaterial practice.

Background – global-local divides in critical Ed Tech research

For years, the dominant approach to studying educational technology has focused on questions related to 'what works?'. These types of questions produce positivist, instrumental forms of research, aimed at ascertaining whether technology has achieved prescribed educational objectives (Friesen 2009). While important, this approach typically ignores the kinds of knowledge generated by practitioners in favor of codified, standardized measures reflecting entrenched political interests (Oliver and Conole 2003). It privileges experimental study designs over other research methodologies, promoting 'evidence-based' teaching and learning while discounting the power relations which contribute to the production of 'evidence' and the 'scaling-up' of educational interventions (cf. Biesta 2010). Bemoaning the preponderance of instrumental research in Ed Tech, Selwyn and Facer (2013) have concluded that the field seems far more interested in what could or should happen than what actually does, arguing that the ethico-political grounding of the discipline has been shaped largely by the experiences and perspectives of powerful and vested interests, rarely showing any awareness of alternative views.

In response, a growing number of scholars have looked beyond such instrumental studies to adopt a more critical stance vis-à-vis educational technology initiatives (Eynon 2018). Many of these researchers draw from Critical Theory in the tradition of the Frankfurt School, engaging in spirit, if not expressly, with Habermas' conceptualization of emancipatory knowledge (see Nichols and Allen-Brown 1996; Friesen 2009). A central aim of this scholarly critique is to emancipate the oppressed by putting all dominant forms of ideology to the test, interrogating 'knowledge that presents itself as certain, final, and beyond human interests or motivations' (Friesen 2009, 174). In this context, the term ideology 'refers to *any* kind of knowledge (whether technical, practical, or emancipatory) that *appears* to be purified or free of political interest- knowledge that is presented as most self-evidently factual, neutral, or objective' (Ibid., 175, author's emphasis).

Academic work within this critical strand of Ed Tech therefore seeks to 'make problematic what is taken for granted in culture, so that a degree of social justice can be had by those who are oppressed' (McCarthy 1978, 43). Consistent with Critical Theory and its subsequent post-structural elaborations in fields such as Critical Pedagogy and Critical Literacy (e.g., Freire 1969; Apple 1987; McLaren 1994; Hayles 1999), these studies examine social structures, power relations, and control, as well as subversion and resistance in educational technology initiatives. Some, for example, adopt approaches from political economy to reveal how corporate and venture capitalism have co-opted the ostensibly liberatory ethos of technologies such as Massive Open Online Courses (see Hall 2015) and the One Laptop per Child program (see Selwyn 2013). Others have analyzed the rhetoric of powerful government actors, highlighting complex and vested policy agendas that are often black-boxed as widely-held truisms related to 'technology-enhanced learning' (see Bayne 2015), 'inequality' (see Czerniewicz and Rother 2018), or 'learning to code' (see Williamson et al. 2018). These critiques of the entrenched establishment are further reinforced by fine-grained ethnographic studies describing how teachers and learners appropriate digital technologies in ways that subvert dominant 'disruptive' narratives (e.g., Cuban 2001; Sims 2018) and other forms of socio-political oppression (e.g., de los Ríos 2018; Stornaiuolo and Thomas 2018).

However, most socially-embedded ethnographic accounts of Ed Tech users fail to connect lived experiences with wider socio-political discourses; and critical investigations into the power elite rarely incorporate the day-to-day practices of teachers and learners (see Dussel, Ferrante, and

Sefton-Green 2013 for a notable exception). Rhetorically, both of these critical approaches operate by setting 'global' discourse *against* 'local' deployments, contrasting dominant agendas with the situated practices of users. There is a longstanding argument in Actor-Network Theory that 'the global' does not exist 'above' or 'beyond' the local; analytically, practices should be treated as being 'flat', so that as hierarchies appear, it is possible to explore the kinds of connections and movements that create and sustain them (Latour 2005). In the context of education, Dussel and Dahya challenge this idea of a global/local binary that fixes digital technology on the side of the global, while schools, training workshops or teachers and learners are positioned as 'local' (2017). Drawing upon post-structural feminist theory in education (e.g., Lather 2000; McLeod 2009) and emerging feminist empirical work in Ed Tech (e.g., Dahya 2017; Judge and Tuite 2017; Valdivia 2017), they argue that 'global' learning technologies are enacted through local or situated educational environments, while 'local' people become *constituted* as global when 'they relate and mobilize global icons, languages, and genres that affect their lives and identities' (2017, 5). The 'global' in education is not inherently something of a different scale to local practices; instead, the very idea of 'scale' is something that is itself produced through educational practices and movements (Nespor 2004).

Purpose – incorporating feminist STS scholarship into critical Ed Tech

We therefore assert that to fully explore the liberatory potentials and pitfalls of educational technology, it is important to not only expose the contradictions between 'global' Ed Tech discourse and 'local' practice, but to also ask how such dominant narratives travel and take hold on the imaginations and practices of users around the world. As Friesen notes (2009), emancipatory research requires not just the deconstruction of dominant rhetorics, but also the interrogation of subaltern understandings of these dominant narratives, and critical analysis of how such interpretations advance or undermine human freedoms. Accordingly, the purpose of this paper is to advance the emancipatory project in critical Ed Tech research by demonstrating how concepts and methods from Feminist Science and Technology Studies (FSTS) can be deployed to trace 'global' narratives to 'local' users.

FSTS is an cross-disciplinary tradition of feminist research and activism concerned with gender disparities, reductionism, and injustice in science and technology (Weber 2006). Over four decades of feminist engagement with technoscience has illuminated the barriers faced by women in institutions of science and technology, as well as the gendered production and consumption of technological artefacts (see Wajcman 2010). As McNeil and Roberts recount (2011), this empirical attention to exclusions, affect, and the unpaid or invisible forms of labor has generated influential post-structural feminist scholarship related to the cyborg (e.g., Haraway 1991) and the material-discursive apparatus (e.g., Barad 2007). These concepts, along with other FSTS theoretical work on multiplicity and marginalization (e.g., Star 1991; Mol 2002), have helped to cultivate an intersectional understanding of gender and technology which is situated within the complexities of sex, race, economics, and empire (Bauchspies and Puig de la Bellacasa 2009).

Joining others in fields such as post-colonial studies, feminist anthropology, and post-structural strands of Science and Technology Studies (STS), FSTS scholars have made the interrogation of dualisms a central pillar of their theoretical, empirical, and political work (Suchman 2008; Law 2017). Reflecting on FSTS in the domains of computing, information science, and artificial intelligence, Suchman describes how oppositional binaries are more generatively understood as sociomaterial assemblages to be unsettled, rather than pre-existing boundaries separating humans from machines, nature from culture, same from other (2008). She draws from Haraway (1991), Braidotti (2002), Mol (2002), Verran (2001), and Strathern (2001) to assert that deconstructing dualisms should be an explicitly political intervention that not only exposes how binaries emerge, but also reveals who and what is marginalized when these categories become engrained in practice (2008, 140).

Treating oppositional binaries as politically-charged, 'sociomaterial assemblages' or 'cyborgs', FSTS scholars have gone on to analyse the intricate power relations that constitute a wide range

of dualisms, such as 'human/machine', 'male/female', 'subject/object', 'mental/manual', 'us/them' (Suchman 2006). In this paper, we will adopt work by Anna Tsing to interrogate another binary: the 'global/local' divide in Ed Tech research and practice. Tsing's scholarship in FSTS draws upon intersectional feminist theory to promote more equitable post-colonial formations of science and technology (Roosth and Silbey 2008; Martin, Myers, and Viseu 2015), making it particularly relevant for the study of emancipatory politics in Ed Tech. She has argued that whether globalist aspirations are linked to imperialist conquest or liberatory movements, none can spread without the 'grip of worldly encounter' across differences (2005, 1).

To trace this 'sticky' materiality, Tsing puts forth the concept of 'scale-making projects', approaching the global/local binary not as an essential oppositional pairing, but as a practical achievement that is enacted through multiple, sociomaterial arrays of trans-national, multi-sector, cross-disciplinary practices. These far-flung assemblages make competing claims about the universal – claims which are 'at the heart of contemporary humanist projects: Scientists, economic reformers, and social justice advocates all appeal to the universal' (Ibid., 6–7). In this paper, we will deploy Tsing's concept of 'scale-making projects' as an example of how the theoretical, methodological, and political commitments in FSTS can be used to advance the emancipatory aspirations of critical Ed Tech research.

The exemplar of scale-making in a mobile learning intervention

Our exemplar case of scale-making in Ed Tech is distilled from a thesis completed by the lead author (Henry 2018). Empirical data for this doctoral work came from a larger, 3-year academic research intervention led by the other co-authors (NW & MO) and funded by the ESRC-DFID Joint Fund for Poverty Alleviation Research. The stated aim of the larger mCHW project, as this mobile learning intervention was named, was to design, develop, deploy, and evaluate a 'pedagogically-rich' mobile learning intervention for Kenyan Community Health Workers (CHWs). This ESRC-DFID Joint Fund project was a multi-sector, trans-national partnership involving two UK-based universities, and an established international non-governmental organization based in Nairobi with long-standing health programs across the African continent.

Research context

Aligned with progressive educational theories and principals of critical design, the 'pedagogically-rich' mobile learning intervention initiated by NW and MO entailed a set of key academic practices involving: (1) participatory action research, (2) practice-based learning; and (3) several iterative cycles of co-design. This research activity led to the production of a smart phone based application to train health workers on the assessment of childhood development milestones. This digital learning tool was deployed to 90 CHWs and their supervisors, mostly female, in two different settings: Kibera, a large informal urban settlement in Nairobi; and Makueni, a rural district in the Eastern Province. More description of the mCHW mobile learning intervention is provided in subsequent sections of this paper as part of the empirical findings of this case study, and further details about the design and deployment of the larger ESRC-DFID Joint Fund initiative can be found on the project website (http://www.mhealthpartners.org/projects/mchw).

Methodology

The doctoral research from which this exemplar case is drawn was framed as an ethnography of the 'Laboratory Life' of the mCHW research intervention itself (see Latour and Woolgar 1979). JH assumed an insider-outsider role as a participant observer and conducted a study of how knowledge and artefacts were produced in the mCHW intervention as led by NW and MO. The goal of this ethnographic engagement was to add a layer of critical reflexivity to the mCHW intervention, by

having JH conduct a concurrent but separate study of the sociomaterial practices of the mCHW intervention, in the tradition of STS. This doctoral work was our collective response to the funding councils' appeal for applied research related to the Millennium Development Goals that might also contribute to the theoretical and methodological foundations of social science research.

Given that the mCHW team was separated geographically, but connected digitally from numerous different settings in Makueni, Kibera, Oxford, and London, this account of the sociomaterial practices of the mCHW project relied on methods of multi-sited ethnography established by Marcus (1995) and extended in Hine's work on virtual and connective ethnography (2000, 2007). Aligned with Ed Tech research by Dussel and Dahya (2017), the resulting multi-sited, connective ethnography of practice adopts a non-representational approach to social research (Thrift 2008; Vannini 2015), one which departs from classic genres of realist ethnography.

Data collection

As seen in Table 1, data for this case study drew from a variety of sources, including: (1) an on-line repository containing project documents; (2) field notes and audio files recorded by JH during face-to-face contact with researchers, NGO employees, Ministry of Health officials, and CHWs; and (3) notes and electronic logs from digitally-mediated interactions that took place through a project blog, a project Twitter account, and a Whatsapp learning forum.

Ethical approval for the work was secured both from the lead university and from the non-governmental organization partner organization. This approval ensured informed consent before data were collected, guarantees of confidentiality and anonymity for participants, as well as the right of participants to withdraw and have their data removed.

Analysis

NVivo was used to analyze 31 interviews conducted between April 2013 and December 2014. Descriptive codes related to Actors, Space, Activity, Event, and Object (Spradley 1980) were developed and mapped in relation to one another to produce a baseline visual inventory. This initial mapping served as the starting point to 'follow the actors' (Latour 2005), whereby an ethnographic narrative of the mCHW project was generated using the remaining data sources, in dialogue with concepts from FSTS and other material-semiotic traditions. In this paper, we focus largely on Tsing's idea of 'scale-making projects', and how this FSTS concept can be used to problematize global-local divides in the mCHW initiative.

Table 1. Data sources for analysis of 'Laboratory Life' of mCHW mobile learning intervention.

Source	Date range	Description
On-line mCHW document repository	1 October 2013 – 20 June 2016	52 project documents, including funding call, research proposal, meeting minutes, photos, and field reports
mCHW blog	11 November 2012 – 21 January 2016	49 blog entries
mCHW interview transcripts	29 April 2013–11 December 2014	282 pages of typed transcript from 31 baseline interviews with 10 CHWs, 5 public health officers, and 5 NGO administrators, and 2 community leaders
JH's field notes	13–21 March 2016	42 pages of typed notes (from face-to-face contact with researchers, NGO employees, Ministry officials, and CHWs)
JH's audio files	13–21 March 2016	10.5 h of recordings (from face-to-face contact with researchers, NGO employees, Ministry officials, and CHWs)
mCHW's photo-elicitation transcripts	13–21 March 2016	66 typed pages of transcripts from 4 sessions with10 CHWs and 5 public health officers
mCHW Twitter account	29 November 2012 – 18 October 2015	302 tweets/retweets
mCHW's WhatsApp learning forum	19 August 2014 – 1 March 2015	1830 posts

Findings – a multiplicity of global scale-making projects

Tsing contends that capitalism, science, and politics all depend on trans-national, sociomaterial connections that constitute global/local dualisms in practical, concrete ways. She elaborates the concept of 'scale-making projects' as an approach to trace these distinct sets of global connections, arguing that these sociomaterial mappings provide ethnographic insights into why actors find certain global ideologies persuasive and how such universalisms move across localities and 'spread as frameworks for the practice of power' (Ibid, 10). To this end, we will deploy the concept of 'scale-making projects' to illustrate how multiple sets of contested global narratives circulated through the mCHW research intervention and enacted the Kenyan Community Health Workers as active learners, consumers, cadres of the public health system, and disability advocates.

Academic scale-making – enacting the CHW as active learner

The term 'Community Health Worker' (CHW) has a specific operational definition in the context of global health programs. The World Health Organisation describes them as: (1) members of the communities where they work; (2) selected by their communities; (3) answerable to their communities; (4) supported by the health system, but not necessarily part of its formal organization; and (5) have shorter training than professional workers (1989). Over the past 20 years, large-scale investments from multilateral institutions and private organizations have supported the training and deployment of CHWs, as part of broader initiatives to strengthen national health systems in low and middle income countries (Global Health Workforce Alliance 2010).

With support from the ESRC-DFID Joint Fund, the mCHW research project set out to enact these Kenyan CHWs as *active learners* in a 'pedagogically-rich' academic intervention. One of the goals of this progressive educational research project was to empower these workers by having them define their own learning objectives, rather than follow formal curricula. To this end, a group of 18 CHWs and their supervisors was convened for a first participatory design workshop held at the Training Centre in Nairobi. Through a series of design exercises, the CHWs expressed their desire to use the mCHW research intervention as an opportunity to learn more about the stages of normal childhood development and the early detection of disabilities.

In response, NW, the principal investigator, looked to scientific expertise in public health and enlisted a survey known as the Malawi Development Assessment Tool (MDAT) (see Gladstone et al. 2010) as content for a new mobile phone learning application. With funding from the Wellcome Trust, the MDAT was developed by physician researchers at the University of Liverpool and consisted of a graphic questionnaire with 136 items, divided into 4 domains of child development and presented on four separate sheets of A4 paper, accompanied by a basket of small props to be used during a child assessment. Because the MDAT was envisioned to eventually serve as a diagnostic tool, concepts about child development were organized and presented to guide health workers during an encounter with a child. In this way, explicit knowledge came bundled in form of a scientifically-validated protocol to promote experiential learning as CHWs interacted with children in community households.

Loaded onto a succession of yellow and pale blue interface screens of a new mobile phone application, the MDAT participated in the enactment of 'learning actions' (cf. Sharples 2002) that were woven into the clinical practices of the CHWs and recorded in digital format. Other than the initial training sessions on how to use the new mobile application, classroom, acquisition-based approaches to learning and teaching would not be part of the 'pedagogically rich' mobile learning experience, consistent with the prevailing academic assertions of progressive scholarship in mobile learning (cf. Roschelle 2003, 260), and the desire to implement a novel approach to CHW training (see Winters, Langer, and Geniets 2018) (Figure 1).
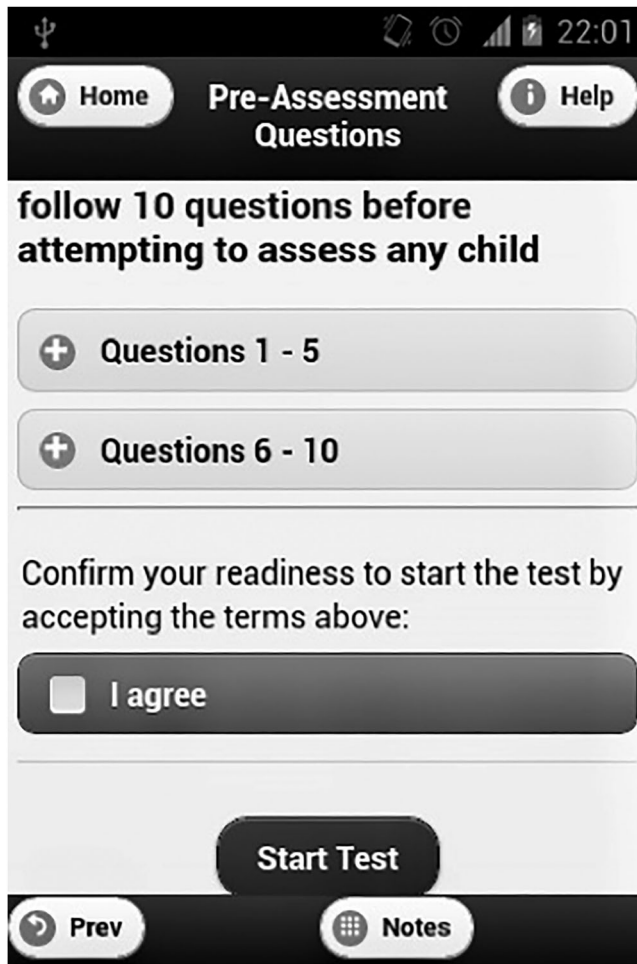
Figure 1. A screenshot from the mCHW mobile learning application.

In this context, the global-local dualism could be understood as a sociomaterial assemblage or network achievement constructed through the practices of UK academic research, as funded by the ESRC-DFID Joint Fund. In this configuration, 'local' knowledge was attributed to the Kenyan CHWs, who were seen to possess expertise 'about building links between formal healthcare and the community, and about the successful implementation of new initiatives' (Oliver et al. 2015, n.p.). This was positioned in opposition to 'global' expertise – that is, forms of knowledge that have been made legitimate through scientific practices in public health and educational technology research, and reified in artefacts such as peer-reviewed academic publications and the validated MDAT assessment tool.

In this context, the empowerment of the Kenyan CHWs was problematized in terms of their identities as *active learners*, and was to be achieved by bringing the 'local' knowledge of the CHWs *into dialogue* with the 'global' expertise amassed and disseminated through academic research practices. In an interview with the mCHW researchers, a CHW reported:

> So the knowledge we are given, empowerment that we are given […] is very nice […] I'm one of the benefi-ciaries who has benefitted much and I'm looking for more. Now I can use the smartphone, now I can work […] There before I used to work with papers, now I am happy working with digital and I know you will keep on empowering us. CHW3, September 2014, Kibera

Here, empowering the CHWs meant *bridging* a 'global-local' knowledge divide through a participatory, experiential, practice-based learning intervention. This intervention assigned the CHW the role of an 'active learner', the MDAT served as 'progressive educational content', the mobile phone was a promising 'learning device', and the children in community households were enacted as part of a 'task-practice environment for learners' needs' (cf. Laurillard 2002, 11).

'Bottom of the pyramid' scale-making – enacting the CHW as consumer

As with any material artefact, the mobile phone was endowed with the politics of its own sociomaterial legacy, one that distributed power in ways that engendered a particular set of resistances (see Winner 1980). The mobile phone may have been enacted by academic researchers as a 'pedagogically-rich' learning device to draw 'local' expertise and 'global' scientific knowledge closer together, but such artefacts are nonetheless manufactured as retail products produced to generate corporate profits by appealing to the desires and purchasing power of individual consumers at the 'bottom of the pyramid':

> The Bottom of the Pyramid (BOP) is a socio-economic concept that allows us to group that vast segment – in excess of about four billion – of the world's poorest citizens constituting an invisible and unserved market blocked by challenging barriers that prevent them from realising their human potential […] in joint efforts for the unleashing of their creative and productive potential as part of an inclusive capitalist system, free of paternalism toward the poor. (Financial Times n.d.)

The handsets deployed in the mCHW project were budget smartphones marketed to the BOP market segment and provided an Internet connection not typically available on the basic handsets that most CHWs already owned. With their rounded edges and rubbery black casing, the rugged, compact Android smartphones fit securely in the palm of an adult hand to deliver Internet, voice and messaging functionalities, a simple camera, 4 gigabytes of storage space, a battery that provided nearly 7 h of talk time, as well as a screen that was large enough to navigate menus and applications and browse photos and websites. Consistent with its sociomaterial heritage as a retail commodity, the device's shallow design inscriptions allowed for user customization to maximize consumer choice (cf. Donner 2010) (Figure 2).

One CHW explained enthusiastically, 'we are now digital through the Internet and have learned a lot. We feel so proud when charting through Whatsapp and many more [applications]' (CHW3, December 2014, Makueni). In interviews with mCHW project researchers, the CHWs not only provided feedback on the deployment of the new mobile application to assess childhood development milestones, but also expressed their pleasure with 'going from analog to digital' (CHW4, WhatsApp log, November 8, 2014). Consistent with the academics' adoption of participatory action research and their emphasis on collaborative knowledge building, CHWs were permitted to use the features of the smartphone as they deemed appropriate. This user discretion was also aligned with the mobile phone's sociomaterial provenance as a consumer good that enabled and amplified human choice, but this freedom created tensions similar to those described by Donner:

> A development application residing on or accessed via a mobile phone constantly has to share the limelight with the phone's connection, entertainment, and self-expression functions […] Your users likely learned their mobile skills pursuing these expression and entertainment functions, and they may evaluate your application by similar standards […] does your public health reporting tool look as sharp and run as smoothly as that downloadable game? (2009, 98)

With CHWs enacted not only as active learners, but also 'bottom-of-the-pyramid consumers', the new mobile learning application remained as one among many applications and features of the mobile phone.

Irrespective of the countervailing aspirations of the academic researchers, this 'bottom of the pyramid' sociomaterial ordering regarded the poor as 'excluded from the modernity of globalized civil

Figure 2. Deploying mobile handsets to the Kenyan CHWs.

society, including consumption and choice' (Financial Times n.d.). The 'bottom of the pyramid' was subjected to conditions of extreme poverty, which constituted the 'local' in this context. This 'local' was materialized in the documented violence in Kibera (cf. Erulkar and Matheka 2007), its lack of public sanitation systems (cf. Lusambili 2011) and alarming levels of mortality among young children (cf. Olack et al. 2014), as well as the reported food insecurity and high rates of chronic malnutrition and stunting in Makueni (cf. ACF International 2012).

Under this economic logic, empowering the CHWs would require forms of 'inclusive capitalism' that would increase their access to choice and thereby close the gap between 'local' conditions of poverty and 'global' standards of modernity. Here, by assigning CHWs the attributes of a consumer, the mobile phone was enacted as an 'amplifier of choice and consumerism' that was made more accessible to the poor through an 'elegant and complex combination of infrastructure, networks, regulators, markets and handsets' (Donner 2010, 3). Within this economic 'bottom of the pyramid' scale-making project, the new mobile learning application was thus positioned as an added choice, one which could expand the CHWs' capability to improve their livelihoods and reduce the socio-economic disparities that distinguished 'local' poverty from 'global' modernity (cf. Kleine 2013).

Public health scale-making – enacting the CHW as health system cadre

While the academic research initiative problematized the CHWs as active learners, and the market-oriented framing of the mobile phone problematized them as consumers, another identity of a CHW had been officially promulgated by powerful multilateral health institutions (see World Health Organization 1989). This officially-endorsed definition of a 'CHW' was tightly-coupled to the Kenyan Community Health Strategy, a set of government policies and provisions aimed at strengthening

the Kenyan health system and meeting the quantitative, health-related targets of the Millennium Development Goals (Ministry of Health 2006). These Millennium Development Goals comprised the backbone of what was described as 'an unprecedented agreement – among developed countries, developing countries, and international agencies – to work towards a world in which sustaining development and eliminating poverty would have highest priority' (World Bank 2003, 7). In this context, training interventions were aimed at enhancing a CHW's performance as an instrument of these widely-endorsed health policies, rather than promoting learning outcomes per se (see Hongoro and McPake 2004; Raven et al. 2015).

As such, the CHWs looked to training initiatives as a means of improving their access to the Ministry of Health:

> [W]e are the ones who provide information from the CHWs to the health centers. We link one another, we are the ambassadors. […] We want […] to find ways to link with the government of Kenya – to see which kind of methods and working systems that we may introduce. And we may [be] lack[ing] because of lack of follow up, motivation, skill, no addition of training and so forth. So we are willing to get more trainings and motivational ways of work. (CHW5, July 2013, Kibera)

The academics' new mobile learning application would help to enhance the productivity and improve the performance of CHWs in their identities as 'human resources for health', ensuring they 'practise[d] within the limits of what they can achieve and for what they have been trained' (Jaskiewicz and Tulenko 2012, 4).

The rhetoric of empowerment in this policy-driven sociomaterial ordering was directed not at the CHW as a learner or consumer, but rather at the community – conceived broadly here as citizens committed to improving their personal and collective health status:

> [A] major intended impact of the [Community Health Strategy] approach is that the communities will thereby be empowered to demand their rights and seek accountability from the formal system for the efficiency and effectiveness of health and other services. (Ministry of Health 2006, 2)

Empowering the CHW as a learner was not necessarily discouraged, but was nonetheless viewed as inadequate if it did not, in turn, achieve specific health priorities – such as HIV and malaria prevention – set forth in the Millennium Development Goals and instantiated through operations of the Kenyan Ministry of Health's Community Health Strategy (Figure 3).

With the community thus defined as the object of a comprehensive health system intervention, the delegation of roles and attributes differed from those enacted by an academic educational intervention to empower health workers, or a market selling a commodity to empower consumers. In a sociomaterial ordering where the 'global' was constituted by the policy practices linked to the Millennium Development Goals, CHWs assumed the role of 'health system cadres'. These individuals were part of an apparatus that included the Kenyan Community Health Strategy and the internationally-endorsed health operations of the formal health system. The mobile phone, along with its newly-developed mobile learning application for assessing childhood milestones, constituted a 'job aid' to enhance the productivity of the CHWs within this national health system. Overall, this form of 'health system strengthening' in Kenya, with its health delivery and data collection activities, was expected to result in the generation of 'local' statistics that conformed to the targets that were established through 'global' policy-making practices. Here, the 'global' and the 'local' were materialized as quantitative indicators, abstracted away from the social practices of both policy-making and health services delivery, and formalized into relations of monitoring and accountability.

Participatory scale-making – enacting the CHW as disability activists

Notwithstanding the alternative orderings which treated the CHWs as consumers or as health system cadres, the mCHW project did succeed in enacting these individuals as active learners. With the deployment of the new mobile learning application, they developed expertise in the assessment of child development milestones and gained the trust of increasing numbers of community households.

Figure 3. Posting quarterly community health indicators in Kibera.

At first, the majority of children assessed by CHWs were found to be developing normally and did not require follow-up referrals to a local facility. This was consistent with the original objective of the new mobile learning application, which was to train CHWs in the early detection of childhood disability.

However, as the CHWs gained visibility in the community with the use of the new mobile learning application and their enhanced expertise, the mCHW research intervention began to enact new, unexpected performances – it started drawing out severely disabled children that had been hidden from the rest of the community. As one CHW explained:

> As a neighbor, I've been there for so long, but I was not aware that this baby has disabilities. Serious. It took me a long time to understand that this baby has a disability because she [the mother] used to cover her, covering her from head [to toe]. […] Nobody bothered about them [the disabled children] […] We the CHWs, we didn't know whether in our communities there were so many kids--because every mother used to close her kid in the house. (CHW4, March 2015, Kibera)

Integrated into the mobile learning application, the MDAT provided CHWs with a structure and a set of talking points to initiate a dialogue with parents of disabled children.

The deployment of the new mobile learning application triggered a growing awareness about the unmet needs of disabled children in the community, creating a social movement among CHWs and parents of disabled children:

> They were 15 mothers. Now she's recruiting another 20. The number is now 35 […] Even now, I know there are so many kids and what we also ask ourselves is why so many children within Kibera were born with cerebral palsy during this time. (Ibid.)

This emergent awareness led to a new parent support group, a micro-credit scheme and an informal system of cooperative childcare. The CHWs developed paper-based patient registries to identify disabled children, to define their clinical and psycho-social needs and to direct them to appropriate treatment and support from the formal health system (Figure 4).
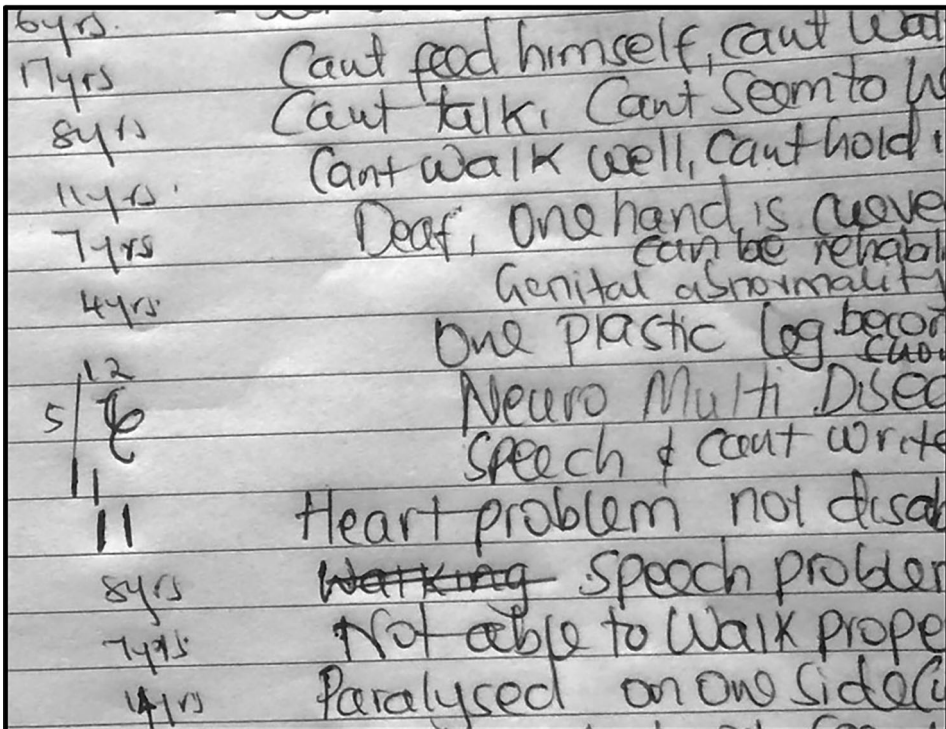
Figure 4. Paper-based patient registry for disabled children.

However, the CHWs' new ability to identify and refer children with delayed developmental milestones was enacted through practices that were excluded from operations of the formal health system in Kenya; disability was not mentioned in any of the eight Millennium Goals or its associated 21 targets and 60 indicators (see Groce 2011). Yet as described earlier, funding, programs, facilities, providers, supplies, equipment and practices all circulated through these policy provisions and its aligned health ministry operations. To empower these disabled children and their parents, the CHWs were enacted as disability advocates and the mobile learning application functioned as an advocacy tool. The 'local' was constituted by a set of practices that led to the identification of these children and reified in the paper patient registries compiled by the CHWs. This enactment of the 'local' was positioned in conflict and tension with the 'global' practices associated with the Millennium Development Goals and the Kenyan Community Health Strategy. Here, the relationship between 'local' and 'global' was not one of monitoring and accountability but that of community resistance, subversion and opposition.

Discussion – the ontological politics of empowerment

Using the FSTS concept of 'scale-making projects', we have described four sets of encounters between universals and particulars that emerged out of the situated yet trans-national practices of the mCHW intervention. We identified how these extended 'scale-making projects' (including one of our own design) operated as distinct 'frameworks for the practice of power' (Tsing, Ibid, 10), conjuring different imaginaries of the global/local divide, of empowerment, and of emancipation. These competing imaginaries were materialized through the lived experiences of the CHWs and their multiple, entangled identities as learners, consumers, health system cadres, and disability activists. Controversies over the identities of the CHWs can be understood in terms of power

struggles that took place between these conflicting scale-making projects, each enacting its own form of empowerment to attenuate a global/local divide in the name of justice.

We suggest that these tensions and conflicts correspond to what Mol calls 'ontological politics' which raise the following questions related to the practice of power: '*Where* are the options?' '*What* is at stake?' '*Are* there really options?' '*How* should we choose?' (1999, 79, author's emphasis). In our exemplar case, attending to the ontological politics of scale-making projects generated questions beyond 'what works?' in educational technology. It brought to the foreground other questions such as: Was the mobile phone a learning device, a commodity, a job aid, or an advocacy tool? How and when should the CHWs enact the practices of a learner, a consumer, a health system cadre, or a disability activist? Who was to be empowered – the CHWs, the community, or just the subset of disabled children in that community? These kinds of questions reveal just how much can be hidden behind the apparently simple idea of technology 'working'. Moreover, we suggest that these kinds of questions can also help us analyze more carefully the mechanics of power, and attune to the nuances of justice in all its sociomaterial complexity.

Conclusion – FSTS and critical theory in Ed Tech research

A core aim of FSTS is to interrogate how oppositional binaries emerge and enact exclusions and injustice in the domains of science and technology (Suchman 2008; Law 2017). We argue that this feminist tradition of scholarship and activism can help advance the emancipatory agenda in critical Ed Tech research. To support this claim, we presented an exemplar, illustrating how the global/local binary in a mobile learning intervention for Kenyan CHWs can be problematized using the concept of 'scale-making projects'. In linking 'global' narratives to 'local' users, this FSTS concept served to foreground the 'ontological politics' (Mol 1999) of our trans-national, multi-sector mCHW initiative, illustrating how empowerment was a contested practice related to multiple imaginaries of the global/local divide and social change.

Through these more extensive conceptualizations of power and dominance, we suggest that FSTS can support new kinds of analyses which complement existing forms of Ed Tech critique. As Allen contends, these post-structural strands of feminist theory act as 'an invitation to rethink our understanding of emancipation' (2015, 514), enriching the liberatory currents of Critical Theory from the Frankfurt School through the

> precise and specific analysis of domination that illuminates the intersecting and overlapping structures of gender, sexuality, and race with those of class, culture, and postcolonial imperialism, theorized in a transnational frame. (Ibid.)

In problematizing, rather than pre-supposing oppositional binaries, FSTS approaches can help to answer what Selwyn calls the 'big questions' in Ed Tech research having to do with *how* the 'micro-level concerns' of individual tutors and learners *relate* to the 'meso-level of the processes and procedures of educational institutions' and the 'macro-level of wider cultural, societal, political and economic values' (2010, 70). Accordingly, this theoretical paper has demonstrated how the politically-engaged and theoretically-rich tradition of FSTS scholarship offers a new way of studying educational technologies 'on the ground': as 'scale-making projects' involving emergent practices that take hold on actors and materials as they constitute the micro, meso, and macro levels of our fragile and globally-connected digital society.

Disclosure statement

Funding

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