Using technology to accomplish comparability of provision in distributed medical education in Canada: an actor-network theory ethnography

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Abstract

This article is derived from a three-year ethnography of distributed medical education at one Canadian University across two Canadian provinces. It explores the ways in which students and staff work inside the technologically rich teaching environments within which the curriculum is delivered. Drawing on data constructed through observations, interviews and photographs, the article seeks to explain how the key concept of comparability of provision is accomplished. The article concludes that the education received at both campuses is comparable. However, simply to attribute this comparability to the technology itself is to ignore the central role that is played by the staff – academic, administrative and audio-visual. The article concludes by arguing that, notwithstanding the fact that people will always respond to technologies in unanticipated ways, the curriculum within which they are enfolded is sufficiently robust to accommodate such practices whilst at the same time maintaining the quality of the provision.

Key words

Actor network theory; distance learning; distributed medical education; ethnography; higher education; information and communication technologies.

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Introduction: two campuses, one programme of study

Higher Education in a Digital Economy (HEDE) was a three-year research project funded by the Social Sciences and Humanities Research Council of Canada (SSHRC), conducted from 2012 to 2015. The broad aims of the project were to explore the implementation at one university in Canada, from September 2010, of a new medical education curriculum distributed across two campuses spanning two provinces, 400 kilometres apart. This new distributed medical education (DME) curriculum was designed explicitly to rest on information and communication technologies (ICTs). The application of technology (digital video, digital learning platforms, e-learning devices and such like) functions as a means to enact synchronously the DME curriculum across the two campuses, which are here referred to as Main Campus and Satellite Campus. The need to establish comparability of provision in terms of both educational experiences and assessment methods across the two sites is required by the Liaison Committee on Medical Education (LCME) for North America (the accrediting body for all such programmes), providing the external policy driver for the curriculum that we have been researching: "the curriculum of a medical education program must include comparable educational experiences and equivalent methods of assessment across all instructional sites within a given discipline" (LCME, 2013: 8). Specifically, we sought to explore the ways in which staff and students would work within and respond to, the DME curriculum.

At both sites, large lecture theatres, smaller seminar rooms and even student lounges have been equipped with videoconferencing systems. Regardless of size, all of these teaching spaces are equipped with an array of monitors that allow not only for the display of media-rich teaching materials (the curriculum is delivered on a largely paperless basis), but also for staff and students at one campus to see and to hear their counterparts at the other, during lectures, seminars, laboratory sessions and panel meetings. State-of-the-art camera and microphone systems within all of the teaching rooms allow for synchronous teaching by one member of faculty staff across both sites, for question-and-answer sessions that students at both sites can take part in, and for the recording of lectures and seminars for future revision and reference. Press-button systems allow students to activate the microphones in front of them (in any teaching room, there is a button and a microphone at every seat) so that their counterparts at the other campus can hear their questions. At the same time, the cameras in each room focus on the student group and transmit their image to large screens at both sites. Teaching materials are collected and formatted in advance of each lecture or seminar by a specialist team of Audio-Visual staff who are also more widely responsible for the technological infrastructure – ICTs, cameras, microphones and so forth – that the curriculum rests on. The specialist teams work out of control booths (one at each site) from where they orchestrate the technologies that are in use during lectures, seminars and other meetings. Main Campus is (unsurprisingly bearing in mind the nomenclature that we have used in rendering the campuses pseudonymous) larger and busier than Satellite Campus. The size of the student cohort at Main Campus is more than three times that at Satellite. It is at Main Campus that the bulk of 'real world' teaching takes place, with students at Satellite participating via the videoconferencing system: it is relatively uncommon for teaching to take place at Satellite and be transmitted to Main.

A framework for inquiry: actor-network theory

As ethnographers, we are interested in the ways in which the people who actually 'do' the curriculum – the students and the lecturers – work with, make sense of and talk about it. We were interested in how they are enrolled or organised to work in the ways that they do at a local level, in lecture halls or seminar rooms, on an everyday basis (Tummons, MacLeod and Kits, 2015).

The theoretical framework for our research is provided by actor-network theory (ANT) (Callon, 1986; Latour, 2005; Law, 1994, 2004; MacLeod et al., 2015). Other ANT studies have explored not only medical education but also adult basic education, archaeology, management studies, physics, and teacher education (Bleakley, 2012; Fenwick and Edwards, 2010; Hamilton, 2009; Nespor, 1994; Rimpiläinen, 2015; Tummons, 2010). It is a sociological framework that is increasingly widely used within educational research in order to explore the relationships between the human (students, lecturers, technicians) and non-human (handbooks, tablet computers, textbooks, cameras) elements that constitute educational curricula, and to consider the ways in which these elements are arranged across temporal, spatial and geographical boundaries, and, mindful of its derivation from anthropology and ethnography, is particularly well suited to our research.

ANT has been described in several more-or-less synonymous ways: as a component or characteristic of ethnography that is concerned with "the processes of ordering that generate effects such as technologies (Law, 1994: 18); as a "way of talking… [that] allows us to look at identity and practice as functions of ongoing interactions with distant elements (animate and inanimate) of networks that have been mobilized along intersecting trajectories" (Nespor, 1994: 12-13); and as a "sociology of the social and … [a] sociology of associations" (Latour, 2005: 9). Extant ANT literature allows three key themes to be identified so that that a working definition can be operationalised. Firstly, ANT is a *sociology of association* (Latour, 2005), or of *ramifying relations* (Law, 2004). ANT is a way of exploring how social projects are accomplished, in ways that can be traced, across networks of associations or links. Such networks can consist of concentrations of all sorts of stuff: stories, people, paperwork, computer simulations, routines, texts, and voices. Any social project will always create and embody characteristic forms of representation (Law, 1994). ANT is not concerned with what such stories or routines might mean, however: reflecting its routes in post-structuralism, ANT rejects overarching explanatory frameworks (Latour, 2005). Instead, the focus of an ANT account is on what such stuff – people as well as objects – can accomplish once they have been linked or associated into a network (Fenwick and Edwards, 2010; Fox, 2005). Secondly, ANT provides ways of thinking about how networks or associations both carry influence and influence each other, and foregrounds the ways in which people are made to do things across networks of geography or time or across institutional boundaries. "How to make someone do something" is a central concern (Latour, 2005: 59). In order for a social project to be accomplished, a network of people and things needs to be brought together. A network can be established through persuasion, inducement, coercion, or any combination of these. And a network can break down at any point or link: consequently, the social project can be slowed down, misdirected or even lost, whether the broken link is an object (for example, a rule or regulation that has been forgotten or misinterpreted), or a person (for example, someone who has decided for whatever reason not to act in the way that the network requires). Both people and objects can make (or fail to make) other people do something; that is to say, both people and objects are granted *agency* within ANT. Thirdly, ANT proposes the principle of *symmetry*, which states: "humans are not treated differently from non-humans… Humans are not assumed to have a privileged *a priori* status in the world but to be part of it" (Fenwick and Edwards, 2010: 3). In ANT, it makes

no difference whether the network constituents being explored are people or things. Both human and non-human elements can come together and be held together in order to ensure the performance of the social project in question. Indeed, it is the case that both human and non-human elements are *always* present and *need to be so.* This is not because such a mixture of people and objects makes a network seem to be more sustainable. Rather, this is a reflection of the fact that to attempt to bifurcate people and things when considering how the social is enacted creates a false dichotomy: it is simply the case that the one cannot be without the other (Latour, 2005: 75-6).

Distance learning and ICTs in professional higher education

The distributed nature of the DME curriculum constitutes one of two prime characteristics (the other being the role of ICTs). It is important to remember that distance learning provision should not be conflated with the use of ICTs to facilitate learning more generally (Richardson, 2000: 1-13). In our research, we defined distance learning according to four elements. Firstly, it is institutionally based; secondly, it is characterized by separation (geographic and/or temporal) of teacher and student; thirdly, it uses either synchronous and/or asynchronous telecommunications; and fourthly, it rests on the sharing of resources (Caladine, Moore and Morris, 2000; Greenhow, Robelia and Hughes, 2009; Simonson et al., 2012; Simpson, 2002; Toomey et al., 2013). It is in considering the third and fourth of these elements that we foreground the role of ICTs which, in this DME curriculum, provide an architecture for both synchronous and asynchronous telecommunications and for the wider sharing of pedagogic resources.

Three areas of research relating to ICTs are of particular relevance here. The first is research in the pedagogic beliefs and practices of HE teachers using ICTs. According to this research, ICT use is externally guided by policy, not academic, drivers, reflecting discourses of globalisation and massification in higher education and positioning the greater use of ICTs as a response to the market pressures of greater student numbers and diminished financial resources (Hartley, 2009; Price and Kirkwood, 2013). The second area to be considered is the gap between pedagogic theory and practice, and technology. This gap has been explained as being between the reality of HE teaching and learning practices (Breen et al., 2001), and the rhetoric of institutional policies relating to e-learning and ICT use (Habib and Johansen, 2014); as being between pedagogy and technology (Unwin, 2007); as being between semiotic needs and technological needs (Blin and Munro, 2008); and as being between educationalists and technicians (Bothma and Cant, 2011). The third area is the ambiguous impact of technology on teaching. Resting within a broader critique of research into technology that focuses too much on processes and too little on student learning, this serves to remind us firstly that it is often difficult to identify the specific impact of ICTs within broader curriculum reform (John and Sutherland, 2005; Lautenbach, 2014); and secondly, that much research reflects the experiences of early adopters rather than more representative samples of university teachers (Kirkwood and Price, 2013). We argue, therefore, that the use of ICTs constitutes an area for debate that is far from settled, that is fraught with difficulties: ICTs are a *matter of concern* (Latour, 2005: 115) and they are the focus of the ANT account presented here.

Methodology and method

Four methods for constructing data were employed within the *HEDE* project (Tummons, MacLeod and Kits, 2015). The first method was *observation*: observations (n=108) were conducted in lecture rooms, seminar rooms, staff meeting rooms, and technicians' control rooms, and were carried out between January and November 2013. The second method was *interview*: semi-structured interviews (n=31) were conducted with academic staff, administrative staff, technical/audio-visual staff, and students, and were carried out between July and December 2014 (staff interviews (n=16), lasting between 50 and 60 minutes), and February and April 2015 (student interviews (n=15), lasting between 26 and 56 minutes). The third method was *document analysis*: documents (n=60) relating to curriculum design and implementation, professional accreditation, institutional policy, and technical design and implementation, were analysed between January and December 2013. The fourth method was *visual*: photographs (n=136) of teaching rooms, administrative offices and audio-visual booths at both campuses were taken between January 2013 and January 2014. Data management and analysis was facilitated through the use of qualitative data analysis software.

The findings reported in this article are derived firstly from the observations and the photographs, and secondly from the interviews with a purposive sample of staff from across both campuses (academic staff: main campus n=4; satellite campus n=1; administrative staff: main campus n=2; satellite campus n=3; audio-visual staff: main campus n=4, satellite campus n=2). It is the interview data that is drawn on in this article: extracts from transcripts are labelled according to the location of the staff member as well as their role (academic (AC), administrative (AD) and audio-visual (AV)). Observation data (reported more extensively in Tummons et al., 2016) were analysed through the use of a conceptual framework that focussed on: the places/spaces where observations took place; the activities, artefacts and people involved; and the goals behind the actions that were observed. Transcripts from observations were analysed alongside relevant photographs (Banks, 2007).

Findings

Four key areas for discussion emerged from our data, and we discuss each of these in turn here. The first of these relates to the ways in which staff constructed their own understanding of the *comparability of provision* that the DME curriculum sought to establish. The second relates to the central role played by the *audio-visual technicians* in the establishment of the curriculum. The third focuses on the ways in which teachers' adjusted their *pedagogical practices* in response to the technologically rich environment that they were teaching in. The fourth relates to the ways in which *students* responded to the requirements of these same environments.

First theme: comparability of provision

> It's hard to compare experiences, right? Like a student in rotation here across the street…is going to get a fundamentally different type of experience that one of our students at Satellite. And you know, at the end of the day, they're both going to have an MD. So they have to be comparable.
> (AV4, Main Campus)

I think that the two experiences are comparable. I do think the powers that be have done a very good job. I think the technology is a huge part of it. And […] I think this is money well spent.
(AC3, Main Campus)

Like I know in tutorials, each tutor is going to have a different way to present each case. But as long as at the end of the case you come out with the same outcome, as long as the objectives are met. I know objectives are very important. Between the two sites, I just hope that what's happening here and what's happening in Main Campus are equal.
(AD4, Satellite Campus)

The delivery of the curriculum at the campuses does not have to be identical in order to be comparable, and this is recognized both by the LCME accreditation framework as well as by the staff who are involved in curriculum planning and delivery. At the same time, it is understood by staff that comparability has to be accomplished through work and that there will always be differences between the modes of delivery of the curriculum across the campuses. That is to say, above and beyond the considerable – and impressive – technological infrastructure that links Main and Satellite, other patterns of everyday work are required to establish links between the two, ultimately in order to provide a comparable experience for the students. Sometimes, this kind of work will be specific to particular staff. For administrative staff, it can involve practices such as maintaining a room scheduling system that works across both sites rather than treating each site separately, using shared email signatures and sending departmental emails and such like to all students, and using video conferencing and networking tools so that the administrators at Main and at Satellite can talk with each other as they might if they shared a physical office. For audio-visual staff, it can involve travelling between sites and sharing responsibilities for providing technical support across both campuses. For academic staff, it can involve distributing curriculum leadership across the two campuses, redesigning learning and teaching activities in order to respond to the differences between the two campuses that are not rooted in distance, but in other factors such as class size or legislative framework – or even something as simple as ensuring that both libraries could offer the same materials to the students.

Second theme: the audio-visual technicians

One of the things I like to say about our system is we didn't really change what an instructor does, typically, on a day coming in to teach, too much. Because typically what an instructor would do is they would prepare their PowerPoint presentation, they'd come in, they'd lecture. […] And for the majority of them, the only real change was getting the content in early.
(AV3, Satellite Campus)

There was a lot of little intricacies in the slide development I think, because they do reformat everything to the [Main Campus] wide screen format, which I didn't know about. And I spent a lot of time going through my slides, making sure everything was positioned correctly, and then they'd reformat it, they'd change the colour scheme, they'd send it back, and everything is stretched out or in different places. And that was, you know, a little stressful.

(AC2, Main Campus)

Telepresence isn't just having, like, a video conferencing unit and a camera. It's the whole way the room is designed. […] When you look at our rooms, our rooms in Main look like our rooms in Satellite. So it's this idea that you're creating this similar experience that's good for communication.
(AV5, Main Campus)

There has been, alongside the expansion of university provision (in terms of numbers of students and institutions, but also in terms of the breadth of courses that are offered) over the last twenty-five years, a growth in the numbers of staff who are not classed as academic but who nonetheless have a key role to play in terms of the delivery of the curriculum: academic skills tutors, technicians, language teachers, and so forth (Tight, 2009). In our research, we found that staff of all kinds and across both sites had established a relationship with the curriculum that was characterised in part by what we described as 'seamlessness' in terms staff working together to enact the curriculum. The narrative above, relating to lecture slides, provides just one example: teaching staff are required to submit their slides and other lecture materials such as videos for reformatting – so that compatibility across both sites can be guaranteed – in advance of the actual lecture. In turn lectures are recorded and stored online – an additional driver for ensuring that materials are correctly formatted. In case of cancellation, a previous iteration of the same lecture can be retrieved from the archive and distributed to students. These as well as other stories – examples include drafting lecture schedules, creating VLE pages and posting materials online, setting up orientation meetings and, in one instance, improvising ICT links when one member of staff was unable to attend the campus due to a snowstorm – illustrate quite clearly the ways in which different levels or qualities of cooperation between academic, administrative and audio-visual staff, are required for the DME curriculum to be accomplished. It goes without saying that the academic function of the curriculum remains of the highest importance: at the same time, our research demonstrates that this academic function is a product of work done by academic as well as non-academic staff, and that it is not possible to straightforwardly delineate between these two.

Third theme: pedagogical practices

So let's say that we chose, you know, in terms of different modalities of delivery of, say, lectures or panels. Let's say that we had a panel. Well, in one of the ones that I do, for instance, I might run the panel but I have panellists in Main Campus and Satellite Campus so that neither campus feels slighted by not having someone right there.
(AC4, Satellite Campus)

[I am] trying to give the users and the presenters kind of an awareness of, okay, "I'm no longer just teaching in a normal classroom." They have to be conscious of the camera and the distance site. […] It was pretty much mandatory that, you know, the staff would come in, the lecturer would come in at least a week in advance to kind of get a tutorial on the room. And also, there's always a tech[nician] there to greet them at the beginning of the session.
(AV5, Main Campus)

We had such an issue in replicating what we were doing here and there. And the truth was, Satellite seemed to have more resources to manage some of this stuff than we had here, at least to organise it. Smaller numbers, right? So if you have 20 people and 2 lab rooms, you can make a lab [laboratory-based session] happen. Whereas here, you'd have 100. […] We'd call it an interactive lecture and call it a lab. But the reality was, it wasn't a lab.

(AC3, Main Campus)

Our data demonstrated unambiguously that teaching within the DME classrooms impacted on pedagogical practice, in terms of paying attention to students (some physically present, others on screen), the relative lack of freedom to move around the lecture room, and the restriction of non-verbal communication, for example. These shifts in teaching work were similarly recognised by interview respondents. Audio-visual staff spoke of the ways in which they constructed their roles as facilitating academic staff in teaching in these new spaces; administrative staff spoke of the ways in which they observed staff and students becoming acclimatised to the teaching environment and came to know how the room worked as a pedagogical environment; and academic staff commended the technology whilst at the same time acknowledging the differences between speaking and responding to those students who were physically present and those who were virtually present. This contrast was most conspicuous when discussing asking and answering questions in class, but other issues also emerged during the interviews. The first of these was the issue that notwithstanding the technological infrastructure that brought them together, there was nonetheless a permanent 'disconnect' or distance between the two campuses. In part this was due to geographical distance, and in part due to institutional or organisational difference (in terms of bureaucratic procedures or routines, for example). The second issue was the extent to which this distance between the campuses led to different levels of involvement or engagement by students during taught sessions. Finally, the third issue revolved around the fact that although the teaching rooms were admired and commended, they were still constructed by some academic staff as being 'not normal'.

Fourth theme: students

And this is the thing where I think I see more of a disconnect because the Main Campus students have an opportunity to come to me after [the lecture] and ask questions. And maybe that's why I get more questions or talk from the Satellite cohort during the actual lecture time. […] And the first thing they say is, "I didn't want to press the button so I came up and asked."

(AC1, Main Campus)

It's definitely different. […] In Main Campus it seems like it would be better from an academic perspective because at the end of the lecture, all the students that didn't want to ask questions to everybody came down and chatted directly, one-on-one. But in Satellite, because they are a smaller group of students, they seem to be much more close with each other. And since there's not as many faculty members there, they have a lot more communication and talking amongst themselves. So it's much more of a peer-to-peer learning experience.

(AV6, Main Campus)

> We're sitting in the control room. […] And all of a sudden, we're all kind of taking note of this giggling and snickering that's going back and forth. And at first, we're not catching on to what's happened. And then all of a sudden, we click in all at once, and we just started laughing. […] So the students in the front rows [at both campuses] all had their laptop screens open, and they were doing different things, like big smiley faces on one screen, and "hi, happy birthday." All these messages being passed back and forth – it was like the electronic age of passing notes.
>
> (AV1, Satellite Campus)

For the curriculum to be successful, it is important for the technologies to be constructed in such a way that question and answer is open to all so that all of the students can learn – in part – by talking with academic staff as well as with each other about the issues that they have been listening to in the lecture. And in many ways and for many reasons, staff involved were impressed with the technologies of the classroom. However, interview respondents also noted several factors that render opportunities for discussion and for question-and-answer, within this curriculum, problematic. There were three aspects to this. Firstly, there was reluctance on the part of some students to ask questions due to an unwillingness either to press the button or appear on the overhead video screens, or both. Secondly, there was the sense that for one group of students (the group that were only virtually and not physically present with the lecturer), the pedagogic context would always be different. This might be because the virtual group could not stay behind and ask more questions at the end of the class, or simply because of a sense of disconnect between the lecturer and the students on screen. Thirdly was the phenomenon that the success of the question-and-answer session as technologically mediated depended very strongly on the attitude of students not only in terms of getting used to the technology but also policing the technology and taking responsibility for it, by asking lecturers to remember to press the correct button or even, on several occasions, asking the other/virtual group of students to remember to press their buttons so that questions and comments could be heard by everyone.

Discussion: tracing the actors within the DME curriculum

Actor-network theory informs us that for any social project (here, the technologically-mediated DME curriculum) to be accomplished, a series of four steps, traceable through empirical anthropological or ethnographic research, need to be considered (Callon, 1986; Latour, 2005; Law, 1995). Firstly, there is *problematisation*: the identification of the nature of the social project that needs to be accomplished. Here, the project is a medical education curriculum that needs to be delivered in such a way that the nature of that delivery is *comparable* across both sites, in alignment with the framework established by LCME. Secondly, there is *engagement*: the processes by which all possible social actors (human and non-human, remembering the principle of *symmetry*) are identified or defined, 'locked into place' (Callon, 1986). Here, the curriculum is identified as distributed, as resting on a distance learning model; teaching staff are identified as social entities who are to be persuaded to engage with the ICT infrastructure that the curriculum will rest on; technical support staff are identified as one of the entities by which this infrastructure will be enacted – the other being the ICT equipment. If engagement is successful, the third step is *enrolment*: the procedures, movements and actions that are employed to move actors. Here, teaching staff are required to submit their PowerPoints for formatting and early uploading, to have their classes recorded, and to restrict their physical

movements when teaching; students are required to sit in particular places, to learn to use the button and microphone system for participation in question-and-answer, and (particularly for students at Satellite) to acclimatise to a teaching environment where the instructor is a virtual, not a physical, presence. Finally, there is *mobilisation*: the moment where all of the elements of the network are established and the social project is accomplished. The social project that has been identified at the moment of problematisation has been transformed, or *translated* (Callon, 1986; Latour, 2005; Law, 1994), through a series of social processes (meetings between staff, teaching, the writing of course materials, the uploading of PowerPoint presentations, and so forth), in such a way that the network, and hence the social project that it sets out to establish – the DME curriculum – has now been accomplished.

ANT reminds us that any such social project is held together across a network that can be easily damaged or broken down, however: almost by definition, such networks possess a level of precarity or fragility, requiring the network to adjust in order to maintain integrity. Within the actor-network that we discuss here, these moments of breakdown and repair can be seen in several places. The reluctance of some student users to press their buttons in order to ask questions because they did not wish to be shown on the big screens led to changes in the camera protocols, where the camera would zoom in onto both the student asking the question and the student sat next to them. The pressure plates that were originally installed at the front of the rooms so that the lecturers would be automatically tracked by the cameras were disengaged because despite being very sensitive, they could not cope with the ways in which some lecturers moved. The initial installation of the question and answer button system did not provide a way of indicating to the lecturer whether the question was coming from a student who was physically present or was virtually present: as such, the lecturer did not know whether to address the answer to the room or to the camera. Therefore, a 'traffic light' system was introduced so that the lecturer would know if the questioner was at Main or at Satellite.

On other occasions, breakdowns or fractures in the network were not repaired, but the overall strength of the network was such that these breakdowns could be overridden. Some academic staff resisted the requirement to submit PowerPoints and other materials two weeks in advance (to allow for formatting and compatibility checks), deciding instead to bring their work on a USB memory stick. On some occasions this resulted in classes being cancelled. Teaching staff were required to not only get used to the cameras and the microphone systems, but also to the fact that the furniture could not be re-arranged, and that their own movements around the room would be restricted by the need to be captured by camera and microphone. Some, lacking familiarity with the equipment, needed to be relied on advice from students when using the room. Many were keenly aware that the pedagogical benefits of the technologies were accompanied by drawbacks, particularly opportunities for new, technologically-mediated, distractions: students passing messages in class or checking emails or Facebook notifications, instead of concentrating on the PowerPoint. On other occasions, students covered up microphones, or moved seats to avoid being seen on camera, and invariably filled up the seats at the back of the lecture halls first.

These breakdowns and fractures (such as: students not always pressing the button for questions; teachers not always submitting their slides for formatting; students reminding teachers how to use the ICT; teachers remembering – or not – to stand still for the camera) demonstrate how an actor-network can sustain itself in

two ways. Firstly, the people and things enrolled in the network can be adjusted or altered. People cannot always be made to change how they work in lots of ways, but they can be pushed or nudged to change their practices in some ways – ways that are sufficient for the curriculum network to accommodate them. Thus, some teachers will adapt their presentations from the start, whilst others will only do so after one of their lectures has been cancelled because they did not submit their materials for reformatting. Likewise, technology, or other non-human artefacts, can be redeployed, adjusted or modified to some degree, but only insofar as their functions are not seriously impaired. Thus, the pressure-plate camera switches were deactivated and the traffic-light system was introduced. On other occasions, artefacts can be seen to shape or adjust how people work: students changed their question-and-answer style; teachers learned to be more still when speaking to the class; students learned where to sit if they wanted to ask a question but avoid being displayed on screen.

Conclusion

The account that we have given here demonstrates one of the key tenets of any actor-network account: that in considering any social project, the project in question is never completed or closed off. Instead of a fixed notion of order, there is instead an ongoing process of order*ing* – a continuous flux of movement and activity enrolling people and artefacts (Latour, 2005; Law, 1994). The actor-network that accomplishes this DME curriculum, delivered across the geographical as well as institutional boundaries that divide Main and Satellite, is complex, expensive and overwhelming: it is also successful, engaging and emancipatory. It rests on a custom-built length of fibre-optic cable, 400 kilometres in length (including back-up systems), on audio-visual systems that are more commonly found in the entertainment industry in order to provide audio and video of high quality, on skilled audio-visual technicians who have worked in the entertainment industry as well as in universities, on skilled and committed clinicians who are willing to adapt their 'part-time' teaching practices to the requirements of the technology, on knowledgeable administrators who can improvise solutions to problems that are occurring a long way away from their own desk or office, and – finally – on students who are willing to shift their understanding of what it means to be a student and who come to work alongside and talk with peers who are at a considerable distance but who – thanks to the aforementioned technology – sound and look as if they might simply be in the room next door. The DME curriculum that we have researched in the *Higher Education in a Digital Economy* project works not because it draws on ICTs in a headlong rush to implement e-learning as a way to maximize student numbers whilst minimizing staffing, nor because it fetishizes ICTs as necessary for the 'digital natives' of today (whatever that might mean), but because it uses technology in order to solve a specific, tightly bound problem relating to curriculum provision and successfully enrolls distinct groups of people, all of whom are required for the curriculum to become established. In this DME curriculum, the technology serves the curriculum and is bound up, inextricably and indivisibly, with the rest of the network of technicians, administrators, and clinicians, operating as *pedagogical partners* in order to enact the curriculum (MacLeod et al., 2016). The DME curriculum does not provide for an identical experience between Main and Satellite – but it does provide for a comparable one, as identified at the moment of problematisation. It is a comparability that rests on a complex network of actors, consisting of not just technology, but of people and practices as well: a conglomeration of human and non-human actors that embody the principle of *symmetry* within ANT (Fenwick and Edwards, 2010; Latour, 2005; Tummons, 2014). The DME curriculum is constituted within a network that needs – and deserves – to be

carefully described or accounted for in order for the provision to be evaluated, and carefully modeled and anticipated if similar curricular provision is to be established elsewhere.

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