Quantum Ontologies: Beyond Efficiency in Digital Learning Technologies

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Abstract

This text argues that digital learning technologies, like LMSs, are typically enacted as a means of efficiency—as a way to compress geographic space and increase temporal connection in higher education. Such an enactment of digital technologies is problematic when efficiency becomes a de facto means and end unto itself, obscuring the possibility of enacting these technologies in service to alternative like social justice or accessibility. In response, I argue for understanding that space-time configurations, or chronotypes, can exist in a state of *quantum superposition* within a given digital technology. Using the results of a qualitative research study, I trace the ways that digital technologies are simultaneously enacted as a matter of flexibility, disconnection, as well as social justice. Importantly, the ability to enact digital technologies in ways beyond that of efficiency hinges on the direct and purposeful application of institutional energy. This theorization of digital technologies is paramount at a time when social justice efforts in higher education are facing increasing legislative threat.

Enactment

This PDF enacts quantum superposition by existing alongside and with/in its accompanying webtext. Space and time are differently enacted and experienced in each iteration of this text. This PDF encourages, perhaps even requires, linearity in ways distinct from the webtext. Paradoxically, the webtext both is—and is not—the PDF; which is to say that they are *entangled*. There are innumerable material and digital affordances, constraints, and possibilities that emerge with each enactment of this text.

space-time mattering

How you are viewing this text matters. It matters in the sense that technology, whether analog or digital, necessarily mediates experience; and, so, the ways that you are able to interface with the text—and thus, the content of this article itself—hinges on technology[1]. Mobile, desktop, and print-based experiences are each unique material configurations of this text, and each offer a nuanced, but also mutually dependent, enactment of this scholarship. But this text and its various iterations are also a matter of temporality because, as special relativity reminds us, space and time can never really be discussed independently. By this I mean to suggest, in a very literal sense, that the various matterings of this text each *do* time in unique ways. Space-time matterings are not stable nor singular, but rather emergent and iterative. A brief, and admittedly reductive, example will (hopefully) help begin to elucidate this point.

Perhaps this text is being displayed on a laptop via a web browser; and, perhaps that laptop is at a coffee shop, people bustling about and music piped gently in overhead. Since the device is connected to the public wifi, various applications are running in the background causing email and news notifications to flash across the top of the screen momentarily interrupting this text. The world closes in here; time accelerates and vast geographic distance is spanned at the rate of 200,000 km/second (depending on the quality of network cable).

Now consider that this text is being displayed on a laptop, but this time it's in a private study room at the university's library. The laptop, again, is connected to the internet, but the "do not disturb" function is enabled. The same music from the coffeeshop is playing, but this time it's delivered through headphones. The global network is still at your fingertips, yet it nevertheless seems somewhat removed, held at arms distance. Time ticks slower here.

Now suppose this text isn't being displayed on a laptop at all, instead it's coming across on a PDF that's been printed and is sitting on a dining room table. Perhaps there are a variety of hardcopy articles on similar topics stacked next to this one, a situation seemingly analogous but not substantially equivalent to multiple browser tabs being open on a wifi connected laptop. Here the world spreads out and the flow of time grinds, at least relative to the first scenario presented above.

It's not (just) that the technological medium of delivery affects the content. Nor am I suggesting that each material configuring fixes the ways in which time and space are experienced. Quite the opposite, in fact. Space-time, as I hope to show in this article, can be, and frequently is, done differently with/in each configuration. In presenting the above example, I want to introduce the idea that time and space are entangled phenomena. That is, space and time do not exist as pre-existing, discrete entities. "Time" Karen Barad (2007) argues, "is not a success of evenly spaced intervals available as a referent for all bodies and space is not a collection of pre-existing points set out as a container for matter to inhabit" (p. 234). Instead, space-times are better conceived of as "differential patterns of mattering ('diffraction patterns') produced through complex agential intra-actions of multiple material-discursive practices or apparatuses of bodily production" (p. 140). Space-time is being *done*—is becoming—in a variety of ways. One of the ways that space-time is frequently enacted, especially with/in digital learning technologies, is in terms of efficiency.

To be sure, efficiency, in and of itself, is not overly problematic. There are many times when efficiency in a space-time configuration (or chronotype) is not only desirable but an ethical imperative. Such instances include the ease and efficiency with which a given technology, like closed captioning, can meet the accessibility needs of users with disabilities (Colton & Holmes, 2018; Horton & Quesenbery, 2013; Zdenek, 2015, 2020). In this case, efficiency is more a matter of social justice than speed of use. Efficiency in space-time configurings becomes problematic, however, when it becomes a topos with an internal logical consistency that justifies its own existence, when efficiency is enacted for efficiency's sake. Take, for example, the not-uncommon argument that digital technologies and online course delivery are desirable because they enable the university to reach quickly across geographic distance and thus grant access to a broader global marketplace. Here technological efficiency becomes closely yoked to fiscal success, creating a self-sustaining logic of efficiency (Katz, 1992) that harbors the potential to obscure the very existence of alternative enactments of digital technologies such as the social justice iterations aforementioned. Or consider that Lauren Salisbury (2018) found that university faculty frequently do not view digital technologies as a part of their pedagogy or as matter of social justice, and, instead are most likely to view technologies as a way to "(a) improve efficiency and (b) make teaching and learning easier for themselves and their students" (p. 11). These technologies, then, become a space-time configuration that is predicated on the compression of space and time and is thereby rhetorically dominated by a neoliberal enactment of efficiency.

In this article, I want to posit a way past such a singular space-time enactment of digital learning technologies by arguing for what I term *quantum ontologies* wherein many value-laden chronotypes can occupy the same techno-material space in a state of superposition. I turn to the quantum as a *theoretical* framework for understanding the chronotopic consequence of digital technologies in higher education. Thus, my employment of the quantum is less a matter of physics qua physics, and is more accurately described as an overarching "quantum philosophy" that is not only useful for rhetorical studies, but I argue is necessary to apprehend the complexity of technological space-time matterings. Karen Barad (2018) affirms the importance of the quantum, arguing that "Quantum theory, despite tales to the contrary, is not restricted to some alleged micro-realm…Nor does quantum theory live in the realm of rarified ideas that now and again has applications for the real world" (p. 62). Quantum theory, then, bears direct value on issues such as "war, militarism, racism, colonialism, capitalism, and imperialism" (p. 62).

Importantly, a foundational aspect of quantum superposition is that measurement is key to resolving indeterminacy. Meaning that it is only when we actually *look* for enactments of technologies beyond that of efficiency that we create the possibility for their existence. One of the findings from this IRB approved research project[2] is that for many instructors in online learning spaces there is a vague sense that digital teaching technologies can indeed be enacted so as to meet social justice needs, but they are unsure, though, of how to bring this about in their online courses. Quantum ontologies, then, offer a way forward for understanding and enacting the chronotropic complexity of digital technologies in ways beyond that of just efficiency. This work is especially important at a time when social justice efforts in higher education are under increasing legislative threat and continue to face roll-backs nationwide.

(a brief history of) space-time and rhetoric

Time has long been a touchstone of both rhetorical theory and practice, even if it has never fully been afforded canonical status within the discipline. As Collin Bjork and Frida Buhre (2021, "Resisting") note, despite the fact that temporal rhetorics may not be an officially named subfield of research within rhetoric, there is no shortage of scholarship that centers temporal concerns. To name only a few examples, time has been central to investigations of social justice (Bjork & Buhre, "Braiding" 2021; Gomez, 2021), gender studies (Aronson, 1999; Jack, 2007, 2009; McBean, 2015), disability studies (Gallop, 2019; Samuels, 2017), and social responsibility (Vivian, 2014). In fact, such attention has been afforded to time that Doug Downs (2022) has recently called for it to be named threshold concept proper in writing studies. Such a wide disciplinary engagement evinces the fact that the very idea of temporality is rather complex as it has been conceptualized and operationalized in a multiplicity of divergent ways. Therefore, it might do better to conceive of time as entangled—as mutually-informing but nevertheless multiple rhetorical *times*: namely *chronos, kairos,* and *chronotypes*.

As I'll show, these three frameworks for engaging temporal concerns are not mutually exclusive, independent categories but instead are entangled—weaving deeply in and through each other. I want to elucidate how the very concept of *time* is itself a "coordinating mechanism" (Mol, 2002, p. 117) that holds together a distributed collective of mutually informing types of time. Through this entangled reading of rhetorical times, one of my aims is to locate the temporal with/in the material, to demonstrate how times are not just discursive but also-always ontological. I also want to draw attention toward how various configurations of space-time (again: chronotypes) can be productive for understanding value-oriented enactments of digital learning technologies. Finally, I want to push against the concept of multiple ontologies and instead argue for what I call *quantum ontologies* wherein chronotopic enactments of technologies don't [necessarily] arise from discrete sites of becoming, but instead exist in a quantum state of superposition. Such a topos allows for many chronotypes to occupy the same techno-material space. This extension of chronotypes is important because it helps demonstrate how digital technologies, especially in online learning environments, can work in service to ethics other than that of expediency.

chronos

The first framework for understanding time is *chronos,* or time as broken into discrete, quantifiable, and linear units of measurement. On its surface, such a rendering of time might appear to exist outside the purview of rhetoric, a refrain not unfamiliar in rhetoric. For instance, Michelle Ballif (1992) argues—rightly—that the reclamation of women's histories hinges, in part, from time being "experienced *kairotically* not chronologically" (96). Here, Ballif seems to downplay the rhetorical aspects of time-as-chronology. However, as John Gallagaher (2021), counters (also rightly), more overtly rhetorical forms of time, such as *kairos,* are only possible because of the organizational structures provided by chronological time. Gallagher contends that "*chronos* frames and circumscribes *kairos*" (p. 533), thereby more closely relating these two temporal frameworks and, in the process, highlighting the distinctly rhetorical consequence of *chronos*. Further, I would argue that it is rather reductive to characterize chronos in such descriptive, a-rhetorical terms as "mere chronology" might suggest on its surface. The very

conceptualization of clock time after all, involves the imposition of a linear organization of events which, in turn, implies at least some level of rhetoricity, however subtle and naturalized.

kairos

More frequently than *chronos*, time has also been framed in more overtly rhetorical terms via the Aristotelian notion of *kairos*, or the importance of timeliness for persuasive discourse. If chronos represents time as quantitative, kairos introduces a qualitative and more distinctly rhetorical perspective of time. This is not to suggest, though, that kairos, as just one iteration of time, can itself even be limited to *just* opportune timing and appropriate measure. On the contrary, following James Kinneavy and Catherine Eskin's (2000) call to consider a more expansive definition of kairos, this temporal framework has experienced rich, multidimensional engagement across the field including its theorization as mindfulness (Peary, 2016), a rhetoric of revelation or divine time (Crosby, 2009), ambient dwelling (Rickert, 2004, 2013), and as a *spatio*-temporal analytic tool for image events (Stephenson, 2009). This is to say, then, that much like chronos, kairos too exists as an entangled multiplicity of time/s in and of itself; to say nothing, again, about the ways in which it is always-already entangled with chronos.

An important aspect of kairos as a rhetorical framework is that it is not limited to (just) the discursive but is also inclusive of material concerns. While many rhetorical theorists have engaged *kairos* as a matter of (also) matter, arguably none have been as forceful or thorough as Thomas Rickert in mattering time, particularly in his pivotal work *Ambient Rhetoric.* Importantly, for Rickert, an acknowledgement that kairos and place are enmeshed is not a novel or even recent advancement in the field. For both ancient and contemporary rhetorical theorists, Rickert argues that,

> "...kairos itself, as something ontological, is inseparable from new forms of becoming, new forms of disclosure. The kairos of a situation is a moment placed not as something between a subject and exterior situation but as mutually involved and evolving vectors of material and discursive force….[p]lace on this account is not a neutral, material stage for the emergence of a kairotic situation but itself a complex of relations vitally enmeshed in what comes forth to take place as kairos" (p. 90).

The place-based, situatedness of time is not meant to contradict the more traditional discursive approaches to understanding kairos; rather, it extends them by recognizing that some discursive possibilities are foreclosed and others created precisely *because* of the material affordances of time-as-emplaced. To invoke time as rhetorical, then, is likewise to invoke place. That is, the environment, to include the material as well as the temporal, is merely not a backdrop for rhetorical action but is itself agential. This coupling of matter to time is largely commonplace in lay terms: we never ask someone to meet us at a certain time without also specifying where to meet. But the entangling of temporality and materiality is significant for rhetorical theory because it opens up the possibility for time to be both enacted and experienced differently in relation to material (and, as I'll also argue, technological) configurations; which is to say that time can be read as *chronotopic.*

chronotypes

In composition-rhetoric, the concept of the chronotype has not necessarily been an area of intense disciplinary focus, but it has been employed as a framework for analyzing the relationships between: genre and power (Schryer, 1999), writers' process and literate activity (Prior & Shipka, 2003), argumentation and deliberative rhetorics (Jack, 2006), and subject-matter expertise and ontologies (Jack, 2022). Of these unquestionably important figures, Jordynn Jack stands apart given her sustained and extensive efforts to draw disciplinary attention to the rhetorical consequence of spacetime configurations. Jack (2007) initially attended to chronotypes in largely representational terms, as "a way to understand not only how such [ideological] arguments depend on specific configurations of space and time, but also the implications of those space-time configurations for argument and decision making" (p. 52-53). More specifically, Jack uses the concept of chronotypes to analyze the ideological underpinnings of policy arguments associated with genetically modified foods (GMFs). In total, Jack identified four distinct chronotypes related to GMFs (See Table 1).

Chronotype	**Characteristics**	**Spatiotemporal Constructs**	**Ideological Arguments Authorized**
Time-space compression	"refers to technologies that seem to accelerate or elide spatial and temporal distances" (p. 57).	present and immediate future; global marketplace	regulatory practices hinder growth; rapid proliferation of technologies is desirable so as to avoid falling behind
Substantial Equivalence	suggests that [new] technologies can be evaluated in comparison to existing analogs (p. 59).	present; narrowly defined contexts of use	new regulations are unnecessary; dismissive of ethical concerns related to technologies because of equivalence
Precautionary Principle	argues against the release or wide-spread use of technologies until their long-term safety is proven (p. 61).	long-term future; broadly drawn conception of space and time	regulations are an ethical imperative; emphasizes the contingent and evolving nature of technologies
Life cycle	focuses on the cyclical, developmental, and continually changing aspects of technologies (p. 63).	past, present, and future; ecosystems	ambiguous about regulatory practices; ideologically ambidextrous and can serve other chronotopic arguments

Table 1: An adaptation of Jack's (2006) initial description of the four dominant chronotypes used to support policy arguments related to genetically modified foods.

While Jack's work in "Chronotypes" is foundational for many reasons, I want to draw attention to two insights of particular importance. First, chronotypes not only create meaning, but they also are performative in that they coordinate action. "The relationship between space and

time," Jack argues, "is always *value-oriented*, reflecting societal assumptions about the place of human individuals in space and time and the type of action allowed within that space and time" (p. 67). Thus, chronotypes are more deliberative than they are descriptive.

Second, Jack's early work positions the technological as also material. GMFs, for Jack, are both a material thing *and* a technology. This point is key because technology, especially digital technology, is frequently read in non-material ways. For example, digital learning management systems (LMSs) are typically positioned as inert vessels through which instruction passes—as *non-places* that lack, or at best inhibit, relationships (Rice, 2012, p. 8). The technological *is* material *is* rhetorically consequential. Angela Haas (2012) argues just this point when she defines technology as a techné, "not as transparent things but as cultural artifacts imbued with histories and values that shape the ways in which people see themselves and others in relation to technology" (p. 288). Digital technologies, such as LMSs or GMFs, then, are not virtual spaces through which information passes devoid of relationship, they are highly consequential techno-material places—places with spacetime configurations that have the potential to control and coordinate users' values and actions therein.

(re)turning to chronotypes

Jack (2022) re/turned[3] to chronotypes as a means for examining the relationship between subject matter expertise and water ontologies (See Table 2). This further exploration of chronotypes again drew on a public policy debate (this time over water rights) but was decidedly less interested in the discursive forms of rhetorical argument possible in a given spacetime configuration. Instead, Jack worked to tie ethos (expressed as expertise) to materiality vis-à-vis the chronotype. She argued clearly that "we can understand these different enactments of water not simply as discursive frames that all represent the same thing but as *ontologies* arising from diverse enactments of water present in different communities and institutions" (p. 328, emphasis added). Yes, chronotypes are discursive; but they are also deeply ontological—entangled with and in matter.

Toward this end, Jack offered three different chronotopic enactments of "water-as", each with a unique spatiotemporal relationship that authorizes unique types of expertise. The naming of multiple (and, per Jack, competing) ontologies represents a crucial advancement in theorizing the rhetorical import of chronotypes (See Table 2). For one, as an ontology, *water itself*, not the arguments it authorizes, is an iterative and emergent rhetorical agent. What's more, similar to the aforementioned concept of times as multiple, water ontologies too emerge as chronotropically multiple: water located in a lab (water-as-chemical-entity) is not the same water that is located in a private well (water-as-resource). Importantly, for Jack, chronotypes are indeed multiple and simultaneous, but they arise from discrete space-time configurings[4]. For example, the water-as-lifeblood ontology could not result from a space-time configuring wherein water is located in a lab.

According to multiple ontologies, it is the limited space-time of the laboratory itself that allows water to be enacted as water-as-chemical-entity; conversely it is the deep time scale and a broad ecosystem that enables the performance of water-as-lifeblood. And as multiple, these two ontologies could not occupy the same topological space and therefore necessarily exist, at least

partially, in contradistinction to one another. This is not to say, however, that these ontologies are wholly separate; they are not. As Annemarie Mol (1999) has argued, "what 'multiplicity' entails instead is that, while realities may clash at some points, elsewhere the various performances of an object may *collaborate* and even *depend on* one another" (p. 83). It might therefore be more accurate to say that chronotypes can be enacted as a mutually inclusive single-multiple—as "more than one but less than many" (Law, 1999, p. 10). But despite this hanging-together of chronotopic ontologies, we are still confronted with the problem that multiple enactments of chronotypes remain separate enough such that they are unable to simultaneously occupy the same space-time locality. The time-space configuring seems to limit and fix what chronotypes may arise from it.

Ontology	**Characteristics**	**Space-time locations and chronotype**	**Expertise authorized**
water-as-chemical entity	configures water in molecular terms, subjected to the scientific method and yields quantifiable data (such as alkalinity and hardness levels)	laboratory; test tube. operates under a settler-colonial chronotype that "disconnects water from its embeddedness in an ecosystem or in the lives of people who use it" (p. 333).	testing companies; public health officials and agencies
water-as-resource	configures water in terms of human use; water is *done* in terms of quotidian and daily usage (e.g., drinking, cooking, bathing, etc.)	houses; water wells; farmland. operates under a settler-colonial chronotype that ties water to the legal rights landowners, specifically those in rural areas; present-focused and elides future consequences	land and homeowners; rural community members; select members of the scientific/technical community (e.g., geologists)
water-as-lifeblood	configures water in ecological and interconnected terms; water itself becomes vibrant and agential; "humans…are responsible to water, not owners of it" (p. 335).	aquifers; groundwater. operates on a decolonial, sustainability-minded chronotype that "assumes a long timescale and a broad spatial scale" (p. 335); inclusive of ancient past, the present, as well as distant futures	Indigenous peoples and "knowledges that stretch over a longer history and extend into the future" (p. 335).

Table 2: This table presents Jack's (2022) most recent re-theorization that situates chronotypes as multiple ontologies; important to note is that each chronotype is restricted to discrete material sites—chronotypes do not flow between or within localities.

But in technologically mediated space-times, quite often multiple chronotypes frequently do inhabit the same material configuring—a contradiction that multiple ontologies seemingly cannot resolve. Learning technologies, like LMSs or Zoom, can simultaneously be enacted as a matter

of efficiency *and* social justice in the same space-time configuration. What I am proposing, therefore, is a model of quantum ontologies that builds on Jack's theorization of chronotypes and is better able to account for a variety of value-oriented chronotopic enactments existing within the same material configuring. Whereas Annemarie Mol (2002) argued for flow *between* sites of becoming, I posit the existence of flow *within* a site. Such a re-rendering of chronotypes is important because technological spaces are frequently underwritten by what Stephen Katz (1992) has previously termed an ethic of expediency wherein efficiency-for-efficiency's sake becomes the driving ethical force, and so "subsume all other ethics under it, making all ethics expedients and thus replacing them" (p. 270). However, even though quantum ontologies create the potential for enactments of digital technology beyond that of efficiency, it is vitally important to note that the realization of such enactments hinges on their ability to be accounted for. What is needed, then, is what Barad (2003) terms a *politics of possibilities:* "ways of responsibly imagining and intervening in the configurations of power, that is, intra-actively configuring spacetimematter" (p. 246). In the following section, I explore the various, quantum ways that chronotypes are enacted in digital technologies.

quantum ontologies & digital technologies

Classic Euclidean geometry holds that two *objects* cannot simultaneously occupy the same space-time location. This is a relatively intuitive topology that informs the way in which the world is typically experienced, both physically and digitally. For example, my coffee mug may rest *on top* of my desk, but it cannot occupy the same space as the desk at the same time. Likewise, in conventional computing technology, a binary digit may have a value of either 0 or 1, but not both. And, as previously discussed, this also extends to chronotypes since they are typically understood to arise from discrete material configurations. But a quantum approach turns conventional thinking on its head and introduces a strange new topology wherein two (or more) objects can, and indeed frequently do, occupy the same space-time locality at once—a core feature of the quantum world known as *superposition*.

Superposition isn't a theoretical construct that is as counterintuitive or complex as it might initially seem; after all, we see evidence of overlap in the oscillations of a medium like water which results in the crests and troughs of waves. A crest is simply the amplification of energy that occurs when two or more waves occupy the same point in space at the same time. All this makes perfect sense when we're talking about waves, not particles. However, precisely because energy and matter are relational, not oppositional, it is possible for matter, too, to likewise exist in a state of superposition. Ontologies, concomitantly, can be thought of as quantum rather than multiple. Quantum superposition is therefore not only a useful, but also a necessary construct for extending our understanding of chronotypes and how they operate with/in techno-material spaces. In what follows, I discuss the results of this research study and show how many chronotypes exist in a state of superposition within various technological learning spaces thereby creating the potential for these technologies to avoid being subsumed under an ethic of expediency. This analysis focuses on the ontological enactments of blackboard[5], as this was the most frequently invoked digital learning technology, but equally applies to other digital learning technologies such as canvas, slack, youtube, microsoft teams, zoom, to name only a few.

A key argument that I draw toward is that the potential to enact digital technologies as a matter of social justice cannot be actualized until instructional and technological energy is directly applied so as to bring social justice into reality. Social justice in digital spaces is thus intra-active and emergent because "quantum superpositions…tell us that being/becoming is an indeterminate matter" (Barad, 2010, p. 251). There is no determinate fact of the matter concerning how these spaces will be enacted, as matters of efficiency or of social justice. Put differently, while superposition does open up the potential for technologies to be enacted in ways beyond that of efficiency, they nevertheless remain in a state of *indeterminacy* until they are observed as such. What is required, therefore, is for institutions and instructors to actively bring matters of social justice to the forefront of their enactments of digital technologies. Failure to do so necessitates that they will remain in a state of indeterminacy and thus increases the potential for them to [continue to] give way to models of efficiency given, again, Katz's (1992) assertion that an ethic of expediency tends to obscure even the possibility of alternative enactments of digital technologies. More succinctly, institutional structures (including faculty) tend to enact digital learning technologies first as a matter of efficiency, as I show below. Absent directed and intentional enactments beyond that of efficiency necessitates that this will continue to be the dominant valuation and enactment of digital technologies.

blackboard-as-flexibility

Despite (or perhaps because of) their near ubiquity in online learning environments, the very mention of learning management systems (LMSs), like blackboard, tends to elicit derisive sighs and remarks about how the software's interface is "clunky" or "not exactly the most user-friendly." Yet, the instructional impact of LMS's is multifaceted, as much a matter of local implementation as it is of generalized design (Boettcher, 2003; Posey & Lyons, 2011), and there are a variety of ways that blackboard iterates as a techno-material space. **Flexibility** is one of the most common ways that blackboard is materially configured and instructionally enacted. For example, when queried about what they value most about blackboard, instructors most frequently cited the flexibility this technology affords students *and* instructors—where flexibility specifically refers to blackboard's ability to distribute instruction both geographically and temporally beyond the traditional boundaries of the university. As one instructor explains:

> "I think the first time I realized how beneficial flexibility was [in blackboard] was when I was pregnant. I was a single mother and was able to continue working…I like being able to work when I want to, and I think that need for flexibility also extends to my students. A vast majority of them [students] work, and so they're not having to try and fit a class into their work schedule and worry about missing a class."

This enactment of blackboard-as-flexibility bears resemblance to Jack's (2006) *time-space compression* chronotype in that it reconfigures the spatiotemporal boundaries that normally mark instruction (See Table 1). Under this chronotype, the institutional reach is global—it's presumed that teachers can teach and students can learn from anywhere (notwithstanding considerations of who actually has digital access, a point to which I return momentarily).

Flexibility, then, becomes closely associated with efficiency and takes the form of geographic and temporal **connection**. This affirms Salisbury's (2018) observation that many instructors see

LMSs primarily as "just a tool" in service to instructional efficiency (p. 11). On the one hand, it is possible to read such a construction as operating under the auspices of an exploitive, neoliberal ethic of austerity (Welch & Scott, 2016) wherein the *ability* to work flexibly can easily be co-opted by the *expectation* to do so—to be available to answer emails at all hours, to work while on family vacation, to set aside care-giving responsibilities to attend to instructional matters. As another participant described: "It [blackboard] is one of those things where it's like 7 or 8 o'clock at night, and I've been up and working since literally 7 am and I'm exhausted. But I'm doing it to meet my students' needs[6]." Another participant described this phenomenon as "teacher immediacy." Another instantiation of this chronotype is the idea that online learning provides students with flexibility toward the completion of their degree and "improved time-to-graduation", arguments made by several instructors in this study. Again, it is the techno-material configuration of blackboard itself that gives rise to this chronotopic enactment of efficiency that compresses geographic distance and elides traditional temporal boundaries associated with the university; but this is not the only possible ontological enactment of this space-time configuring.

blackboard-as-disconnection

While blackboard is often enacted as a matter of flexibility and efficient connection across time and space, it is simultaneously decried for being a techno-material space that is both prescriptively **rigid** and **socially isolating**. As another participant expressed, "Even if you have discussion boards or public journals that have asynchronous contributions [in blackboard], it's all still pretty rigid, pretty hierarchical. And it's hard to have a sense of personality and to click with other people in class."[7] Whereas the previous enactment of *blackboard-as-flexibility* spread the university out across geographic space, this enactment draws the institution decidedly in and locates instruction in more narrow terms, as existing within the confines of a "limiting" and "rigid" software program. In fact, one participant noted that blackboard is far *less* flexible than their in-person teaching, and that inflexibility is highly limiting. They note,

> "The structure of the course *has* to be the same week to week [in an online class] to set students up for success. Whereas when I'm teaching in-person I have more freedom…I can have a topic I want to cover but if there is something interesting happening in the world, I could incorporate that into the lecture or throw out my original lesson plan and build one on that new topic."

Therefore, not only does the enactment of *blackboard-as-disconnection* constrict the material space of instruction, it also seems to fix temporality by its inability to address kairotic events in a timely fashion. Another participant echoes this same limitation, noting that "I'll be scrolling through Facebook or AppleNews and see an article that I really think would apply well to my students, but I really have no way [in blackboard] to, you know, easily and spontaneously share this relevant and recent content with them." Time in this ontology, then, is slowed considerably in comparison to *blackboard-as-connection* as seen when instructors describe the techno-material space as "inefficient," "cumbersome", or "not at all user friendly." Accordingly, the chronotopic flow of time in this space interrupts the accelerated, face-paced experience of time typically enacted in digitally-mediated environments.

Furthermore, because this enactment of blackboard is highly disconnected, both spatially and temporally, it is also an ontology that can create social distance between users. When asked what challenges blackboard presents them, instructors frequently referenced the separation from students that is prevalent in these spaces. As one participant notes, "Teaching online, I feel like it's hard to, I feel like I have a hard time getting to know students, getting to engage with students as people." But more than just a matter of getting to know students on a personal level, *blackboard-as-disconnection* is also an ontology that is capable of obfuscating users' identity and cultural markers in the name of anonymity. Even if this stripping away is not intentional or a matter of purposeful design, it nevertheless has the potential to whitewash this instructional space (Banks, 2006; Kolko, 2000). For this very reason, one instructor noted that "It [blackboard] can erase a lot of students' cultural identity…so, one of the reasons I like Slack is that it's easier for them to create a digital presence that reflects those pieces of themselves." Thus, as a matter of disconnection, blackboard can, in many instances, be both socially *and* culturally isolating— thereby stifling social justice efforts.

blackboard-as-social-justice

Digital learning technologies have frequently been associated with efforts to democratize higher education (Blair & Monske, 2003; Brady, 2001; Sano-Franchini, et. al., 2023). Perhaps ironically, this is an argument that can be, and often is, authorized by the *blackboard-as-flexibility* chronotype even though this spacetime configuration is underwritten by a neoliberal ideology that works counter to social justice efforts. For example, when asked how digital technologies specifically benefit minority students (again, at an institution designated as both an HSI and MSI; see *study design*) instructors often deferred back to the flexibility that digital technologies afford students, offering responses such as "students, if they [minority students] are experiencing hardships for whatever reason, I feel like blackboard gives them some more flexibility to deal with that and go to school" and "it [blackboard] creates opportunities toward finishing their degree that they wouldn't have otherwise."

Another frequent response to the relationship between digital technologies and minority student populations was to, in well-meaning ways, sidestep the issue of culture and race altogether in favor of discussing how digital technologies affect *all* students. One participant noted that "It's not just our minority students. It could be a student who perhaps works three part-time jobs to pay their bills. And so, regardless if they're a minority student…I mean, I grew up poor too, but online learning allows them to work and still 'come to class.'" Another participant responded similarly, saying "I don't know if I have enough information to answer that. I don't want to make assumptions about folks who are LGBTQIA or people of color…I have diverse classes and I haven't seen any real differences between the way that minority student other students are affected by digital technology." Responses such as the aforementioned indicate that social justice enactments of digital learning spaces can be rather obscure and difficult to ascertain; though this isn't to say that such enactments are not possible, only that their realization requires acute and intentional energy applied thereto.

In fact, even though *blackboard-as-social-justice* chronotopic enactments were a minority, there were multiple instances where instructors discussed, in pointed detail, how this digital technology works to serve issues of **diversity** and **justice** in their online classes. To begin, while

many instructors did invoke *blackboard-as-flexibility*, they were equally quick to point to the tacit inequity in this chronotype by drawing attention to the persistence of the digital divide. For instance, the same instructor who above indicated that blackboard creates opportunities for minority students immediately contextualized that comment saying,

> "We like to think of technology as colorblind and an equalizing force, but that's an easy assumption for a middle-aged, white person like me to make. The truth is that it *does* create opportunities, but those opportunities aren't evenly distributed across demographics like income and race. Like, can I reasonably assume that my minority students have the same access to high-speed internet that I do?"

Online instructors, in other words, are acutely aware that differential **access** impacts the social justice potential afforded by this spacetime configuring. In this chronotopic enactment, space, again, is expanded beyond the traditional boundaries of the institution. However, this expansion of space is not *just* about connection; instead, it nuances the concept of connection by also considering how access is more than mere availability. Expanded access in this chronotype is a deeply networked as well as social and material phenomena inclusive of considerations like *quality* (e.g., reliable internet access, a dedicated space at home for doing school work, not having to share technology with other family members, etc.) and even *types* of connection across space.

Just as the quality of access is unevenly distributed across demographics, the ***type* of connection** is also highly consequential for social justice enactments of this technology: desktop-blackboard is distinctly separate from mobile-blackboard. And even though students are, with increasing regularity, accessing instructional materials via their mobile devices, blackboard's user experience is still optimized for a desktop interface. This, again, causes uneven access to instruction. As one instructor noted, "It seems like the way education is moving, students need access to something with a big enough screen that can actually do things. And a keyboard. Like, I know students are trying to submit these long blog post assignments that were written with their thumbs. You can't write an essay with your thumbs. So, I question if those assignments are an unfair ask." Another instructor recalled how a student had purchased a Chromebook only to discover that it wasn't capable of doing the technological work required for the course. Thus, the *material* means of connection across wider geographic space are not, or should not be, a given; they are highly consequential. And in order to enact these technological spaces for equity and justice rather than rote efficiency, instructors must be attuned to the wider, more inclusive aspects of access.

Another important spatial aspect of the *blackboard-as-social-justice* chronotype is that precisely because this technology broadens the traditional geographic reach of the institution, it creates instructional spaces that are more **culturally responsive** and, in many cases, more welcoming for minority students. As one participant explained, "When students go into a physical space on campus, they know very quickly what the dominant cultural narrative is there—it's a white space. Whereas, in an online learning environment, you don't have those traditional white-dominant optics…we can create a space that is free from hegemonic optics." Again, contra *blackboard-as-flexibility*, in this enactment of blackboard, it's *not* that instruction can be *anywhere*, a spacetimemattering that is underwritten by neoliberal ethics; instead, the

specific locations—technologically, materially, and culturally—matter, particularly for minority students. An example of how the specificity of space matter was indicated by a participant who noted that "One characteristic of our student population [as an HSI] is that, and this is anecdotal but it's a fair point, but I've seen in my students a strong connection to place and family. So, online tech allows students the opportunity to stay connected to the cultural places that matter to them while still going to school." In this instance, blackboard is still a matter of connection, but that connection comes to matter through social justice concerns rather than simply being able to access the institution anywhere and anytime.

resolving indeterminacy: toward more socially just digital technologies

Thus far, I have shown how chronotopic enactments of digital learning technologies are quantum, how they exist in a state of superposition with multiple ontologies existing simultaneously in the same techno-material space. I want to conclude by discussing the importance of indeterminacy for enacting more socially just digital learning technologies. Following quantum theory, it's important to note that these various enactments of blackboard don't exist independent of one another; instead, superposition necessitates that they are *entangled* with/in one another. Again, one blackboard is not enough, but two is too many; blackboard is single-multiple.

But even in a state of superposition, blackboard can't at the same time be enacted *both* as a matter of efficiency *and* social justice. Even in the quantum world this would present an intractable paradox. Barad (2007) clarifies this point using the classical Schrödinger's cat paradox: "It is *not* the case that the cat is either alive or dead…or that the cat is both alive and dead simultaneously…or that the cat is in a state of being neither alive nor dead…the fate of the cat is entangled with the rate of the [radioactive] atom, and in the absence of an appropriate measuring apparatus, their fates are indeterminate" (p. 278). The only way to resolve the indeterminacy, again per Barad (2007), is to measure the phenomena: "When we observe a system, it ceases to be in a superposition." It is only through the intra-action of opening the box that resolves the superposition of the cat and atom; likewise, it is only by measuring blackboard—applying direct energy to understanding *how* it's being enacted—that we can actualize it as a matter of social justice because, again, according to Katz (1992) under an ethic of expediency, efficiency quietly and quickly becomes a de facto driving force. In order to elucidate how and why indeterminacy operates in digital learning technologies, I want to turn toward one participant interview, Peyton, in particular from this research study.

As I was interviewing Peyton, it became quickly clear that many of their enactments of blackboard, and other digital learning technologies, were underwritten by efficiency. When discussing the benefits of blackboard, Peyton noted that "what it really comes down to is efficiency and ease of use for me, the instructor. It's wonderful for setting things up where I'm easily able to find people's work and grade it and get it back to them in a shorter time frame." Peyton also shared how blackboard negatively affected the efficiency of their pedagogy, saying "In person, we can have class discussions really easily. But in blackboard, you know, using the discussion board, I'm having to go through and read 150-word responses from, you know, 30 or 50 students and trying to give substantive feedback to them is just impossible." Peyton also made multiple references to how blackboard, youtube, and zoom give students the ability to access

instruction while off campus. “There’s no real substitute for live, in-person meetings,” they noted, “but at least they have the option to access that content when it’s convenient for them.” I want to be clear that in offering this extended example from Peyton’s interview I am not intending to criticize these efficiency-minded enactments of blackboard; rather, I am wanting to show that, with near ubiquity, Peyton’s enactments closely resembled *blackboard-as-connection.*

However, as the interview drew to a close, I asked Peyton if there was anything else about their enactments of digital teaching technologies that they wanted to share with me. And something unexpected happened. Peyton shared how their child, who is hearing disabled and also enrolled at a different university, performs better in online courses, like courses delivered via zoom, because of the closed captioning capabilities that this technology offers that are not available in traditional, in-person courses. Peyton relayed specifically that online courses and supplemental instruction through youtube “creates much higher quality instruction for them [their child]. The closed captioning is really a needed thing.” Such a response was indicative of a social-justice enactment of digital learning technologies, yet Peyton was unable to see such possibilities in their *own* enactments of digital technology in their online classes. I don’t want to wander into conjecture about why Peyton might not have been able to see social justice potential in their own classes; rather the vitally important implication that I am driving toward is that such an enactment is only possible if purposeful and concerted energy is applied so as to resolve the indeterminacy of chronotopic superposition and make social justice a reality through digital technologies.

Haas (2012) argues that “Technology is not just what does the work, it is the work—and that work relies on an ongoing relationship between bodies and things” (p. 291). As digital learning technologies continue to proliferate across the landscape of higher education, a trend that has only accelerated in response to the COVID-19 global pandemic, it is vital for institutions and instructors to conceptualize ways for enacting these technologies, and the work they do, in ways beyond that of just efficiency. More work does need to be done that specifically examines the unique situatedness of minority students in online learning spaces; but quantum ontologies offer a productive way forward for understanding how these technologies can come to matter in more ethically defensible ways. Further, this theorization necessitates that we direct *more* energy, resources, and efforts toward actualizing more socially just enactments of digital technology on campuses.

Notes

[1] I take a broad approach in my understanding of technology. On one hand, following Durak (1997), I take technology to refer "equally to *knowledge, actions,* and *tools*" (p. 258). However, it is likewise important to note that the technological is also always-already cultural (Banks, 2006, 2011; Haas, 2007, 2012).

[2] This research project utilized an IRB-approved, qualitative research design. Data was gathered at a regional, public institution designed as an R2 Doctoral University, Hispanic Serving Institution (HSI), and Minority Serving Institution (MSI) during the fall of 2022. In total, 29 instructors completed an online survey and 23 agreed to the follow-up interview. Participants for this study represented a broad range of disciplinary affiliation and included faculty from all five different colleges across the university: Liberal Arts, Science, Business, Nursing and Health Science, and Education and Human Development. This does not suggest that the data gathered during this investigation should be interpreted as representative of all faculty experiences in the respective colleges; instead, this suggests a level of cross campus continuity about how digital technologies are being enacted.

[3] To re/turn to something is not (necessarily) to go back to an already-established past; instead to re/turn is to "turn it over again and again—iteratively intra-acting, re-diffracting, diffracting anew, in the making of new temporalities" (Barad, "Diffracting" 168).

[4] This reasoning closely follows Annemarie Mol's (2002) understanding of atherosclerosis as being distributed across discrete sites of becoming. For Mol, each enactment of the disease has "a site of its own" (p. 115).

[5] I avoid capitalizing "blackboard" here in order to indicate that this digital technology is quantum, or single-multiple, "more than one but less than many" (Law, 1999, p. 10).

[6] Interestingly, this participant also noted that one of the reasons that they made themselves so openly available to students early and late into the day was their desire to improve on a specific metric from the university's student evaluations, thereby strengthening the claim that time-space compression is underwritten by exploitive, institutional ethics.

[7] Important to note, and central to the argument that I am making, is that this is not the only enactment of blackboard articulated by this particular instructor. After discussing how blackboard is socially isolating, this instructor continued on to discuss how blackboard is also a matter of public health and social justice. Thus, many ontologies of this technology exist in a quantum state for this instructor. These quantum ontologies were a phenomenon observed in almost *every* participant in this study.

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