Community-Engaged, Digital Equity Mapping – Epistemology and Theory

1. Phenomenon description and background

Covid-19 exposed the true depth of the digital divide and the gap between people who have access to broadband internet, computers, and knowledge of how to use both and those who do not [1-3]. Historically, federal policy-makers have characterized the digital divide as a technical problem – a neighborhood either has the physical infrastructure "plumbing, pipes, receivers" to access the internet, or they do not. This centered the national debate on rural physical infrastructure deficits [4]. The position has been informed by data from the Federal Communications Commission (FCC), National Broadband Deployment Map [5] compiled from physical infrastructure access information provided by Internet Service Providers (ISP's – i.e., Comcast, AT&T, Verizon). However, this data does not align with survey information collected from both federal (e.g., US Census, American Community Survey (ACS) and the National Telecommunications and Information Administration (NTIA) survey) and advocacy sources (e.g., the Pew Research Center and Benton Foundation) – that document differential broadband adoption rates and reasons for, "non-adoption". In College Park and Riverdale, Maryland, the 2022 FCC access map indicates that both areas have 100% available coverage, yet ACS data indicate ~20-30% deficits in adoption [5,6].

Underpinning this discrepancy is a lack of granularity on exactly *what* and *where* barriers are and *why* they exist. Research has uncovered that urban issues in access and adoption disparities include [7-12]:

1. Lack of physical infrastructure: last-mile fiber; lack of hardware (computers, tablets, post-3G phones).
2. Affordability: infrastructure is present but individuals cannot afford it.
3. Friction: signing up for direct-to-consumer benefits or negotiating better rates/service is difficult.
4. Quality: individuals have access, but quality (speed/bandwidth) is slow.
5. Digital skills: limitations impact usability.

ACS data has allowed investigation of the phenomenon in relation to demographic information including income, race, employment, and educational attainment. The digital divide's complexity points to deterministic factors originating from political, technical, economic, social, cultural, and ethical realms. Below is a review of epistemological and theoretical lenses that shape my understanding of the issue and may guide the choice of research methodologies.

2. Research questions and methods

My overarching research question is, *how do we permanently close the urban digital divide*? My theory is that urban digital divides are driven mostly by pre-existing economic and social inequalities rather than technological, physical infrastructure deficits. However, it is possible that multiple factors can and do coexist and may exhibit different, place-based configurations. The following sub-research questions may help uncover contextualized understandings of root causes of both access and adoption barriers.

- What is the nature of the digital divide in urban neighborhoods?
- Are there place-based (i.e., neighborhood by neighborhood) differences in where the digital divide exists?
- What tools and methods will enable a full description of a specific neighborhood's digital divide with enough granularity to identify foundational contributing factors at the individual household level? For example, if a household cannot afford internet service, they may also be struggling with food and housing insecurities. How are pressures prioritized?

To answer these questions, in the context of the five articulated barriers, I envision a community-engaged, digital equity mapping research project in College Park and Riverdale MD. The project will collaborate with community leaders and neighborhood participants to co-develop and deploy a broadband access and adoption survey to gather data on: (1) *residential service gaps;* (2) *reasons why service gaps exist; (3) prioritization of pressures; (4) adoption of direct-to-consumer benefit programs; and* (5) *if service is present, a measure of quality per upload/download speed test.* This information will be layered onto existing maps built with the federal data sources noted above, as the foundation for future targeted investments in lowering digital divide barriers. Methodologies will include:

- a survey,

- participatory design, community focus groups to ensure the survey captures both binary information on physical infrastructure access, and contextualized information on underlying systemic, socio-economic adoption pressures,
- ethnographic, semi-structured interviews with community leaders on how best to engage with community members who do not normally answer surveys,
- community-engaged focus groups to discuss/analyze survey results, especially around prioritization of pressures.

3. Epistemological and theoretical lenses

My perspective on the digital divide has been informed by considering both objectivist and constructivist epistemological lenses and a range of attendant theories. The first allows for a better understanding of binary modalities in access and the opportunity to challenge assumptions regarding adoption through empirical design choices. The latter facilitates a contextualized understanding of the complex phenomena that likely interact to create adoption barriers and re-situates reasons for non-adoption at the systemic, rather than the individual level. Each section below will introduce a definition of the epistemology or theory in relation to aspects of the digital divide.

4.a. Objectivist lens

Historically, policy makers, guided by FCC data, characterized the digital divide debate as a binary technical issue; either the physical infrastructure is present to connect to the internet or it is not [4,11]. It is *objectivist,* using Crotty's 1998 definition, in relating the issue to a physical object and establishing that the "truth" of how to "know what we know" about the digital divide, resides in the presence or absence of the physical objects themselves and not in an operation of consciousness (i.e., mind of the researcher) [14]. This is the case in rural digital divides but also in certain urban digital divides where de facto monopolies have resulted in unequal and inadequate physical infrastructure development – factors hidden in past data sets by lax rules [11]. For example, Baltimore City has plentiful last-mile-fiber access in commercial districts and high-income neighborhoods. However, lower income neighborhoods lack ubiquitous last-mile fiber [13]. Building accurate physical-infrastructure access-maps remains a priority for digital advocates because: (1) this data continues to drive policy and funding priorities; (2) fiber access is the gold standard for broadband access; and (3) accurate knowledge of last-mile fiber may lead to increased market competition, vital for lowering consumer costs.

4.b. Objectivist lens informed by information foraging theory, and cost structure theory.

The *objectivist* lens can also be used to deconstruct established paradigms by explicitly challenging assumptions and empirically testing design methods. For decades, internet adoption has been rationalized as a reasoned and logical, *active choice* that people make; either people have an "interest" in getting online (when access is present), or they do not. This increasingly challenged binary assertion derives from a decade of survey responses about non-adoption, collected by multiple sources (NTIA, Pew Research Center), that have allowed for the description of only one primary reason for non-adoption, with the most popular answer as, "do not want/not interested; (no) relevance to my life" [15]. Pirelli and Card's, *information foraging theory* describes this process as analogous to, "evolutionary-ecological explanation of food-foraging strategies" [16]. The theory is developed by (a) adaptation (rational) analysis of information foraging problems and (b) a detailed process model. Here, the theory assumes that people, when possible, will modify their strategies or the structure of the environment to maximize their rate of gaining valuable information. If this were the case in the digital divide, individuals would modify the structure of their environment (get the internet) to gain access to valuable information online; if they do not, then they must not value the information. Recent research by Horrigan has demonstrated that, "no-relevance" responses can be overly-elicited by poor survey design (open-ended vs closed questions). When the question is re-designed with the ability to document multiple, competing reasons/factors that can be prioritized, affordability rises as the primary reason for non-adoption *(cost structure theory)* [15,16]. By drilling down into more granular data via an objectivist lens, with the intent of using more finely tuned empirical designs to challenge assumptions, we can increase our understanding of the problem. Ford's research also encourages empirical redesign of broadband adoption surveys to decrease ambiguity to identify the potential for linked effects (i.e., not relevance or price but relevance and price) [17]. The objectivist lens and related theory will be helpful in ensuring that when the survey instrument is designed for this research project, assumptions are tested, pre-deployment.

5.a Constructivist lens

The *constructivist* lens details that there is no, "one truth" that can be known or discovered. Instead, each participant or group of participants constructs their own understanding of the phenomenon [14]. The lens allows for the *relational* details between physical objects, stakeholders, barriers, and solutions to be a rich source of information and understanding. The lens underscores that the digital divide phenomenon cannot be known and understood except in relation to the actions and interdependent relationships between stakeholders including affected participants, federal and state policy-makers, ISP companies (most often private with just a few municipal providers), anchor institutions (libraries, schools, health care providers), municipalities, and advocates/researchers. Multiple theories, detailed below, allow for the inclusion of contextual and relationally-based research methods to uncover new knowledge.

5.b Constructivist via information infrastructure studies (pre-computer supported cooperative work).

Information infrastructure studies theory, researched by Bowker, Star, Jackson and others [18-20] is squarely constructivist. The theory was monikered the "relationist approach" to encourage users to see technological infrastructure as contextual and not a set of things [21]. It informs the digital divide phenomenon by contrasting the objectivist, physical infrastructure paradigm, with a relational definition for infrastructure – per Bowker, "…understanding the nature of infrastructural work involves unfolding the political, ethical, and social choices that have been made throughout its development" [18, 21]. Sandvig's (2010) review of the theory's history, details that the approach originated from the hybrid socio-technical areas of research that became *computer supported cooperative work* and was developed to help diagnose why large-scale computing projects often ran into unexpected problems and failures. It provides a foundational understanding of "…the *infrastructure* for the computing infrastructure" that is often invisible until something breaks [21,22]. The theory allows for multiple perspectives to be held simultaneously as perspective flips, as in when the background of an image is one thing and the foreground another and one can flip back and forth, visually between them [21].

This theory is foundational in helping to describe and diagnose digital divide barriers. Via this lens, issues can be viewed through multiple perspectives simultaneously: technical and political; social and political; and individual and systemic. For example, some urban neighborhoods have gaps in the last-mile physical infrastructure deployment that can be traced back to ISP cost/profit decisions [13,23] – a technical issue with political influences. As a society we could mandate, via policy, a systemic restructuring of the industry as a utility (a public good like water, gas, and electricity); incentivize local competition to lower prices (i.e., break up monopolistically large companies), or build more municipally owned systems as in Chattanooga, TN and Westminster, MD where the city becomes the ISP and owns the fiber (as well as the risk) – a political issue with social effects. While the industry has aggressively resisted widespread systemic restructuring, debates about options continue to inform the digital divide issue – including how essential the accurate and complete data mapping of the physical infrastructure is to understand the potential impact (positive and negative) of funding and policy decisions. This understanding relates to an extension of the infrastructure information theory that states new technologies emerge on an already existing ecology of ubiquitous sociotechnical relationships [24]. Hence, mobile networks, when introduced, did not close the digital divide as some forecasted. Instead, the divide deepened in new and unexpected ways [25]. People that do access the internet via a mobile phone may still find it difficult to fill out a job application and attach a resume with this limited hardware. Non-adoption survey analyses continue to correlate digital divides with pre-existing socio-economic issues; these gaps are more pronounced for low-income households and communities of color [2,6,7,10,13,15]. Thus, historic systemic inequalities are now being expressed digitally and inflicting new individual harms.

5.c Constructivist lens informed by feminism

Intersectional feminism is an extremely useful theory to contextualize digital divide barriers because, as outlined by D'Ignazio and Klein (2020), it prescribes the interrogation of power systems and opportunities to, "…help overturn systems of oppression that cannot be reduced to a single structure or source" [26]. Data feminism goes further by explicitly detailing the need to examine and challenge power, rethink binaries and hierarchies, and consider context [27]. Stemming from the critical *structuralist* theories of Michel Foucault (per the D'Ignazio and Klein 2021 paper) – that detail how power distorts epistemology and how social hierarchy influences accepted knowledge – these feminist principles have been integrally applied to the research of geographic knowledge and cartography [27]. Kurgan's work allows for the binary

scale underpinning power systems to be visualized by introducing social and political questions onto map visualizations [28]. This additional knowledge not only provides context and complexity but allows the *realness and reality,* with which we inherently imbue maps and geographic images, to be questioned. For example, Kurgan's work exposes that the implied objectivity of Google Earth images are, "a patchwork of archived aerial and satellite images of varying origins, sources, motivations, and resolutions", compiled from different private and government sources. They are not reliable transcriptions of our landscapes (even when useful). This understanding is what Kurgan calls *para-empiricism*, a recognition that data "…means nothing more or less than representations, delegates or emissaries of reality" [28].

This empathetic perspective, when applied to digital divide mapping, can be enlisted to ensure that survey questions meant to uncover barriers, are not over-simplified for expediency, but allow for multiple, competing pressures to be voiced and mapped. This can be best operationalized through methods used to design, test, deploy, and analyze the survey results. Assumptions that will inevitably be a part of an initial survey design (per relational infrastructure deficits) must be tested contextually - with and by community members – to allow for the examination of (sometimes invisible) structural power systems and hierarchies. Further, it will be helpful to provide this positionality in the data analysis and reporting - that the map developed is still just a representation of captured information; it should not be considered complete or finished – but a snapshot of some of the barriers relating to the digital divide.

5.d. Constructivist lens informed by asset-based design.

Asset-based design theory has been used as an approach in both information science and urban planning research to empower community-engaged processes for driving development and articulating prioritized needs; the approach is outlined in Dickinson's (2021) work on community-led violence prevention [29-32]. I first encountered this method in 2017 on a research project I supported where a team of technical and social scientists sought to understand how investments in 5G and smart cities technologies could improve lives. Lung-Amam led the design of a qualitative case-study via an *asset-and-community-based* approach using in-person focus groups with residents in Sandtown-Winchester, Baltimore [9]. These methods allowed participants to collectively construct a knowledge-base that was not neutral; it was immersive, complimentary, and additive. For example, while debating the potential effects of installing neighborhood *smart trash cans* (wifi-enabled trash cans that would digitally alert the City when full), it was noted that trash-collection jobs were important stabilizers for the neighborhood. If these were eliminated, overall employment opportunities might be negatively affected. The group then discussed that they wanted to be, "*…producers and facilitators of smart interventions as well as their users. They argued that new technology should provide residents with jobs and technology-related training".* This led to the discussion of the need for ubiquitous residential broadband access to get these jobs and skills training. This asset-based approach allowed focus group participants to clearly articulate highest priority needs to drive future decision making. My understanding of the impact of the digital divide on both individuals and communities, was shaped by this research project – its intent, design, and outcomes. Future research designed to map digital divide access and adoption barriers, will be enriched by approaching the methodological design with an asset-based approach, strengthened by including community in participatory-design activities that will challenge the assumptions and hierarchies of the mapping survey instrument.

5.e. Constructivist lens informed by information marginalization from a critical, grounded theory perspective.

The constructivist lens is exemplified by Gibson and Martin's (2019) approach to re-situating *information poverty* from a *critical, grounded theory* perspective [33]. Their use of this theory as a pivot toward a more nuanced, theory of *information marginalization* allows a reframing from, "…the behavior of the individual (experiencing "poverty")" to the institution (creating "poverty")". This new theory describes, "…systematic, interactive socio-technical processes that can push and hold certain groups of people at social "margins," where their needs are persistently ignored or overlooked." By utilizing grounded theory, the systematic yet flexible guidelines for collecting and analyzing qualitative data, allow the construction of theories "grounded" in the data themselves. This approach mirrors closely to the asset-based design theory work done by Lung-Amam [9].

What has happened in the digital divide is similar. Non-adopters have been characterized as having made a "choice" as opposed to being negatively influenced by systemic technical, social, economic, and political forces [2,6,7,10,13,15]. These externalities have shaped both technology deployment and access to systematically marginalize adoption – including through gaps in wireline access, friction in attaining affordable service plans, and lower-than-advertised bandwidth speeds that can make the internet functionally unusable (i.e., not able to Zoom) [2,9-13]. Socio-economic factors like income, employment, and race that have underpinned a long legacy of disparities (educational, environmental, health-related), likewise exert their influence on digital access [34]. This was clearly seen during Covid-19 when education departments across the country scrambled to supply computers and hotspots to students to deliver the remote learning curriculum. The service that has politically been termed a luxury as opposed to a utility, was redefined as a basic need, one that has not been accounted for by our systems [35].

6. Conclusion

Reviewing my research topic through multiple epistemological lenses and theories has highlighted the need for my research project to be flexible, collaborative, and contextual. The objectivist lens cements the need for accurate physical access maps at the individual household and neighborhood levels. The constructivist lens ensures that the survey instrument designed to capture this physical infrastructure information also describes the relational, invisible infrastructure and baked-in assumptions. Without both lenses, the research might not be both generalizable per access and describe how systemic structural influences exert adoption prioritization pressures. The community-engaged methods to ensure contextual sensitivity may also provide an avenue for community members to gain experience with digital advocacy methods. Therefore, I see the use of multiple lenses/theories as complementary and additive; used together, they encourage the collection of foundational data while testing assumptions and addressing structurally mediated biases.

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