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# COVID-19 Digital Health Innovation Policy: A Portal to Alternative Futures in the Making

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**Abstract**

''The pandemic is a portal.'' In the words of the novelist scholar Arundhati Roy, the COVID-19 pandemic is not merely an epic calamity. It has opened up a new space, a portal, to rethink everything, for example, in how we live, work, produce scientific knowledge, provide health care, and relate to others, be they humans or nonhuman animals in planetary ecosystems. Meanwhile, as the intensity of the pandemic escalates, digital health tools such as the Internet of Things (IoT), biosensors, and artificial intelligence (AI) are being deployed to address the twin goals of social distancing and health care in a ''no touch'' emergency state. Permanent integration of digital technologies into every aspect of post-pandemic civic life—health care, disease tracking, education, work, and beyond—is considered by governments and technology actors around the world. Although digital transformation of health care and industry are in the works, we ought to ensure that digital transformation does not degenerate into ''digitalism,'' which we define here as an unchecked and misguided belief on extreme digital connectivity without considering the attendant adverse repercussions on science, human rights, and everyday practices of democracy. Indeed, the current shrinking of the critically informed public policy space amid a devastating pandemic raises principled questions on the broader and long-term impacts that digital technologies will have on democratic governance of planetary health and society. To this end, a wide range of uncertainties—technical, biological, temporal, spatial, and political—is on the COVID-19 pandemic horizon. This calls for astute and anticipatory innovation policies to steer the health sciences and services toward democratic ends. In this article, we describe new and critically informed approaches to democratize COVID-19 digital health innovation policy, especially when the facts are uncertain, the stakes are high, and decisions are urgent, as they often are in the course of a pandemic. In addition, we introduce a potential remedy to democratize pandemic innovation policy, the concept of ''epistemic competence,'' so as to check the frames and framings of the pandemic innovation policy juggernaut and the attendant power asymmetries. We suggest that if epistemic competence, and attention to not only scientific knowledge but also its framing are broadly appreciated, they can help reduce the disparity between the enormous technical progress and investments made in digital health versus our currently inadequate understanding of the societal dimensions of emerging technologies such as AI, IoT, and extreme digital connectivity on the planet.

**Keywords:** COVID-19, digital health, innovation policy, digital transformation, digitalism, critical policy studies, futures, risk and uncertainty



## Introduction

The hopes as well as the unchecked fault lines in digital technology design and application have deepened with the COVID-19 pandemic caused by the SARS-CoV-2 virus. Currently, digital health tools such as the Internet of Things (IoT), biosensors, and artificial intelligence are being deployed to address the twin goals of social distancing and health care in a ''no touch'' emergency state (Lin and Wu, 2020; Rahman et al., 2020; Ting et al., 2020; Yang et al.,

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2020). The IoT is one of the network technologies that offer the promise of digital health but its effects are neither invariably benevolent nor limited to a purely technological context. The IoT also makes possible a ''Quantified Planet,'' a state of pansurveillance enabled by extreme digital connectivity (Özdemir, 2018; White, 2018).

Permanent integration of digital technologies into every aspect of post-pandemic civic life—health, education, work, and beyond—is also being discussed by governments and technology actors (Klein, 2020). These debates have, so far, been a neoliberal assemblage in their ethos and practice (Springer, 2016), placing market efficiency and unchecked financial gains over planetary health and its social and political determinants (Friedman, 2020; Furr-Holden et al., 2020; Horton et al., 2014; Kickbusch, 2020). As the virus continued to spread around the world, less attention was paid to human rights and securing the health of planetary society than was to the maintenance of wealth (Kickbusch et al., 2020; Klein, 2020; McNeil Jr., 2020; Özdemir, 2020a; Roy, 2020).

The shrinking of the critically informed public policy space amid a devastating pandemic and the underfunding of planetary/global health raise questions about the broader, long-term impacts that digital technologies will have on democratic governance in systems science and society (Kickbusch, 2020; Roy, 2020). It is prudent and timely, therefore, to ask deeper questions on how best to think about digital health innovation policy, especially when the facts are uncertain, the stakes are high, and decisions are urgent, as they often are in the course of a pandemic. Before we do so, let us first ponder on the basic tenets, aims, and significance of an innovation policy.

## Innovation Policy: Why Does it Matter?

### *An opportunity to steer innovations to democratic ends*

Innovation policy is a popular and yet elusive concept. The term might initially be understood as a mission impossible or oxymoron. By definition, innovations are unprecedented processes and products that create a rupture between the past and the present. How can we design policy for unprecedented events, processes, and products that are unforeseeable or unthinkable?

But innovation policies are important. They can, in the ideal case, broaden our thinking, enhance the reflexivity of people and communities, and conjure up collective imaginations on the:

(1) Broader social and political contexts in which scientific discoveries emerge,
(2) Alternatives to proposed technology solutions,
(3) Proponent as well as dissenting views on new technologies,
(4) Multiple possible future(s) and scenarios in which innovation trajectories evolve, and
(5) Unintended (positive or negative) consequences of emerging technologies.

Innovation policy is one way of collective decision making. It helps ensure that diverse voices are heard in the public policy space and contribute to shaping of alternative futures as new technologies and scientific fields emerge. A critically informed innovation policy allows, therefore, for new fields of science to emerge in ways that are experiential and attuned to broader societal values, and thus socially just, democratic, and sustainable (Bayram et al., 2018; Bayram and Gökırmaklı, 2018; Von Schomberg and Hankins, 2019).

Similar to a garden tended by an astute gardener, knowledge-based innovations can flourish on democratic and robust trajectories if they are steered by broadly deliberated and anticipatory innovation policies. Ultimately, an innovation policy can be understood as an opportunity to democratize the future(s) in the making (Boschele, 2020), by enacting a prefigurative politics by asking ''what kind of a society do we want to live in?'' (Ince, 2012), and thus taking the technology ''genie'' out of its narrow confines in a laboratory.

## COVID-19 Digital Health Innovation Policy

### *Why, when, and how?*

A wide range of uncertainties—technical, biological, temporal, spatial, and political—is on the COVID-19 pandemic horizon. This precariousness calls for astute and anticipatory digital innovation policies. Taking into account, critically examining, and deliberating the values that shape and are shaped by the uncertainties of the pandemic is an integral part of the innovation policy making (Fig. 1).

In the temporal context of the uncertainties, a safe, efficacious, and rigorously tested vaccine is at least 1 year away to offer protection to the planetary population as the current state of science suggests. The spatial uncertainties relate to manufacturing capabilities and equitable distribution across unevenly affected areas, a situation that is made even more complex by the asymmetrical flows of global capital, patent laws, and the ways in which unchecked industry funding can

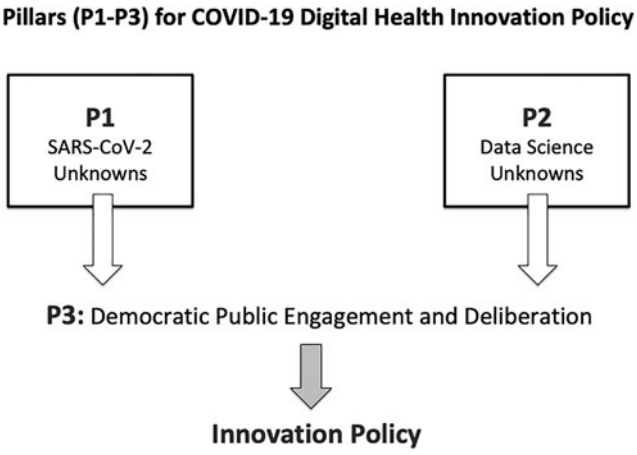


**FIG. 1.** COVID-19 Digital Health Innovation Policy Framework. For anticipatory, real-time, and robust innovation policy, the uncertainties on COVID-19 biology, clinical features, therapeutics, and vaccines ought to be critically deliberated as with the politics of big data and data science that drive the digital health applications amid the pandemic. In addition, the democratic apparatus and public engagement for deliberation of science and technology are themselves in need of critically informed deliberation, with recent rise of post-truth, global populism, and authoritarian governance regimes in science and planetary society.

drive research agendas away from questions that are the most relevant for public health (Fabbri et al., 2018a, 2018b; Lundh et al., 2018). Drugs with established safety records might be repurposed for COVID-19 to offer solutions sooner, but only a small fraction of drug candidates usually prove to be clinically safe and effective after the lengthy clinical trials are completed. Whether hydroxychloroquine ever proves to be a viable treatment for COVID-19, however unlikely at this time, it was clearly reckless for the President of the United States to suggest there was efficacy to this treatment for COVID-19 without robust current evidence (Bero, 2020; Geleris et al., 2020; Singh et al., 2020; The Lancet, 2020). The uncertain risks of government overreach and misinformation are, thus, an additional concern and source of future unknowns.

Insofar as biological, technical, and spatial uncertainties are concerned, the virus is changing, accruing mutations and further uncertainties as it evolves in its new host (humans) in diverse populations, geographies, and health care systems (Sample, 2020). A phylogenetic network analysis of the SARS-CoV-2 genomes sampled from across the world found three main genetic groups of the virus. Groups A and C were observed mostly in Europe and the United States, whereas group B was found most commonly in East Asia (Forster et al., 2020). These, and other anticipated new mutational variants that will likely be discovered in the future, could potentially help explain individual and population variations in disease phenotypes, spread, and outcomes. By taking into account the putative clinical impacts of the virus variants, COVID-19 vaccine and drug design can improve as well.

In a context of the planetary ecosystems, COVID-19 is a zoonotic disease that jumped from animals to humans, followed by human-to-human transmission that eventually led to the current pandemic. It is estimated that ''3 out of every 4 new or emerging infectious diseases in people come from animals'' (Centers for Disease Control and Prevention, 2017). SARS-CoV-2 is unlikely to be the last zoonotic outbreak in the 21st century as we continue to invade the natural habitats of animals (Özdemir, 2020b). The unchecked extraction of nature and finite planetary resources by humans dissolved the barriers and boundaries between humans and nonhuman animals. Our appetite to consume animals as a source of food has exacerbated the potential for interspecies transmission even further. This calamity is evident from nearly one million animal and plant species that are currently threatened with extinction on the planet, and the billions more that serve as cogs in the machinery of global capitalism's obsession with factory farming (Levitt, 2019). The loss of biodiversity in planetary ecosystems has manifold negative impacts that contribute to the rise of zoonotic outbreaks (Diaz et al., 2019).

As noted earlier, making innovation policy requires mapping and critical study of societal values, preferences, hopes, fears, and power asymmetries shaping science and technology design, development, and implementation (Fig. 1). In the case of the COVID-19 digital health innovation policy, would it suffice to incorporate the societal values relating to COVID-19 biology, genetics, drug/vaccine technology, or other disease-related uncertainties into the pandemic policy making juggernaut?

There is an additional dimension of uncertainty that ought to be critically deliberated in a context of the pandemic digital health innovation policy. That concerns the ''politics of data'' broadly, and of data science specifically; both are significant drivers of digital health. Let us clarify, however, what is meant with politics for a science and technology readership in a context of COVID-19:

Politics refer to constitution and contestation of power in society. There is ''politics'' whenever there is a power asymmetry or a difference between ''what is said'' and ''what is actually happening'' in society. Even a smile can be political, if it is intended to exert influence and power on others. Testing for disease *[*e.g., *COVID-19]* is inherently political: the criteria for who should be tested, choice of the laboratory method, centralized or distributed testing, and how the test results are reported, among other decisions. We live in times of authoritarian, anti-intellectual populism. The late Hannah Arendt (1906–1975), an astute political theorist, has said, ''words can be relied on only if one is sure that their function is to reveal and not to conceal'' (Arendt, 1970). That calls for open, independent science, for COVID-19 testing (Özdemir, 2020a).

Consider the concept of ''raw data.'' This term is often used in many fields of science and engineering, digital health and data science included, as though some data such as those coming out of a DNA sequencer are above the fray, and thus not subject to politics, immune from human values and power. We ought to recall that data are neither neutral nor apolitical, or simply a material entity (Guston, 2009; Guston, 2019). Importantly, all data have *provenance*: ''the assortment of technical, social, and political forces that enact on data in their trajectory from study design, funding, choice of laboratory technology platforms to transfer, and distribution of data across laboratories, analysts, and user communities. Big Data are no exception, and have a sociotechnical provenance that tends to be overlooked in data science applications.'' (Özdemir, 2019a).

COVID-19 digital health innovation policy would, therefore, be well served by addressing the politics of data and data science practices. Data are never ''just'' data, and they come with social and political metadata (data about data) (Collingridge, 1980; Didier et al., 2015; Feyerabend, 2011; Sarewitz, 2016; White, 2018). To this end, critical political science scholarship serves as an antidote to deliberate the politics, and power asymmetries embedded in COVID-19 biology as well as data science (Fig. 1).

Although the digital transformation of health care is underway by social distancing and pandemic lockdown, we ought to ensure that digital transformation does not degenerate into ''digitalism'' (a term coined by coauthor M.B.), which we define here as an unchecked and misguided belief on extreme digital connectivity without considering the attendant adverse repercussions on science, human rights, and everyday practices of democracy.

## Innovations as Knowledge Ecosystems

Going forward, how do we account for the social and political forces mentioned earlier that increase the future uncertainties and, by extension, shape the digital health futures in the making?

A good place to start, in this context, is to rethink innovations as knowledge ecosystems (Fig. 2). In this conceptual framing of digital health innovations, the narrators serve as ''observers and analysts of the actors coproducing

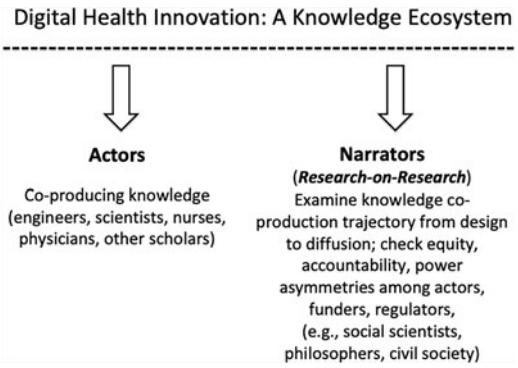


**FIG. 2.** Rethinking digital health innovations as knowledge ecosystems comprising actors and narrators.

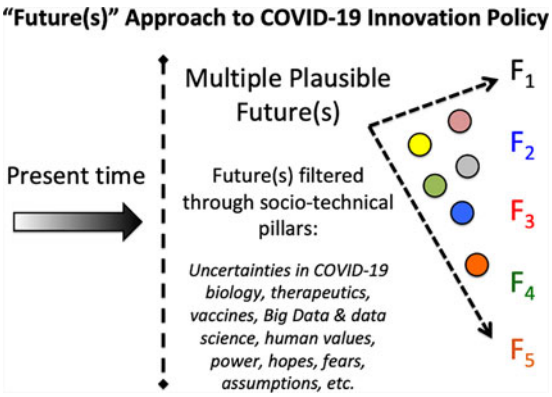


**FIG. 3.** The ''future(s)'' approach to COVID-19 innovation policy. To democratize the pandemic innovation policy, we ought to broaden the collective imaginations on multiple plausible future(s). This can help open up epistemologically diverse discourses that are rich in understandings of the knowledge frames in which an alleged COVID-19 innovation is conceived, implemented, and shared by the planetary society. When stakes are high, uncertainty and unknowns are profound, and yet, decisions have to be made rapidly, as we currently face in the course of the COVID-19 pandemic, the proposed future(s) approach to pandemic innovation policy should prove more effective and accountable, compared with determinist technology road maps that cannot readily address the rapidly shifting unknowns on the COVID-19 pandemic.

health relevant knowledge'' and thus, ''have particular importance to democratize planetary health'' (Özdemir, 2019b). Often, the narrators are social sciences and humanities scholars, civil society organizations, and independent and critically informed press, among others. In representative and democratic forms of governance, narrators are essential to ensure a system of ''checks and balances.'' (Özdemir, 2019b).

Narrators, in essence, have an important role as a check on power or put in other words, as a ''third eye'' function on the knowledge-making and innovation trajectory. Narrators can also be conceptualized as actors who conduct ''research on research.'' In doing so, narrators hold the politics and power embedded in emerging technologies to account. There is evidence that laboratory research thrives more effectively on integration with natural and social sciences, enhancing the creative processes in the laboratory and helping generate novel paths to problem solving in science and innovation (Fisher, 2010; Flipse and van de Loo, 2018).

An innovation policy can be an antidote, but only if it is democratically framed and critically informed, to technocracy, the age-old system of governance wherein decisions in science are made purely by technical knowledge, bracketing out the social and political context and the human values that co-produce scientific knowledge. It was already clear before the pandemic that we were treading a slippery slope in terms of the sidelining of the social sciences and humanities in favor of technocracy-centered STEM-based research programs (Frodeman, 2020). The economic fallout of COVID-19 among the world's universities only threatens to push this trajectory even further.

On the other hand, although integration of the social dimension of emerging technologies might offer instrumental and pragmatic gains for scientists, it also has normative or principled caveats on the types of science promoted and the ends to which technologies are selectively steered. This situation requires critical thinking on the concept of public engagement in policy making, be it for innovation or elections and governance of an institution or country.

### Public Engagement Is Not Enough for Policy Making

At this stage of our analysis, we hope it is clear to our readers that making innovation policy requires more than technology roadmaps or forecasts of a preordained determinist technology future. Instead, we have so far argued for broadly incorporating the public in collective decision making on technology futures. This futures approach to policy making accepts that technology and innovation futures are always in the making, contested, and ought to be deliberated by diverse publics (Fig. 3).

Having said this, innovation policy has to go beyond town hall meetings or other types of public engagement on a new technology, and actively seek to ''inject'' the human values embedded in society into the technology development trajectory. How such public engagement is framed/designed upstream (by whom, to serve which ends?) also matters, and by extension, determines the quality of the policy outcomes as well as the types of values (e.g., critical vs. uncritical, common public good vs. markets oriented, competition vs. mutual aid, etc.) prioritized by innovation policies (Özdemir, 2020c).

That is, the politics of and the power embedded in public engagement (who is represented, included, or excluded in engagement, and why?) should also be borne in mind (Barad, 2011; Özdemir et al., 2015; Özdemir, 2019a; Sarewitz, 2016; Sclove, 2020; Stilgoe et al., 2014) so as to prevent, as noted aptly previously by Garvey and Maskal, such public engagement exercises ''from being transformed into hollow pageantry to improve public relationships or a ''tick the box'' exercise devoid of meaningful exercises of technological democracy'' (Garvey and Maskal, 2020).

The concerns on and caveats of uncritical public engagement in science and technology governance mentioned earlier are not trivial. We live in an era of policy making that is colored by a long-standing neoliberal discourse since the

1980s that placed market efficiency and unchecked extraction of finite planetary natural resources over and above public health needs and priorities (Frodeman, 2020; New York Times, 2020; Özdemir, 2019b, 2019c; Springer, 2016; The Lancet, 2020), thus causing a de facto contraction of the critically informed public policy space (Frodeman, 2019; Frodeman, 2020; Özdemir and Springer, 2018; Von Schomberg, 2019; Wade, 2020). The neoliberal structure and ethos prevalent in science policy and health care, as discussed further next, has become more obvious and acutely palpable with the COVID-19 pandemic (Furr-Holden et al., 2020; Harvey, 2020).

The negative impacts of neoliberalism have not only been limited to innovation actors in the scientific laboratory but also extended to innovation narrators/narrating fields such as social sciences and humanities. For example, the availability of generous but strings attached neoliberal funding streams have increasingly begun to steer social sciences and humanities research toward the ends of a critically uninformed public relations exercises and unchecked commodification of scientific products over the past decades, in large-scale biology research in particular (Özdemir, 2019b, 2019c). Universities are increasingly looking to ill-defined ''industry connections'' as a measure of academic performance, which encourages an uncritical chasing of funding opportunities regardless of the potential ethical concerns that may be presented (Halffman and Radder, 2015).

This has, worrisomely, softened the cutting critical edge of the ordinarily broad inquiry of social sciences and humanities in certain applied fields such as technology ethics and global health in particular (Özdemir, 2019b, 2019c), but the effects are also felt across the whole of the social studies including in human geography and environmental studies. This has, in effect, helped the proponents of generous neoliberal funding of social sciences and humanities to place unchecked commodification and wealth maintenance before planetary/global health priorities (Kickbusch, 2020; Özdemir, 2019c). Our broad tolerance of neoliberalism in planetary health (Horton et al., 2014), not to mention in technology governance and innovation policy (Özdemir, 2019c), has contributed to the longstanding policy drifts toward a technocratic as well as a neoliberal vision of ''future-proofed'' and thus, allegedly, commodification ready innovations.

In the next section, we propose a potential remedy for the innovation policy drifts toward undemocratic and unsustainable ends mentioned earlier, and we describe the concept and importance of ''epistemic competence'' in policy making. We argue that epistemic competence in science and society can help overcome, at least in part, the uncritical approaches to public engagement and innovation policy as well as help address the growing democratic deficits in civic life with the recent rise of global populism and authoritarian governance (Holst and Molander, 2019; Kickbusch, 2020; Levitsky and Lucan, 2002; Rankin, 2020).

## Epistemic Competence to Democratize Innovation Policy

Democratic theory is a subfield of political theory dating back to ancient Greece. Its etymology includes *demos* (the people, the many) and *kratia* (power, to rule) in Greek. The types and practices of democracy vary, for example, from direct, representational, and deliberative to epistemic democracy. Democracy involves some form and process of self-rule. A democratic innovation policy brings everyone, not only the appointed elite experts but also diverse publics, to the decision-making process, and by extension, enables broad participation in policy making to steer the emerging science toward democratic ends. Seen in this light, an innovation policy designed or decided by one person, an elite unelected expert committee, or institution would not be democratic.

Democracy operates, however, in multiple levels and orientations. Voting is only one component of democracy, where voting by itself could be considered as ''electoralism'' rather than substantive democracy (Springer, 2011). For those who win an electoral campaign and acquire political authority, there are, and should be, limits to their reach and power to guard against any potential tyranny of the victor or of the majority. Each and every person, including minority groups, whether they have voted for those who won an election or not, should be guaranteed their civil rights and liberties in a democracy. In the next social movement and electoral campaign, the opposition then has a fair chance to gain political authority. In a genuine democracy, the power of an elected political authority is limited by several mechanisms. This includes, for example, free press and critically informed media to hold power to account and fact-check; separation of powers (e.g., of legislation and judiciary); and guarantee of civil rights and freedom by the constitution and their enforcement by an independent judiciary. The majority rule and power, therefore, has limits in a well-functioning democracy.

Over the past decades, the meaning and the actual ways in which democracies function have been in regression (Boschele, 2020; Diamond and Plattner, 2015; Geiselberger, 2017). With global populism and authoritarian governance regimes highly prevalent around the world at the moment (Diamond et al., 2016), the majority rule and political authority have begun to dismantle the free press, threaten the separation of powers, weaponize social media to engineer the electorates, and create post-truth perceptions to replace material scientific findings, thus consolidating and concentrating political power after an election and breaching the limits to the majority rule noted earlier (Geiselberger, 2017; Rankin, 2020).

Earlier, Levitsky and Lucan (2002) have also noted the rise of another phenomenon and practice, competitive authoritarian governance, wherein elections and other democratic procedures continue but under very unfair conditions for the opposition. Competitive authoritarian governance is worrisome in particular, because it gives the dangerously deceptive impression of a democracy by virtue of the apparent presence of elections whereas the functioning of democracy is already compromised or nonexistent (Diamond et al., 2016). Collectively, these regressive changes in the way democracies function in the first quarter of the 21st century call for devising new instruments and conceptualization of democracy to ensure that an allegedly democratic innovation policy is, indeed, democratic.

At present, innovations in response to the COVID-19 pandemic are emerging whereas the publics are in lockdown and those healthy and ill are being tracked with digital technologies in a state of pansurveillance. Therefore, it is

time to scrutinize the policy and society nexus once again (Klein, 2020; Sclove, 2020). Specifically, to democratize the pandemic digital health innovation policy, the presence of elections and elected political leaders do not, in and of themselves, guarantee the democratic quality of the innovation policy outcomes. Indeed, political scientists have long noted the imprecision of voting as a mechanism for democratic decision making, and they have observed that elected officials and government functionaries can, in fact, act as barriers to greater popular control over policymaking (Lindblom and Woodhouse, 1993).

Epistemology concerns the frames and framings of knowledge (*how do we know what we know?*). We propose that questioning the epistemology of a given body of COVID-19 knowledge before accepting its legitimacy, an epistemic competence, is a new and much needed skillset to democratize the emerging COVID-19 innovation policies in the current climate of populism, post-truth, and pandemic lockdowns. Our rationale is that the chosen epistemologies also produce what gets to be produced and accepted as knowledge. The choice of a particular epistemology over another one, for example, whether health care is a human right and ought to be available to all people versus a commodity to be traded, has direct impacts on the targets and outcomes of COVID-19-related innovations in the short and long term.

We provide two examples on the significant role that epistemic competence plays in devising a democratic and critically informed, and thus, robust innovation policy.

### *Frame check 1: Is health a right or commodity?*

Richard Sclove, a scholar and writer on politics of technology, has made the following apt observation: ''the term consumer is often treated as being interchangeable with citizen. In reality, those are two very different ways of characterizing who a person is. As consumers, we're typically on the lookout for the best deal; as citizens, it's our task to play our part in discerning and advancing the common good.'' (Sclove, 2020).

Health is ''part of the right to an adequate standard of living'' as recognized by the 1948 Universal Declaration of Human Rights. The right to health was also recognized as a human right in the 1966 International Covenant on Economic, Social and Cultural Rights (United Nations, 2008).

COVID-19 pandemic has raised both instrumental/practical and principled questions on health. From a practical and efficiency standpoint, inclusive access to planetary health care, by all people from all walks of life and economic status, is important to stem the pandemic. Absent inclusive access to health care, the marginalized, underserved communities, overcrowded work spaces that lack preventive health care, and social distancing, not to mention war and social conflict zones, will pave the way for recurring peaks of new cases and deaths from SARS-CoV-2, especially if extensive diagnostics capacity is not in place to test, trace, and isolate the new cases.

From a principled/normative standpoint, adopting health not as a right, but as a commodity to be traded and profited from, conflicts with human rights, and ultimately, threatens human dignity and deepens the fault lines in the social fabric and ethos of 21st-century communities (Butler, 2020).

For COVID-19 innovation policies, epistemic competence on the meaning and consequences of framing health as a human right versus a commodity (i.e., framing of patients as customers) has vastly divergent impacts in making democratic/undemocratic choices as new vaccines, treatments, and diagnostics emerge.

Placing adequate emphasis on epistemic competence is much needed in both scientific communities and social sciences and humanities that traditionally have an important narrator function in devising innovation policies. On the latter point, we provide an example next on epistemic competence in social sciences and humanities in relation to the anthropocentric framings of knowledge in planetary health and political ecology.

### *Frame check 2: planetary health beyond anthropocentrism*

In May 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services warned that ''around one million animal and plant species are now threatened with extinction.'' (Diaz et al., 2019). As noted earlier, COVID-19 appeared after several other zoonosis outbreaks within the very first two decades of the 21st century. COVID-19 will likely not be the last microbe to cross over from animals to humans, because we continue to invade the natural territory of nonhuman animals as evident from the enormous loss of biodiversity on earth. In this context, planetary health is a new and welcome field that has emerged over the past several years (Horton et al., 2014).

Still, planetary health scholarship does not sufficiently extend beyond an anthropocentric epistemology. We ought to change the human-centric mindsets that continue to value nature and other life forms instrumentally by their usefulness to us. The instrumental and anthropocentric framing of health is problematic, because it limits the effectiveness of progressive innovation policies in ecology. To the extent that the agency of nonhuman animals is not recognized in planetary health, ''internal brakes'' in our mindsets will not materialize to rethink and stop the reckless extraction of nature, or resist the unchecked dogma of exponential growth with finite planetary natural resources (Özdemir, 2019b). Extending the scope of planetary health conceptual frames beyond anthropocentrism is helpful not only for physicians and health scientists but also for social science and humanities scholars who study power and politics in human societies.

Zoonotic infections such as COVID-19 are kind reminders that unchecked power asymmetries and politics exist not only within human societies but also at the human and nonhuman animal interfaces. In a context of such cognitive dissonance among scholars who study politics and power and yet who tend to overlook the politics between humans and nonhuman animals, Simon Springer has aptly noted ''How is it that those who hold anti-racist, decolonial, environmentalist, feminist, autonomist, poststructuralist, queer, anarchist, and otherwise critical perspectives continue to ignore the horrors perpetuated against the non-human animal 'other'?'' (Springer, 2021).

In frame-checking the anthropocentrism of innovation policy and its subsequent ignorance of the non-human other,

one fruitful place to look for alternatives is outside the confines of ''modernity.'' In contrast to the suicidal tendencies of contemporary technological civilization, traditional cultures around the globe demonstrate epistemic competence in maintaining locally emergent social ecosystems that combine unalienated value flows and high productivity (Eglash and Garvey, 2014).

Anthropologist Steve Lansing has shown how irrigation management in Balinese rice farming can be achieved in the absence of hierarchical control through a bottom-up system of collaborative scheduling that combines extensive deliberations between social castes, ecological knowledge, spiritual beliefs, material artifacts such as wooden calendars, and the rhythms of non-humans—including pests—to achieve optimum yields (Lansing, 1987, 2007). In a win for non-anthropocentric planetary health, game theoretic modeling of this traditional institution (Lansing and Kremer, 1993) ultimately convinced Indonesian officials to halt the environmentally damaging transition to chemical fertilizers and pesticides, then being spearheaded under the auspices of multi-million dollar Green Revolution development projects (Lansing, 2000).

Similarly, the traditional Japanese *satoyama* style of rice production, in contrast to modern, large-scale mono-crop agriculture, juxtaposes distinct biotic regions in a multifunctional landscape that produces ecological ''edge effects'' in and around rice paddies; in addition to productive outputs, this creates new niches, leading to a net increase of biodiversity (Kadoya and Washitani, 2011; Katoh et al., 2009). This and other examples of co-evolutionary symbiosis between human and non-human show that when value is returned to the locality in unalienated forms, ''the core generative properties of this social ecology may well be retained, despite the introduction of modern technologies to the scene'' (Eglash and Garvey, 2015). Importantly, these traditional systems contrast sharply with the exploitative social ecology of the (often illicit) global trade in nonhuman species believed to be responsible for the zoonotic transmission of COVID-19. One lesson from the pandemic for planetary health innovation policy may, therefore, be the desirability of envisioning, provisioning, and maintaining such emergent, local, hybrid ecologies, partly as a bulwark against future zoonotic transmissions (Özdemir, 2020b).

Framing health through anthropocentrism determines the types of questions we ask and the answers we seek in life sciences as well as social sciences and humanities. Epistemic competence serves as a truth tracker and can boost collective reflexivity as new science and innovation policies emerge in response to the current COVID-19 pandemic, and other likely zoonotic outbreaks in the future.

## Conclusions and Outlook

Digital technologies are playing a prominent role in the global COVID-19 pandemic response. Hence, their development and applications cannot be left to a laissez fair, anything goes, approach (Özdemir, 2020c). Innovation policy can prevent the evolution of the current tide of digital health technologies toward a technocratic antidemocratic future and digitalism.

COVID-19 digital health innovation policy design should have, at a minimum, three essential pillars as proposed in this article (Fig. 1). There is an urgent need to consider and deliberate on, first, the current and future uncertainties and unchecked assumptions in SARS-CoV-2 biology, diagnostics, therapeutics, and vaccines. For example, despite the initial and justified focus on impacts in the lung, it is becoming clearer that COVID-19 is more likely a systemic illness that affects other organs as well such as the heart and the kidney. Moreover, we still do not know the long-term effects of the virus, not to mention in pregnancy, newborn, or the virus interactions with comorbid disease and nutrition in granular detail. A robust and democratic innovation policy would help to critically examine the emerging knowledge, assumptions, and unknowns, and thus contribute toward the speed, scale, and surge capacity that is much needed in public health systems around the world.

Second, uncertainties and socio-technical dimensions of big data and data science that drive the digital health innovations should be part of the future innovation policies. Data are never ''just'' data and have a socio-technical provenance that ought to be taken into account in policy making. Because factors such as race, gender, and region are likely to be included in systematic data collection efforts related to COVID-19, addressing data provenance is crucial for avoiding biases and other unintended consequences that could ''skew predictions, diagnoses, risk scores, and decisions about where, or to whom, finite resources and care should be prioritized'' (Horvitz et al., 2020).

Third, the global rise of populism and authoritarian governance regimes across the world are threatening the veracity of public engagement and other instruments of democracy that play a crucial role to surface, contextualize, and democratize the human values and motives that drive digital health.

Addressing these three crucial domains of knowledge and unknowns would certainly help devise robust innovation policies that have traction and relevance on the ground among diverse planetary professional communities and society.

Pandemics are not purely medical, technical, economical, or logistical challenges. They are also social and political, as noted throughout the article. At the same time, pandemics pose constraints and lack of resources in terms of material availability of goods and time. This means priorities and emphasis points might have to be noted in resolving and responding to the challenges of pandemics. We suggest that pandemics such as COVID-19 can be resolved into four overlapping phases:

*Phase 1*: Acute planetary health response and mutual aid,
*Phase 2*: Food and shelter sustainability and mutual aid,
*Phase 3*: Economic sustainability and search for new models of economy in a world with finite resources and existential threats, and
*Phase 4*: Critically informed social sciences and humanities that extend throughout the former Phases 1 to 3, culminating in new insights to build a new ''post-corona world'' that is resilient against existential threats by addressing the social injustices highly prevalent in the pre-corona world.

At the moment, Phases 1 to 3 have high intensity and need more guidance from critical social sciences and humanities. Of note, the narrator role played by social sciences and

humanities in Phase 4 can be played by a diverse range of actors, including the critically informed independent journalists, writers, nurses, physicians, engineers, and life scientists who record the history in the making collaboratively with social sciences and humanities scholars.

Finally, in the words of the novelist scholar Arundhati Roy, the COVID-19 pandemic is not merely an epic calamity but also a ''portal'' (Roy, 2020). It has opened up a new space, an interregnum, that enables us to rethink everything in a post-corona world, for example, in how we live, work, produce scientific knowledge, provide health care, and relate to others, be they humans or nonhuman animals in planetary ecosystems so that we might come to recognize our relationality in more caring and supportive ways (Springer, 2020).

In this article, we have also proposed and emphasized the practice of epistemic competence on the ways in which planetary health is understood. We think epistemic competence is crucial in both life sciences as well as social sciences and humanities to preserve their critically informed cutting edge, especially when the facts are uncertain, the stakes are high, and decisions are urgent, as they often are in the course of a pandemic.



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**Abbreviations Used**

AI = artificial intelligence
IoT = Internet of Things