



Postdigital Citizen Science and Humanities: A Theoretical Kaleidoscope

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Abstract

This collective article presents a theoretical kaleidoscope, the multiple lenses of which are used to examine and critique citizen science and humanities in postdigital contexts and from postdigital perspectives. It brings together 19 short theoretical and experiential contributions, organised into six loose groups which explore areas and perspectives including Indigenous and local knowledge, technology, and children and young people as citizen researchers. It suggests that this collective approach is appropriate because both postdigital and citizen research are founded on and committed to collaboration, dialogue, and co-creation, as well as challenging the tenets and approaches of traditional academic research. In particular, it suggests that post-digital transformations in contemporary societies are both changing citizen science and humanities and making it more important.

Keywords Postdigital · Research · Theoretical kaleidoscope · Citizen science · Citizen humanities · Citizen social science Collaborative writing · Collective writing · Technology · Artificial Intelligence · Activism · Data

Introduction (Michael Jopling)

Citizen science involves non-professional researchers in scientific research processes (Senabre Hidalgo et al. 2021), for example in submitting data to bird censuses or monitoring water quality. Although it has a long history which precedes

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academic research, the term citizen science has only been used extensively since the 1990s. Since then, it has been acknowledged as a ‘key pillar’ of open science (Eitzel et al. 2017) and an important influence on widening participation and democratisation in science (Shirk et al. 2012; Sauermann et al. 2020). How participatory citizen science is in practice may be questioned, as participating citizens are still much more likely to collect data for use by professional scientists than collaborate with them in a more meaningful sense (Mueller and Tippins 2012). More recently, interest has been growing in how to increase collaboration and use citizen science to promote scientific literacy and combat scepticism about areas such as climate change (Eleta et al. 2019).

This has led to calls for citizen science to be redefined, for example, as ‘community citizen science’ or ‘civic science’ (Weinstein 2011). While some of the contributions to this article offer further redefinitions, our focus is different. Our starting point, presented in more depth in ‘Postdigital Citizen Science: Mapping the Field’ (Jandrić et al. 2023a), is the contention that transformations in contemporary societies described under the broad heading ‘postdigital’, in which our human and digital lives and social contexts are increasingly entangled and inseparable, which makes citizen science both different and more important.

As such, this article is a logical extension of the interest of postdigital research and praxis in collaboration (see Jandrić et al. 2023b) and dialogue (see Jandrić et al. 2019). This has been reflected in an interest in facilitating collaborative and cross-sector approaches to research that are necessary to investigate and understand the postdigital contexts we inhabit and the postdigital challenges we face. It is undeniable that the new technologies that have emerged since the late twentieth century have greatly increased the accessibility of science, which has increased the recognition and participation of non-specialist researchers (Vohland et al. 2021), although concerns remain about lack of diversity among citizen scientists (Waugh et al. 2023). Adopting a postdigital perspective draws attention to the concomitantly huge increases in the quantity of data that is collected about and from each of us, which also raises questions about how those data are used (see Hayes et al. 2023).

This requires citizen science to address issues relating to how data are used and who collects them. The hybrid, inclusive nature of the postdigital (Jandrić et al. 2018) also requires us to extend the focus from citizen science to encompass social science and humanities, both conceptually and methodologically. This is one of the starting points of this collective article: social-technical challenges require social-technical explorations and solutions (Jandrić et al. 2023b), which in turn require interdisciplinary approaches. These also have important political implications. This is why our focus is explicitly broadened to include citizen humanities *and* science, including social science. This indivisibility is reflected in the form and structure of the article and its central metaphor of the kaleidoscope, made up of multiple intersecting theoretical perspectives, which is used to understand and critique the complexity and potential of postdigital citizen science and humanities.

Constructing the Kaleidoscope

This article takes inspiration from ‘Understanding Digital Inequality: A Theoretical Kaleidoscope’, in which Kuhn et al. (2023: 896) use the kaleidoscope as a metaphor ‘to describe the need for different theories, or sometimes, the intersection of multiple theories, to unpack and understand the complexity’ of digital inequality in the postdigital context.

It has long been common, indeed almost a cliché, for researchers to write of applying a specific theoretical lens to a phenomenon. The metaphor revivifies this notion by bringing multiple perspectives into play (an important word—kaleidoscopes are also toys), just as the kaleidoscope uses ‘two or more mirrors/lenses, angled at particular points, which, when rotated, allow the viewer to see an increasing array of complex patterns that would be hard to see with our naked eye’ (Kuhn et al. 2023: 896). Just as each turn or shake of the kaleidoscope changes the pattern the viewer sees, each theoretical perspective in this collective article should function as a new lens or mirror, shifting our perspective, offering a new angle, and prompting our own reflections on citizen science and humanities. Of course, it is important to acknowledge that this metaphor can only be pushed so far.

The postdigital context is also reflected in the collective nature of the article, which joins a growing body of collective work informed by postdigital perspectives (e.g. Jandrić et al. 2020, 2023b; Kuhn et al. 2023). This is part of a deliberate resistance to, and redefinition of, academic writing, which attempts to represent a diversity of viewpoints with minimal interpretative organisation (Peters et al. 2021; Jandrić et al. 2023b) and emphasises the value of collaboration and shared ownership in research. It also highlights a deliberate postdigital commitment to dialogue, which has been described as ‘an exchange of information between people, a linguistic format which supports such exchange, a form of art, a type of inquiry, an approach to pedagogy, a precondition for social change and much more’ (Jandrić et al. 2019: 163).

The approach to dialogue taken in this article was an open call for 500-word contributions from a range of theoretical and research perspectives. The call suggested some of the lenses contributors have used in the article, such as Artificial Intelligence (AI), feminism, and philosophy of technology, but writers were also free to suggest other perspectives. In order to avoid duplication or substantial overlap, it was agreed with each writer which of the kaleidoscope’s lenses they would use before they wrote their contribution, but there were no other restrictions. Some editorial support was offered, mainly to reduce word count and to highlight common themes and issues.

This has allowed the 19 theoretical and experiential perspectives collected in this article to be presented in combination and tension without hierarchy and with minimal editorial intervention. The ordering of the contributions was not determined collectively, primarily for pragmatic reasons, but also because it should only be regarded as provisional, necessary as part of the process of producing a publishable article, but by no means final or important. Ideally, they would be

free-floating, like B. S. Johnson's (1969) book in a box, *The Unfortunates*, whose 25 central sections (excluding a first and last chapter) can be read in any order.

It should not be overlooked that this collective approach is also a remarkably efficient and rewarding way of writing, sharing the means, as well as the outcome, of academic production. The collective approach embodies the collaborative ethos of citizen science, social science, and humanities, which at its best is founded on participatory, co-creational, and collective approaches to research (Senabre Hidalgo et al. 2021; Thomas et al. 2021) and as such necessarily involves a plurality of voices, ontologies, and theoretical perspectives. Finally, the article can be read in tandem with the other emerging articles about postdigital citizen science and humanities, combining to form a larger kaleidoscopic collective approach and ongoing postdigital dialogue.

Indigenous and Local Knowledge as Citizen Science

Māori/Indigenous Knowledge and Postdigital Citizen Science (Georgina Tuari Stewart)

The dominant meaning of 'citizen science' is when members of the public collect data for use by institutional science. Astronomical observations and environmental monitoring are two common forms of scientific data collected in such 'contributory citizen science' (Jandrić et al. 2023a). Citizen science varies according to the degree of citizen participation/agency, and key foci for citizen science include conservation, education, and digital technology.

But what if a modifier like 'citizen' affects and changes what is understood by 'science'? Both words—'citizen' and 'science'—are associated with histories of exclusion, including the exclusion of Indigenous peoples and their knowledge (Jandrić et al. 2023a). Yet the two concepts and their webs of meaning and linked concepts are in entirely different domains. Such two-word terms modify a strong knowledge noun (science is paradigmatic) with a 'social' adjectival modifier—in this case, citizen—to create a conundrum, a philosophical puzzle, a concept of unclear and unsettled meaning. The same dilemma is raised by terms such as 'Māori science' or 'feminist science'.

According to Jandrić and colleagues (2023a), postdigital citizen science encompasses the social sciences and humanities, going beyond the strict meaning of 'science' as used within Anglophone knowledge systems including the university. By this reasoning, Māori philosophy (Stewart 2021a, b) and other philosophical approaches to Indigenous knowledge (e.g. Yunkaporta 2020) can be seen as Indigenous forms of postdigital citizen science.

The meaning of 'Indigenous' is itself unsettled (Stewart 2018), but here is used to mean peoples whose lands have been settled by Western powers. Indigeneity is a form of ethnicity, which is in itself a contested concept, dependent as it is on the recognition of power relationships between particular cultural groups, many

of which arose during the era of the Voyages of Discovery—of European expansion and colonisation of claimed territories in Asia, Africa, America, Australia, and Aotearoa. Since this process is now (almost totally) complete, it is reasonable to argue that few if any new ‘ethnicities’ will arise in the future (Stewart 2023). Indigenous perspectives comprise one category of critique of science and mainstream Western knowledge systems and processes. Each Indigenous scholar writes from their own cultural perspective, and this commentary is written from a Māori viewpoint on the question of how Māori/Indigenous knowledge partakes in citizen science in the postdigital era.

To explore Māori knowledge is a form of citizen science because Māori knowledge bases reside within particular communities and *iwi-hapū* (kin groups). Exploring Māori concepts in the postdigital era exploits the affordances of the Internet and digital technologies, far more powerful research tools than were available for all previous generations of researchers. But how, exactly, are we to understand the term ‘postdigital Māori/Indigenous citizen science?’ The terminology threatens to overwhelm thinking: how many modifiers can be used in front of ‘science’ before it loses all meaning?

An example of ‘postdigital Māori/Pasifika citizen science’ is the current topic of being Māori/Pasifika in the academy or in science (Airini and Mila-Schaaf 2010; Cram et al. 2014; Matapo 2018; Naepi 2019). This work is ‘adjacent’ to science; it is written by scientists and addresses science as a social institution, but does not fit within the tight bounds of scientific research. It is instructive to look at the range of methodologies in these papers. Some use statistics (McAllister et al. 2022) or surveys (Naepi et al. 2019), and others use autoethnography and narrative methods (Stewart et al. 2023). Narrative methods are post-qualitative approaches that confront the reader with compelling insider accounts of the research topic or question. Post-qualitative approaches do not conform with ‘scientific method’ in research (St. Pierre 2021; Stewart 2024).

Not to align with science methods has been seen predominantly as a deficit in research. Following the general rule that informed critique depends on mastery of the subject, it stands to reason that Māori philosophers with science backgrounds will be needed to complete a Māori critique of science. Postdigital Māori citizen science deliberately and wholeheartedly steps away from the scientific method and the role it plays in contemporary mainstream educational theory. This is not to reject science and all its benefits and tools, but rather to stop pretending that ‘scientific method’ can tell us what to do when investigating philosophical and ethical questions in education and related disciplines. Instead, to proceed with this work it is important to ‘listen’ to the material we are collecting and working with in order to decide what to do next (Stewart and Devine 2024).

This work is part of a larger shift towards overcoming the historical bifurcation of the Western world of writing into literature and science (Richardson 1990). Māori/indigenous perspectives have the advantage of access to other philosophies and knowledge in which this bifurcation never occurred. This is one way in which science can benefit from cultural difference.

Recognising Local Knowledge in Community and Citizen Science (Shane Orchard)

Local knowledge is developed through traditional practices, cultural norms, and personal experiences (Raymond et al. 2010). It accrues at personal to community-wide levels and contributes to traditional knowledge, which has been defined as the knowledge, innovations, and practices of indigenous and local communities (United Nations Environment Programme 2021). The resulting knowledge base embodies arguably the world's most significant contributions to collective intelligence and has a history as long as civilization itself, far exceeding that of modern data collection methods (Silvertown 2009). While citizen science proponents often point to the need for new approaches to address the scale and scope of contemporary challenges, there is equally a need to recognise and appreciate the wisdom of these earlier forms of knowledge (Tengö et al. 2014).

The development of local and traditional knowledge presents an interesting theoretical lens through which to view the scope of public participation in the generation of knowledge. It offers insights into the depth of participation that may contribute to contemporary collective intelligence. Despite its local connotations, the accumulation of many observations and experiences may provide a detailed understanding of wider regions and include the evolution of traditional knowledge passed down through generations (Antweiler 2019; Campbell and Orchard 2023). In subtle and sometimes unseen ways, local knowledge also contributes to the availability and interpretation of public knowledge, thereby informing the discussion of epistemologies (ways of knowing) and investments in the pursuit of knowledge.

These aspects of local knowledge align with the 'democratization of science' perspectives of Irwin (1995) and others, while extending them further to embrace the origins of existing knowledge. Increasingly, this is becoming better recognised and enabled in the context of Traditional Ecological Knowledge (TEK) and related approaches to sustainable development that may offer apparently new solutions to modern challenges (Huntington et al. 2011; Long et al. 2020). However, with citizen science having now attained a relatively mainstream status in the science-policy discourse, there is also a need to ensure that institutional support and other investments do not merely reflect an extension of data collection priorities that derive from top-down processes (Kukutai and Cormack 2020; Kullenberg 2015). Instead, citizen science offers a way to redress information disparities and imbalances. This suggests a need to recognise diversity in the many forms of community and citizen science (Orchard 2019; Sauermann et al. 2020).

Further complexities include intersections with social science methodologies that engage with knowledge holders using elicitation techniques such as surveys, interviews, Volunteered Geographical Information (VGI) platforms, and participatory mapping or appraisal exercises (Brown 2012; Haklay 2013). However, it is essential to recognise that these more formal research methods are designed to harvest and synthesise the knowledge that already resides in the observations and perceptions of individuals. At the same time, this local knowledge exists independently of whether it is actively communicated by knowledge holders, or otherwise shared with more formal research efforts. Indeed, there are many examples of local and traditional knowledge that is primarily collected for a specific purpose, and

which may not necessarily be intended for a wider audience. Importantly, such purposes may be accompanied by sensitivities around the sharing and potential misappropriation of knowledge by others, as is recognised in the principles of Free and Prior Informed Consent and the Nagoya Protocol (Morgera et al. 2014; Williams and Hardison 2013).

More recently, attention to these principles and technological solutions for addressing them have been at the forefront of developments in digital and online technologies. These include systems for addressing privacy issues and attaching licences to community-contributed data to facilitate their reuse while ensuring adherence with the conditions under which they were originally provided. It can also be noted that all of these examples fall within the ambit of community and citizen science, despite representing very different modes of public participation and agency in the process of knowledge generation. For example, the elicitation of local knowledge using social science techniques could occupy many different positions on Arnstein's (1969) 'ladder of citizen participation' depending on the relationships between the actors and the level of co-creation. These aspects illustrate some of the complexities that may be encountered when addressing local knowledge, yet do not undermine its validity.

Activist Citizen (Social) Science and Humanities

People's Critical Social Science (Juha Suoranta)

Critical social sciences, which aim to promote social justice and equality, have a long history of fostering collaboration between non-experts and social scientists. This field encompasses a range of research methodologies, such as participatory action research, public sociology, activist research, critical pedagogy, and citizen social science (Martínez 2023). Social sciences working for the liberation and emancipation of the people practice their critical function in addressing human misery and improving people's lives by acting with the people and refusing abstractions and high theory (Denzin 2001). They sometimes work as militants, struggling with the people for their fundamental human rights (Suoranta 2021). The union between critical pedagogy and citizen social science is an attempt in this direction.

Critical pedagogy is a progressive alternative to standardised pedagogical models (Freire 2005). Following Marx's dictum, it aims to make the world a better place, not only interpret it. Citizen social science involves the active participation of people in social scientific research at various stages of the research process, fostering collaboration between professional researchers and the broader community (Tauginienė 2020).

Citizen social scientists share most of these aims and take collaboration between research scholars and others seriously. They emphasise mutual interaction between scholars and ordinary people doing social research. After Antonio Gramsci (1971: 3), they maintain that all human beings are intellectuals 'in the sense of having an intellect and using it, but not all are intellectuals by social function'. Critical pedagogues and citizen social scientists are convinced that

during the current environmental, political, and warfare crises and biological hazards, it is essential that as many people as possible can be intellectuals also ‘by social function’, use their intellect, and participate in world-making together.

Several common characteristics unite the projects of critical pedagogy and citizen social science. The following syntheses can be used to explore the intersection of critical pedagogy and the principles of citizen social science by the European Citizen Science Association (2021). The syntheses emphasise the active involvement in learning and social research in different roles.

Citizen social science and critical pedagogy prioritise *ordinary individuals’ perspectives*, particularly those of the marginalised or whom Frantz Fanon (2004) called the wretched of the earth. They are committed to *public engagement and the democratization of research* (Chan et al. 2020). Democratisation ensures that marginalised people can influence the research process and identify what is important to research and how the community may benefit from it (Edwards and Brannelly 2017: 275). Moreover, citizen social science and critical pedagogy *emphasise empowerment* and agree that professional researchers and participants can *learn from each other*. Engagement in the research process can enhance learning opportunities, personal enjoyment, social benefits, and the common good. The synthesis of citizen social science and critical pedagogy values *openness* and advocates for the public availability of education and research to guarantee the democratisation of knowledge.

The time has come to combine critical pedagogy and citizen social science. Together, practitioners can create dialogical and participatory educational practices globally to empower people as active agents and world makers, increase mutual understanding of people through research, dialogues, and negotiations, and decide what is worth studying and researching, who owns the projects, whose voices are heard, and who benefits from the results. It is vital to democratise our knowledge practices to overcome the world’s ills (Tandon and Hall 2021).

However, the term ‘citizen social science’ may not include all individuals as not everyone holds citizenship status and exists within a Western hegemony of nation state-based hierarchy. Therefore, it may be beneficial to reconsider the use of ‘citizen’ and find terms that better capture the idea—perhaps people’s critical social science—in the global world, which often moves in random and uncoordinated ways. In this regard, postdigital approaches to citizenship (Rapanta 2023a) and citizen education (Rapanta 2023b) are a useful point of departure. Furthermore, in a world shackled by capitalism’s chains and stifled by authoritarian regimes’ grip, a new vision emerges—a vision that beckons humanity towards liberation and empowerment. It requires establishing *critical people’s universities* for all.

The call is for a collective critical consciousness to transform citizens into active change agents. The traditional paradigms of citizen social science need to be revised in the postdigital era; we need a relentless pursuit of knowledge that challenges existing power structures and fosters a deep understanding of the political dynamics of authoritarian dominance. People’s critical social science empowers individuals to question, analyse, and deconstruct the narratives woven by oppressive ideologies. It is a call to arms, urging citizens to become scholars of their own experiences, illuminate society’s obscured corners, and challenge the status quo (Denzin 2019).

The idea is to establish critical people's universities that go beyond arbitrary academic walls. They would provide a space for dialogue, dissent, and intellectual exploration where diverse voices converge to dismantle structures perpetuating inequality. The goal is to create a global network of such universities, forging alliances that transcend borders and cultural boundaries. These universities would become crucibles of resistance, transforming society through critical thought and collective action. The vision is for citizens to rise as scholars, not restricted to ivory towers but immersed in the struggle for justice. Let's embrace the power of critical emancipatory citizen science and create a more just and equitable world.

Feminisms and Postdigital Citizen Science (Sara Tolbert)

What is a feminist postdigital citizen science? While feminism defies singularities, a unifying matter of concern for feminism is the inequitable distribution of power and participation, particularly at the intersection of gender with other marginalised social categories, such as race, class, immigration status, and disability (Truth 1851/ 2020). Feminist scholarship has historically been concerned with critiquing patriarchal norms of knowledge production and, like postdigital scholarship, transcending normative disciplinary boundaries and Cartesian dualisms. Feminist science and technology studies could be viewed as a precursor to postdigital feminisms (Hurley 2023). Donna Haraway's (1985) iconic *Cyborg Manifesto*, for example, proclaimed that we are all cyborgs, problematizing definitive distinctions between human and machine, natural and artificial, physical and non-physical, human and non-human animal, etc.

Postdigital feminism is an emerging transdisciplinary field in its own right that builds on and transcends prior conceptions of feminism, maintains anti-capitalist commitments, and interrogates (subverts) postdigital hegemonies (Deepwell 2020; Hurley 2023; Jandrić and Ford 2022). Postdigital feminism brings attention to technological biases (D'Ignazio and Klein 2023), platform patriarchy (Hurley 2023), and the 'flawed' and 'partial coverage' of women and other marginalised positionalities (Deepwell 2020: 250), including nonhuman animals (Whitlock 2021) in digital spaces (see also Russell 2020). Katy Deepwell (2020) called on the field of postdigital education to consider how feminist knowledge production, when placed at the centre of postdigital inquiries, might reveal alternative framings and solutions to persistent inequities in postdigital contexts.

Feminist postdigital citizen science is not a term used within feminism or elsewhere; I use it here as a tool for theorising what a feminist postdigital citizen science might offer as part of a theoretical kaleidoscope. Feminist postdigital citizen science, like feminisms and postdigital scholarship more broadly, could be characterised as a highly diverse constellation of projects. The concept of 'feminist postdigital citizen science' intersects with cyberfeminism, data feminism, glitch feminism, and feminist digital humanities in that all of these cyber/post/digital/glitch feminist projects are creating ruptures in cis/male-dominated digital and technoscientific worlds through artistic/activist/anti-disciplinary/theoretical/ grassroots interventions. Postdigital feminist knowledge collectives such as subRosa (2008), The



Fig. 1 Social media post by Kate Clancy

Women’s Writers Project, and FemTechNet, operate at the intersections of knowledge production and activism (da Costa and Philip 2008). These collectives often challenge traditional modes of authorship and attribution, producing and publishing trans/anti-disciplinary postdigital art, science, and scholarship not under individuals’ names but rather as collectives (see Azarmandi and Tolbert 2024).

A more recent example of feminist postdigital citizen science emerged during the COVID-19 pandemic. Many women and others who menstruate were reporting abnormalities in their menstrual cycles as a result of the vaccine, side effects discounted on public health websites and not documented in other major vaccine trials, underscoring persistent gender biases in clinical research. Biological anthropologist Dr. Kate Clancy used social media to crowdsource these experiences (see Fig. 1), which in turn became part of a postdigital feminist citizen science movement that led to women’s post-vaccine related experiences—previously written off as ‘stress-related’—becoming the subject of a series of publicly funded clinical studies (Cousin-Frankel 2022).

This movement echoes other citizen science (or *ciencia popular*, Weinstein 2011)-oriented movements in which women have, through the collective sharing of stories and anecdotes, mobilised resources towards the more systematic investigation of their marginalised concerns (e.g. the grandmothers in the TCE contamination in South Tucson, Arizona; the mothers seeking out scientists’ help to investigate drinking water contamination in Flint, Michigan; mothers analysing post-Fukushima radiation in foods) (see Kimura 2016; Krauss 1993).

Citizen science has been critiqued for the ways in which it can be corrupted by scientism, as well as for falling short of its democratising and participatory aims (Kimura and Kinchy 2016). Feminist science and postdigital feminism seek to make science and postdigital scholarship more liberatory and accountable. I propose that, when (postdigital) feminism is placed at the centre of its inquiries (Deepwell 2020), postdigital citizen science is better positioned to harness the radical potential of citizen science movements. In short, feminist postdigital citizen science is

an amorphous, tentacular constellation of movements and collectives, which disrupt patriarchal norms, work creatively towards intersectional justice, and contribute to the production of (social/techno/scientific) art and knowledge from the margins.

New Materialism and Theories of Care for Postdigital Citizen Science (Laurène Cheilan)

Citizen science in a postdigital world is an ambiguous domain, rife with tensions and possibilities (Jandrić et al. 2023a). It simultaneously holds the potential to promote more community engagement with knowledge production and runs the risk of deepening inequalities, through only acknowledging certain forms of knowing as valid. Its central ambivalence can disrupt or reinforce the neoliberalisation of knowledge production. An appropriate theoretical approach to critical postdigital citizen science should allow these fundamental ambiguities to be surfaced and acknowledged, while also allowing unequal dynamics at play to be critiqued.

Based on these premises, I argue that approaching citizen science as a set of purely discursive and intellectual practices not only helps invisibilise many dimensions of how citizens can contribute to the production of knowledge, but also limits how knowledge is defined, produced, and engaged with. The argument for acknowledging embodied and affective dynamics in science communication and public engagement with research has been made before (Davies 2014, 2019), based on feminist theories of new materialism which have redefined knowledge as situated (Haraway 1988), material (Hird 2009), and affective (Pedwell and Whitehead 2012). As postdigital citizen science happens in a more-than-human field of relationalities, paying attention to these dimensions of knowledge production allows us to widen our understanding of postdigital participation in science (Jandrić et al. 2018).

Additionally, feminist theories of care have been offering frames for conceptualising how care work and hidden caring dynamics are entangled in all parts of societies for decades. Tronto and Fisher (1990) defined care as the work we do to maintain and repair our world so we can keep living in it as well as possible. This has led to calls to redefine citizenship through care (Tronto 2013) and develop a care politics that centres on interdependencies and ambivalences (Hakim et al. 2020). Care as a mode of being in the world has also been constitutive of citizen science approaches that pay attention to localised and indigenous forms of knowledge (Karrow and Fazio 2010).

In the field of Science and Technology Studies (STS), the redefinition of knowledge politics through ‘matters of care’ articulates how care can be a part of socio-technical assemblages of humans and non-humans with distributed agency (de la Bellacasa 2017). In the ‘ongoing material remaking of the world’ (de la Bellacasa 2011: 87), these assemblages entangle affective dynamics, moral economies, and maintenance work (de la Bellacasa 2015). The dynamic interactions of these three elements define and form the intricate relationships of mutual care through which knowledge is produced.

In a postdigital world, conceptualising knowing as caring means paying attention to the heterogeneous assemblages (human and non-human, material and immaterial, organic and technological) that participate in citizen science. It requires being

particularly attentive to sensory and affective modes of knowing in order to acknowledge all forms of expertise as valid. In terms of critical care, it means asking not only ‘who cares?’ in postdigital citizen science, but also ‘how to care?’ which offers a ‘transformative ethos’ (de la Bellacasa 2015: 67) that goes beyond normative ethics.

However, care is not a reassuring notion, an innocent refuge to revert to when social worlds seem too unsettling, or a guarantee to do things well (Murphy 2015). Because of its potential for ‘staying with the trouble’ (Haraway 2016), care is a powerful epistemological tool for critical postdigital citizen science. It can disrupt extractive and exploitative practices, acknowledge the diversity of existing forms of knowledge, and embed capacity for non-reductive approaches, while holding onto the messiness and ambivalence of doing citizen science in a postdigital world.

Postdigital Citizen Science and Humanities in Authoritarian Contexts (Fei Yan)

The postdigital provides a new condition for the development of citizen science (Jandrić et al. 2023a). However, what has been often overlooked or marginalised in discussions is the extent to which the future of postdigital citizen science and humanities is contingent on the support of a healthy civic society. Anchored in democracy, civic societies provide an arena in which social issues can be publicly debated, facilitating the possibility of achieving social justice through the participation of all citizens. Healthy civic societies are thus the soil in which postdigital citizen science and humanities can grow and flourish.

But the soil is markedly different in authoritarian contexts, where the development of civil society is severely constrained by a powerful state or dictator. In these societies, social issues are easily manipulated as the state typically monopolises not only the content of education but also a wide range of the media through which most people access information. Through this control, the state instils officially approved ideologies, such as nationalism, which fundamentally shape people’s perspectives on issues related to social justice. Examples of such issues include whether to allow ethnic minorities to use their mother tongue in education (Bulag 2023), or whether to support Ukraine in defending itself from Russia’s invasion. It is not uncommon to observe the state in authoritarian contexts devoting significant manoeuvring power to predisposing its citizens to certain points of view (for example, see Yan 2020).

Yet, despite the seemingly omnipresent power of the state in authoritarian contexts, the complexity and hybridity of the postdigital era have created ‘a rupture’ in the real world (Jandrić et al. 2018: 895), which offers opportunities for people living in these societies to engage in social issues in ways that were previously impossible. This was evident in the rare and courageous protests across China during the COVID-19 pandemic, sparked by widespread footage on social media of a deadly apartment fire in the far west of the country (Davidson and Yu 2022). The wave of civil disobedience initiated in the digital space eventually led to the abolition of official lockdown policies in the following weeks, demonstrating the power of grassroots or bottom-up approaches in the postdigital era. Another impressive example of rare online civic activism in an authoritarian context is the widespread public outrage and criticism of officials over the case of the ‘chained woman’ (Xiaohuamei), whose

plight evoked great public sympathy. This raised awareness of China's poor record in preventing human trafficking, supporting women's rights, and treating people with mental illness (Kuo & Li 2022).

The development of postdigital citizen science and humanities in authoritarian contexts depends heavily on the power of the state and how authoritarian the regime is. Any examination of the political dimension of postdigital citizen science and humanities in these societies must therefore consider the extent to which the role of the state, and the power structures within it, differs from its function in more democratic societies. As Strasser and colleagues (2019: 53) point out, we need to interrogate not only 'what kind of science, but also what kind of society' this is producing.

This inquiry raises various intriguing questions regarding the development of postdigital citizen science and humanities in authoritarian contexts. For instance, how does the state regulate the development and utilisation of technology and data, such as through censorship and surveillance? What role does it play in generating and controlling knowledge, including issues of academic freedom and sources of research funding? How does the state organise and oversee postdigital participation, particularly in relation to decision-making and power distribution?¹

Given the recent global surge in authoritarianism, exemplified by countries like Russia, India, and Turkey, alongside the growing influence of authoritarian regimes like China, it is imperative to approach these questions carefully. This is essential to gain deeper insights into the challenges facing the development of both postdigital citizen science and civic societies and democracies more broadly.

Citizen More Than Human(ities) and Science

Postdigital Citizen Science and the More-Than-Human World (Catherine Price)

Postdigital citizen science has the potential to increase and diversify participation in knowledge production, but this can be limited by who or what we consider as participants. Researchers have already shown that it is possible to *learn with* the more-than-human world (Szymanski and Calvert 2018; Tsing 2010). One example is the SCRaMble project where yeast was a participant and given the same agency as the scientists involved in the research process (Szymanski and Calvert 2018). Additionally, in her study on the citizen science river monitoring project, 'Citizen Crane', Ria Dunkley (2023) shows that it is possible for humans and the more-than-human world to gather scientific data together. As these examples show, the more-than-human world can be considered an equal in scientific research and citizen science projects.

Where does this leave postdigital citizen science? As Jandrić et al. (2023a) argue, the 'postdigital age is about openness and inclusivity; professional scientists and citizen scientists need to be accepted as equals'. The postdigital citizen science concept needs to be extended to include the more-than-human world, given that it has already been recognised as a knowledge producer. What is worth remembering for

¹ These questions are inspired by the three challenges raised in Jandrić et al. (2023a).

all of these knowledge producers, whether they are professional scientists or post-digital citizen scientists (human or non-human), is that the relationship between thinking and knowing is made possible due to the concept of ‘care’. Maria Puig de la Bellacasa defines care as:

intrinsically involving an ethical and political intervention that affects also those who are researching care. Because speaking of ‘good care’ – or of as-well-as-possible care – is never neutral. Because the work of care can be done within and for worlds that we might find objectionable. (Puig de la Bellacasa 2017: 6)

Postdigital citizen science provides an opportunity for humans who care about the more-than-human world to collect data on subjects including bird and butterfly numbers (Rautio et al. 2022), the weather (Ghariesifard et al. 2017), water catchments (Mackay et al. 2015), soil (Kovács et al. 2019), and many others. There is the potential to foster a deeper connection with other living and non-living entities and to help address challenges facing the planet such as climate change and biodiversity loss. Including the more-than-human world in this monitoring as an active participant, rather than as a mere object of study, offers the opportunity for transformational change (Dunkley 2023; Rautio et al. 2022).

However, the concept of care is multifaceted and disruptive (Puig de la Bellacasa 2015; Szymanski et al. 2021). Caring for and with the more-than-human world means considering how the postdigital technologies required by postdigital citizen scientists for data collection are produced. The manufacturing of computing hardware and software can actually add to postdigital environmental crises through the extraction of minerals, metals, oil, and gas (Price 2023a). There is also a requirement to ensure more-than-human participants, e.g. birds carrying satellite tags (Price 2023b), are not exploited by humans in data collection in the quest to further knowledge production.

While the inclusion of the more-than-human world as a participant potentially problematizes postdigital citizen science, this does not mean it should be overlooked. Caring for and with the complexities of the more-than-human world might contribute to the survival of life and flourishing futures.

Postdigital Citizen Data: Participation, Partnerships, Precautions, and Possibilities (Sarah Hayes)

While ‘most citizen science projects take place within the problem-focused natural sciences’, social sciences and humanities help to further our understanding of the human dimensions (Tauginienė et al. 2020: 1). This makes a case for the power of an interdisciplinary lens to examine public participation in scientific research, but in postdigital society, the prolific extent of data interactions in human lives calls also for collaborative cross-sector dialogue. This is an inclusive approach that is captured in *Human Data Interaction, Disadvantage and Skills in the Community: Enabling Cross-Sector Environments for Postdigital Inclusion* (Hayes et al. 2023), discussed

too in a showcase of Human Data Interaction Network Plus (2023), recent interview (Hayes et al. 2024), and book review (Turvey 2024).

Since the COVID-19 pandemic, there has been a stronger awareness of the need to improve ‘digital inclusion’ among disadvantaged groups and individuals in communities across the globe (Hayes et al. 2023: xiv). Yet the major focus has been placed on *human computer interactions*, such as improving digital skills and access. How individuals are positioned in their *human data interactions*, as these intersect in complex ways with various forms of disadvantage in postdigital contexts, has been less researched.

Preece (2016: 585) suggests that citizen science and Human Computer Interaction (HCI) researchers ‘can leverage each other’s skills to speed up science, accelerate learning, and amplify society’s well-being globally as well as locally’. However, emerging also from an HCI theoretical background, the Human Data Interaction (HDI) framework (Mortier et al. 2014) calls for *legibility*, *agency*, *negotiability*, and even *resistance*, to give citizens greater capacity to act, as they encounter data-driven systems. Data are no longer simple forms of information entered into a spreadsheet. Data are now deeply interspersed with online and offline forms of media and algorithmic activity, the Internet of Things, and the digitalisation of many social services (Hayes et al. 2023: xvi). The HDI framework suggests that analytics and algorithms ought to be transparent and comprehensible, enabling opting in or out, and personal data to be corrected. This extends to our physical lives too, given that ‘biology as digital information, and digital information as biology, are now dialectically interconnected’ (Peters et al. 2021: 370) enabling the trackability of humans, with or without, our explicit consent.

It is important though that precautionary discussions take place alongside a furthering of participatory possibilities for citizens to interact with their own and other people’s data to contribute to societal research. For example, the Consumer Data Research Centre (CDRC) (2024) points to the valuable insights into human behaviour that might be gained across scientific, social, and economic challenges, via collaboration with consumer data providers. Using consumer data, diverse patterns of urban mobility and travel, flooding, terrorist attacks, areas of food insecurity, or detailed crime narratives can be shared across researchers, businesses, and agencies. Such coordinated HDI activities open routes for valuable local and international, interdisciplinary, and cross-sector knowledge exchange.

Therefore, an interdisciplinary lens on citizen science enables perspectives from the social sciences and humanities to strengthen the dialogue on citizen participation in scientific research. This could, for example, both encourage valuable exchanges of data and knowledge and heed Ritzer’s arguments about shifts in capitalism from an exploitation of producers to an exploitation of consumers (Ritzer et al. 2018, 2024). Citizen con(pro)sumers are now daily generators of digital data in postdigital society, amid rapid developments in algorithmic culture and artificial intelligence systems. This means that there are complex implications for postdigital inclusion as citizen science is enacted in local communities. Ongoing interdisciplinary and cross-sector dialogues on Human Data Interaction (HDI) are recommended to balance considerations of equity and social justice alongside the possibilities for societal research from citizen data.

AI-Powered Citizen Science (Howard Scott)

Could citizen science benefit from integrating AI into co-creation projects through a *postdigital* theoretical approach which draws on the Human Data Interaction (HDI) tenets (Mortier et al. 2014)? Despite its pervasiveness in the postdigital world, access to data remains a challenge for citizen scientists and this kind of integrated approach might help address ethical concerns around AI, including transparency, and improve general AI literacy in harnessing its potential to support co-creation.

Criticisms of data exploitation have been levelled against citizen science because often the data that participants gather are gifted to formal projects without acknowledgement (Weinstein 2011). Far too often, citizen scientists simply assume the role of data collectors, without having input into research methodologies, questions, analysis, or outcomes. As the following examples indicate, using AI such as natural language processing tools may improve citizen scientists' access to projects.

Access to 'open data' can help facilitate the use of real-world AI applications (European Union 2023) in citizen science co-creation projects, where communities may, for example, wish to collaborate. Mortier et al. (2014) propose *legibility*, *agency*, and *negotiability* as tenets which focus on human interaction with data and could help guide citizen science to work with AI. Hypothetically, a citizen science group wishing to monitor and analyse water pollution in their local environment could compare data they collect locally with wider examples from open data and harness AI to analyse it for trends or patterns, as long they are supported to develop the necessary rigour and skill sets to analyse the data they have collected. Access to datasets in a *postdigital* landscape is no challenge in itself. As Green et al. (2020) have identified, using public camera traps in projects produces such massive amounts of data that it is their categorisation and analysis which become challenging.

Citizen scientists might, however, develop AI skillsets, e.g. an understanding of prompt engineering (Bozkurt and Sharma 2023) or topic modelling, which Churchill and Singh (2022) describe as textual analysis by large language models to identify themes and discover patterns 'that allow humans or machines to swiftly grasp salient information or quickly navigate massive databases' (Wong and Li 2023: 4). Alongside this could be the need for monitoring and critical reading of results by a Human-In-The-Loop (HITL) to ensure AI interfaces do not provide false information ('hallucinations').

Co-created citizen science may raise questions about integrity in potential projects, highlighting the need for theoretical guidance. Monitoring pollution in a local water supply, for instance, could produce different results if the stakeholders involve community scientists collaborating alongside employees of a local polluting company. They could undertake this as citizens, but a theoretical perspective drawing on Mortier et al.'s (2014) HDI tenets could require projects to comply with 'legibility', whereby data analytics must be transparent. AI tools such as scite.ai even enable a means of project management for auditing research processes and disseminating results. Trustworthy AI tools that ensure metadata are transparent and of high quality may not be available, so a postdigital human element to research, like HITL, may need to be retained to ensure integrity. In summary, AI can be beneficial to help citizen scientists access metadata and conduct data analysis, but cognisance of ethical approaches, including transparency, need to be maintained.

Angling and Entangling the Kaleidoscope's Theoretical Lenses

Philosophy of Technology (Annabel Latham)

There is debate around whether technology is distinct from science or is the application of science (Encyclopedia Britannica 2024). Herbert Simon (1969) stated that while scientists are concerned with how things *are*, engineers focus on how things *ought to be*. Technology has revolutionised citizen science, improving efficiency in data collection and analysis, reducing cost, expanding the geographic and demographic reach (Newman et al. 2012), and changing the ways that citizen scientists can contribute (Mazumdar et al. 2018).

The Philosophy of Technology can be seen as a study of the meaning of technology in the context of its relationship with and impact on, people, culture, and society. Mitcham (1994) refers to this as the 'humanities philosophy of technology'. This popular standpoint sees technology as a black box (as it originates from the goals and values of humans) and considers its effect as a sociocultural phenomenon in relation to human culture, morality, politics, the structure of society, and metaphysics. As such it tends to view technology as having a negative impact on human society.

An alternative branch, 'analytic philosophy of technology', focuses on the technology itself, aiming to understand the nature, design, and creation of technological artefacts (Franssen 2009). Technology is considered to be grounded in practice, i.e. engineering, with a focus on considering the concepts, goals, and methods from a philosophical viewpoint. Here, design is fundamental to technology, with engineers seeking to solve problems for the good of society. For instance, the Institute of Electrical and Electronics Engineers (2024), the world's largest technical professional organisation, aims to 'advance technology for humanity'. However, the design process includes many considerations: not only functional requirements, but also the values of users, efficiency, safety, sustainability, market success, and financial or resource constraints. This means trade-offs are inevitable. Attempting to integrate values into designs leads to conflicts that are difficult to resolve.

In our postdigital age of big data, algorithmic decision-making, and artificial intelligence, the ethical and social aspects of technology are fundamental. If technology is value-neutral, how do we approach responsibility? Is it possible to assign responsibility for complex systems designed by multiple teams of engineers? Further, outputs from self-learning and intelligent systems are difficult for humans to understand, predict, and control, leading to responsibility gaps (Matthias 2004). Risk is another key concern, but there is rarely sufficient knowledge to reliably assess the consequences of a new technology. This means the focus tends to be on safety rather than social or psychological risks.

Can postdigital citizen science exist now without technology, data, and algorithms? Society and technology are interdependent, each influencing the other. Citizen scientists may rarely consider the personal consequences of sharing and uploading information to apps and, like most people, may not read the terms and conditions. Researchers depending on citizen scientists should consider their use of technology from both humanist and analytic perspectives, asking questions such as

the following: Who is responsible for unforeseen social or psychological impacts on citizens? How inclusive are we being? Are we reinforcing digital inequalities? Is there a balance of power? Will the data gathered be inherently biased? Can we offer alternative methods of participating?

Citizen Linguistics (Ibrar Bhatt)

We can leverage the principles of citizen science to deepen our understanding of language use, variation, and evolution within communities. This approach has the potential to span several areas of linguistic inquiry, including sociolinguistics, literacy studies, and linguistic ethnography. Work in these sub-areas can benefit from the participatory nature of citizen science, where ‘non-professionals’ can contribute to academic research in meaningful ways. By situating ‘citizen linguistics’ within the broader context of the humanities, we open avenues for interdisciplinary collaboration that not only enrich our linguistic knowledge but also strengthen the fabric of humanities research, fostering a holistic understanding of human culture and society.

At its core, citizen linguistics involves the collection and analysis of linguistic data by ‘lay’ people. Our everyday environments and personal lives are rich with linguistic information—ranging from public signs and graffiti (linguistic landscaping) and individual experiences with language (linguistic auto-ethnography) to the observation of how language is used and evolves within our communities. These endeavours are not just about accumulating data but also require us to engage deeply with the language as it is lived and experienced, marking an ongoing effort to document oral and written language development through community participation and metadata collection.

Participants in citizen linguistics can engage in a variety of research tasks. These can include classifying regional accents by listening to audio clips, recording spontaneous language use, and noting the evolving meanings of words and phrases, especially in contexts where multiple languages intersect (translingual practice). Understandably, this process will extend to analysing the semiotic features of the linguistic practices of individuals and groups and will be further interpreted by academic researchers. Thus, citizen linguistics is inherently participatory and fosters a form of epistemic interdependence between researchers and the researched.

Such grassroots engagement is particularly vital in contexts where languages are at risk of disappearing or when heritage literacy practices encompass *transmodal* and *translingual* elements that exceed the boundaries of traditionally named languages. Such practices can be multimodal, multiple orthographies and include gestures and non-verbal communication, which require a nuanced approach to documentation and analysis. For example, languages like the Ainu language in Japan and the Navajo language in the United States exemplify communities where linguistic practices are under threat, necessitating innovative approaches for preservation and documentation.

Moreover, citizen linguistics has practical implications beyond academic research. It supports linguistic policy planning, the development of educational resources, and the documentation of endangered languages and dialects. By involving community members in the research process, it ensures that the outcomes are

relevant and beneficial to those same communities, thus promoting a more inclusive and participatory approach to language study.

Language practices which span various modes and media are most coherently understood within a postdigital context (see Bhatt 2023a, b). Such an approach not only considers people's attachments to analogue technologies but also situates these preferences within a broader 'postdigital literacy ecology' as described by Bhatt (2023a). By framing our understanding in this way, and aided by citizen linguistics, we can appreciate the intricate web of language practices that are shaped by a multitude of influences, offering a holistic view of how digital and analogue experiences coalesce in the modern world.

Citizen linguistics empowers individuals and communities to contribute to the understanding and preservation of linguistic diversity. It acknowledges the complexity of language in its 'natural' settings and seeks to harness this complexity through collective effort. As such, it not only enriches linguistic research but also plays a crucial role in cultural preservation and the promotion of linguistic diversity on a global scale.

Postdigital Citizen Science: An Approach from Economics (Vyacheslav Dodonov)

As an economist, I see great potential for the development of traditional economics through the use of citizen science tools, both in a practical sense by increasing the accuracy of estimates and the measurement of economic processes through expanding data sets with the help of citizen scientists and in terms of enriching theory through cross-sectoral citizen research in economics, sociology, and political science.

Improving the accuracy of the analysis and assessment of economic processes is possible in those areas where the role of citizen scientists is potentially extensive, not so much for obtaining primary data, as for interpreting them at the level of perception within households. This applies to issues such as the impact of inflation on living standards, income inequality, and the quality of municipal government. These issues are especially relevant for developing economies, where problems remain with the accuracy of statistics relating to these parameters and the methodology for calculating the corresponding indicators. Therefore, the involvement of citizen science tools can provide additional impetus for the practical application of the data obtained with its help.

I see the improvement and enrichment of theoretical approaches using the capabilities of citizen science as possible, based on the fusion of approaches of economics and sociology to increase the accuracy of measuring macroeconomic dynamics and its refraction through the perception of citizens. Citizen science and scientists can make improvements in the measurement of macroeconomic indicators and their impact on households by continuing research at the intersection of GDP, human capital, and social indicators (such as the UNDP Human Development Index or World Bank Human Capital Index) or through more ambitious efforts to find alternatives to macroeconomic progress in the form of measuring areas such as gross national happiness (United Nations General Assembly 2011), human wellbeing, and

environmental impact (Happy Planet Index). More accurate measurement in turn can become the basis for policy-focused research and recommendations to improve decision-making processes.

The digital dimension of citizen science in developing and emerging economies is also worth mentioning, in particular, the problem of digital inequality which ‘can be understood as the unequal or differentiated use of the available technology, infrastructure, services, facilities, and information’ (Kuhn et al. 2023: 908). This problem not only ‘threatens to leave those States in the technological wake’ (United Nations General Assembly 2023), but also increases inequality of income and opportunity within these countries. In the postdigital era, digital inequality in less developed countries threatens to increase divides and push large parts of society to the margins of progress. In preventing this scenario, citizen science and, in particular, economics can play a significant role by more accurately and critically assessing the economic basis and scale of digital inequality, determining the focus of its most critical efforts.

Citizen scientists can collect more accurate and representative data on the use of digital technologies in different strata of society by income level, which will make it possible to link income inequality and digital inequality. It is especially important to study digital inequality in business organisation and management in developing countries, where civilian scientists can make a considerable contribution to the study of the interdependent factors that cause it. This can help to develop economic mechanisms for reducing gaps in key areas of digital inequality, mitigating its consequences, and targeting assistance towards the most vulnerable members of the population. This suggests that postdigital citizen science has great potential to enrich the theory and practice of economic science in general and its implementation to address developing countries’ problems, especially those related to income and digital inequality.

Integrating the Lippman-dewey Debate: Pragmatic Idealism and the Mode 3 Universal Network University (Adam Matthews)

Walter Lippmann’s (1922/ 2007) book, *Public Opinion*, introduced the concepts of stereotype and pseudo-environment to conceptualise citizens’ lack of omnicompetence in domains of the modern world beyond their own personal expertise, experience, and context. This for Lippmann raised practical limitations to a fully participatory democratic ideal. John Dewey responded with *The Public and its Problems* (Dewey and Rogers 1927/ 2016), presenting his own democratic ideal of full participation, which saw democracy in terms of a constantly evolving entanglement of communication and problem-solving across all of society.

Both authors advocated democratic ends—a key difference was that Lippmann thought that it was the role of experts (such as academics, professionals, and journalists) to communicate and synthesise information to publics and elected officials, while Dewey called for active participation from all (Whipple 2005). The Dewey-Lippmann debate provides us with two lenses with which to consider postdigital citizen science and humanities where information is abundant (Jandrić 2023) and the epistemological, political, and postdigital are intertwined (Jandrić et al. 2023b).

For Dahl and Shapiro (2015), large-scale democracy requires alternative sources of information, associational autonomy, and inclusive citizenship. The deluge of alternative sources of information in the twenty-first century has democratised access in many cases but such abundance has also resulted in scepticism (and more dangerously, cynicism) and antagonism towards expertise and objective ‘truth’, manifested through contested terms such as postmodernism, post-truth, fake news, and mis/disinformation in the contemporary public sphere (Farkas and Schou 2019). Contemporary issues such as climate change and artificial intelligence are highly technical, and how we respond has wide-ranging implications for all. This poses a technocracy-democracy dilemma (Coeckelbergh and Sætra 2023), similar to that which divided Lippmann and Dewey.

Harjuniemi (2022) juxtaposes Lippmann’s argument for professional standards and autonomy with Hayek’s view of free market neoliberalism as a marketplace of ideas free to emerge from all, not just ‘elites’. Curtis (2020) has described the conflict between democracy and neoliberalism as the ‘second Dewey-Lippmann debate’. ‘Experts’ such as those in universities have come under attack in recent times (Galpin and Vernon 2024) with populist movements polarising ‘elites’ against ‘the people’.

The institution of the university as a key knowledge producer and interpreter in society has seen huge growth since the time of Dewey and Lippman. This has placed greater responsibility upon the university, moving it beyond exclusively academic knowledge (Mode 1) and mass production to solve problems and produce future workforces (Mode 2) towards the Mode 3 Universal Network University (Matthews 2023). This requires the university not only to focus on the research journal article and full-time degree, but also on widening participation, collaboration, and integration with society in (co-)creating and communicating information and knowledge. These modes are not purely historical developments; they also co-exist in tension in different contexts.

Concepts such as integrating and transcending disciplinary knowledge (Repko and Szostak 2021) and the co-production, exchange, and communication of knowledge (Bandola-Gill 2023) are wide-ranging, collaborative tasks, involving many stakeholders (Schütz et al. 2019). Through these tasks, the Mode 3 Universal Network University can draw together both sides of the Dewey-Lippmann debate to contribute a theoretical lens with which to theorise and practice citizen science and humanities. Skills and knowledge drawn from Dewey as a philosopher and Lippmann as a journalist provide integrative promise as well as critical perspectives for collaborative knowledge production, exchange and communication in the public sphere (Duffy 2015; Remler et al. 2014). Dewey’s complexity and ideals are key for equitable and democratic ends and Lippmann’s pragmatism is a reminder of the challenges faced and diverse expertise available in many areas both inside and outside of the university for knowledge production, integration, equity, and access. Integrating and oscillating between the two positions offers opportunities for a pragmatic idealism (Vermeulen and Van Den Akker 2010) as a guiding principle for the Mode 3 Universal Network University, active and participatory in the postdigital public sphere.

Cultural Considerations and Postdigital Participation in Citizen Science (Rami Muhtaseb)

Citizen science transcends the conventional boundaries of research, allowing individuals from diverse backgrounds to participate in scientific projects. This can introduce diverse perspectives into scientific research, particularly when addressing global issues. Research in citizen science demonstrates the influence of culture on citizen scientists' motivations (Rotman et al. 2014; Jeong et al. 2023). Moreover, participation in science is influenced by a range of factors, including gender (Hurley 2023), race, ethnicity (Benjamin 2019), religion (Savin-Baden and Reader 2022) and location, as well as other aspects of identity, intersectionality, and belief (Jandrić et al. 2023a). Consequently, developing inclusive and engaging citizen science initiatives hinges on developing a nuanced understanding of how culture shapes communication and collaboration.

In the postdigital era, it becomes imperative to consider how cultural dimensions intersect with (post)digital platforms and practices in ICT-mediated citizen science initiatives. Hofstede's (2011) framework is one of the most common models for describing how culture affects members' values and behaviour. It situates national cultures along six dimensions: Individualism vs. Collectivism, Power Distance, Masculinity vs. Femininity, Uncertainty Avoidance, Long-Term vs. Short-Term Orientation, and Indulgence vs. Restraint. This contribution begins to exemplify and investigate the dynamics influencing online participation in citizen science across diverse cultural contexts by integrating the postdigital perspective with three of Hofstede's cultural dimensions. Further investigation of all these cultural dimensions can contribute to developing practical guidelines for fostering cross-cultural communication and collaboration in postdigital citizen science.

Individualism vs. Collectivism

This dimension reflects how much a society prioritises individual interests over collective goals. In societies with individualistic cultures, participants may engage in projects that align with their passions and preferences and cherish their sense of freedom and autonomy. Meanwhile, participants from more collectivist cultures may be motivated by a sense of duty to their social group or a desire to contribute to a collective cause (Cardoso-Andrade et al. 2022).

For example, in a citizen science project to monitor bird populations in specific areas, participants from individualistic cultures might be more inclined to work autonomously, focus on personal observations, and contribute based on their expertise. In contrast, participants from collectivist cultures might prioritise collaboration and community involvement, organising local bird-watching events, and sharing their findings collectively on social media.

Power Distance

Power Distance reflects the extent to which a society accepts and expects unequal distributions of power. Given the participatory nature of citizen science, this may influence communication and decision-making. Participants from cultures with high

levels of Power Distance may prefer expert-led citizen science projects. Participants from cultures with low levels of Power Distance may be more inclined to engage in community-led initiatives.

In a citizen science conservation project involving environmental monitoring through social media, communication in high power distance cultures may be more formal and top-down, relying on project leaders for guidance. Participants from low Power Distance cultures might prefer more decentralised decision-making processes and collaborative leadership, using social media for open discussions and decentralised decision-making.

Long-Term vs. Short-Term Orientation

Both forms of orientation relate to the focus of people's efforts and reflect a society's attitude towards future planning. In long-term-oriented cultures, participants may exhibit commitment and perseverance in citizen science initiatives, prioritising the sustainability of citizen science projects. Short-term-oriented cultures may prefer initiatives with quick, observable outcomes.

For instance, projects focused on pro-environmental behaviour, such as tracking changes in air quality, are likely to attract participants from long-term-oriented cultures (Dangelico et al. 2020), to monitor trends and patterns over extended periods. Projects focused on documenting transient events, like migratory bird sightings or responding to emergencies, are more likely to appeal to participants from short-term-oriented cultures.

Children and Young People as Citizen Researchers

According Epistemic Credibility to Young People as Citizen Social Scientists (Alison MacKenzie and Mohamed Owaineh)

Social science research has rarely regarded Children and Young People (C&YP) as credible knowers and perceivers of their own experiences, and neither, consequently, as citizen social scientists. Researchers have researched *on* C&YP using the perspective and experiences of adults—parents, teachers, social workers, or the police, for example. The reasons for overlooking C&YP as epistemic agents—and citizen social scientists—lie in belief systems that C&YP lack rationality, lack the capacity to have valid or reliable views and opinions, and that, below the age of 11, they are not capable of thinking about thinking.

C&YP were seen as immature forms of the human organism who would eventually become the final form—the human adult (the Aristotelian conception of childhood). The Piagetian (1933) stage theory, which conceived of children as developing in age-related stages, viewed them as a configuration of deficits and as lacking the capacities of adults, a paradigmatic view that persisted long into the twentieth century. These influential conceptions have had implications for how we understand C&YP in philosophy, psychology, sociology, education, law,

and other fields, as well as in social science research: as subjects or objects of research rather than as contributors *to* research.

These widely held conceptions, however, are being challenged. The most significant challenge has come from the UN Convention on the Rights of the Child (UNICEF 1989), particularly Article 12, the lynchpin of the convention, which provides for the child's right to participate in processes affecting their lives. This right recognises the child as a full human being who is able to participate in society. Their views, moreover, are to count (given 'due weight'). As they are to count, then children ought to be regarded as epistemic agents who can design, take part in, and offer critical insights into and commentary on social science research, including education, the environment, or social media legislation.

Due weight arguments are supported by Article 13, the right of 'freedom of expression' and 'the right to seek, receive and impart information and ideas of all kinds'. Researchers in the field of children's rights (Lundy 2018), participatory action research informed by children's rights (Lundy and Templeton 2018; Owaineh 2023), and philosophical communities of inquiry (Petropoulos 2023) have shown how critically informed and engaged C&YP are, if they are given the opportunity and the means by which to express themselves. Research which involves C&YP as epistemic agents who are credible citizen social scientists is growing in influence and impact (for example, Templeton et al. 2022).

C&YP are, moreover, growing up in a digital world in which 1 in 3 Internet users worldwide are under 18 (Livingstone et al. 2015). C&YP are skilled users of the digital and are adept postdigital citizens for whom the postdigital merges seamlessly with the off-digital. The knowledge and experience of C&YP mean they are, or should be, regarded as indispensable social citizen scientists.

Owaineh (2023) created a disabled young women's advisory group to explore the myriad challenges which hinder their access to education in Palestine, a context in which the political, cultural, social, and infrastructural barriers to inclusion are systemic and structural as a consequence of, primarily, aggressive settler colonialism and the thwarting of Palestinian statehood. The advisory group sought to use the digital environment to participate in, and contribute to, the research. Among their observations on the advantages of this approach to research was that, for example, video calling both transformed and sustained their ability to communicate, while protecting them from the hazards of travelling in the occupied West Bank.

The advisory group's contributions were thought-provoking: they were surprised at being consulted as no one had ever sought their views, believing they lacked capacity or understanding. Their insights on being disabled, young, female, and Palestinian were acute and harrowing because they were so eloquently expressed from their perspective in their own words. Owaineh (2023) concluded that while lacking professional skills in conventional research, they were valuable epistemic contributors to the field of educational inclusion within a very particular context that is too often described by non-disabled adults and non-Palestinians who lack their fine-grained knowledge. Though overlooked, unseen, and silenced, no one, we contend, could read the accounts of these perforce self-effacing young women and not conclude that they are *bona fide* citizen social scientists.

Postdigital Primary School Citizen Science (Sarah Earle)

Citizen science is increasingly used as a strategy to engage children in science, for example, in gathering data for bird sightings in gardens (e.g. RSPB's (2024) Big Garden Bird Watch in the UK) or testing water samples (e.g. BBC's Terrific Scientific (n.d.)). Children, as citizens, are asked to collect data and submit it digitally, to help scientists. While in theory this sounds as though it actively involves children in science, potentially making them feel part of the scientific community, it may also be embedding the view that science is led by others.

Attitudes to science are built in primary school (Archer et al. 2020; Nag Chowdhuri et al. 2021), with implications not only for engagement in science at secondary school and future careers, but also in terms of the critical thinking required of scientifically literate citizens. The concept of 'science capital' is often represented as a rucksack containing the person's experiences and engagement with science (University College London 2020). For those with high science capital, their 'rucksack' is full of visits to museums and discussions with family and friends who use science in their work, perhaps leading to an understanding of the range of jobs requiring science and the importance of science for society. These children feel that science is 'for them' (Nag Chowdhuri et al. 2022). In contrast, those with lower levels of science capital may only see science as a subject studied at school or something that is done by stereotypical chemists in lab coats; science is not 'for them'. Such beliefs about science may lead to issues with the uptake of science qualifications and roles (Institution of Engineering and Technology 2021) and under-representation and inequity in STEM education and the workforce (All-Party Parliamentary Group 2021).

Efforts to raise science capital and engagement in science could involve visiting scientists or linking more diverse scientists to topics in school (e.g. Primary Science Teaching Trust's (2024) 'A scientist like me'). This may broaden children's ideas about who can be a scientist, but it may not address the issue of science being done by 'others'. Involving children in citizen science activities could help children to see that anyone can do science, with digital datasets cumulatively building in real time. However, from a postdigital citizen science perspective, it is also important to acknowledge other embedded messages within citizen science programmes that seek to engage children. Just as adult citizen scientists could be described as unpaid data collectors in scientist-led studies (Jandrić et al. 2023a), a similar argument could be made for children, as citizen scientists who are contributors only, being data-providers who are 'done to'.

The Primary Science Capital Teaching Approach (Nag Chowdhuri et al. 2021) recognises the importance of children's starting points and interests, suggesting that inclusive practice involves 'personalising and localising', to help connect science to the child's unique context, together with supporting their voice and agency. When children, in collaboration with their teachers, make additions to an online citizen science database, counting birds or litter for example, this could further add to the science capital of those who already have a sense of the importance of science. However, for those with low science capital, it may only be seen as another in-school activity, something that does not sufficiently link science to their own

context. Involving children in citizen science is one of many activities designed to raise the profile of science, but a postdigital perspective is useful to help us consider whether and where it can extend to genuine collaboration, rather than just participation (Jandrić et al. 2023a). Agency may be achieved by providing more opportunities for children to be involved in the whole process of citizen science, rather than just at the point of data collection, for example, by seeking children's perspectives on the questions they have and the problems they would like to solve.

Children With Profound and Multiple Learning Disabilities as Citizen Scientists (Ben Simmons and Zoë Clarke)

Children with Profound and Multiple Learning Disabilities (PMLD) experience global developmental delay stemming from neurological impairments. They are commonly described as functioning at the earliest, pre-verbal stages of development and are perceived to lack formal (symbolic, intentional) language skills, cause-effect awareness, object permanence, and a range of other capabilities associated with later infancy (Simmons and Watson 2014). Children with PMLD present some of the greatest challenges to emerging research paradigms such as 'inclusive research', 'co-produced research', and 'postdigital citizen science', which presuppose a particular kind of 'researcher' or 'scientist', i.e. a rational, objective, agentic, and symbolically-competent individual.

Some might call into question the extent to which children with PMLD can become postdigital citizen scientists given the severity of their impairments—especially when they are described as lacking a 'point of view' (Ware 2004). However, it is our contention that such attitudes are informed by a medical model of disability (Barnes and Mercer 2010), whereby exclusion from science is blamed on children's impairments. A more fruitful approach, reflecting a social model of disability (Shakespeare 2017), is to start from the phenomenological position that views children with PMLD as situated and embodied beings-in-the-world and as 'always-already' postdigital citizen scientists (Merleau-Ponty 2002).

Children with PMLD live in a postdigital age, participate in, and explore social and physical worlds, and are attuned to sensory experiences. As such, they are natural scientists and have much to teach us about the 'being' of a scientist. Rather than asking how we can train children with PMLD to become citizen scientists, we should instead be asking what children with PMLD—as experts in their own lives—can teach us about the meaning of citizen science and humanities.

For example, instead of privileging an objective epistemology which sees knowledge as existing in the world waiting to be discovered (Crotty 1998), detached from the knower, children with PMLD teach us that knowledge can be ambiguous, emergent, and temporary. The child with PMLD communicates not through formal language, but through embodied responses to the world. Their individualised behaviours can require people working with children with PMLD carefully to monitor and revise their interpretations of all children's behaviours because these behaviours need to be interpreted in contexts which change over time. This eschews

the Cartesian desire for certainty underpinning objectivity and supports a view of knowledge as relative and local.

Children with PMLD teach us that human beings are inherently a relational group who depend on others. They do not stand outside of social and cultural worlds, but are very much part of their fabric (Loidolt 2018). Those who spend time with children with PMLD discover not an objective or even intersubjective science, but an intercorporeal citizen science, whereby we engage with one another and the world through our bodies, with particular attunement to sensation and affect (Varela et al. 2016; Szanto and Moran 2016). If postdigital citizen science is for everyone, then we must approach it in a way that includes the lived experiences of children with PMLD. Our claim here is that such inclusion will lead us to science that is affective, relationally embodied, with local and emergent knowledge claims.

Citizen science is unlikely to be inclusive for children with PMLD if it explores research questions and uses methodologies designed without input from children and families. Inclusivity requires researchers to work closely with children with PMLD and their social networks to develop tailor-made projects that value children's uniqueness while recognising their dependency on others. Therefore, the focus and practice of such research must be co-designed to allow it to be meaningful and accessible to children and those who support them.

PhenoloGIT: A Transnational Educational Citizen Science Project (Linda la Velle)

Phenology is the study of periodic plant and animal life cycle events, and how these are influenced by seasonal and inter-annual variations in climate. Collection of phenological information is a long-established citizen science activity across Europe, with national and international associations gathering individual data sets provided by thousands of people annually. However, until 2019, it was a science that for the most part used traditional, non-digital methods to record data.

Harnessing everyday digital tools, the PhenoloGIT² project, which brought together six partners and was funded by the EU's Erasmus+ programme, designed, built, and tested a collaboratively created educational platform. Teachers and pupils in schools across Europe used it to collect and share phenological information and access the extensive digital capabilities of geographical information technologies (GIT) to gather, manage, and analyse data.

That the children were able to act as citizen scientists, whose data collection was as valid as that of participating adults, was genuinely inclusive in the postdigital sense (Tauginiene et al. 2020). It also enabled the use of cultural tools as material and symbolic, 'person-plus' mediators of learning (Baggott la Velle et al. 2004) as a key feature of the postdigital education landscape (Newman et al. 2012).

PhenoloGIT used state-of-the-art mobile technology and GIT to make available to schools the educational potential of these technological developments, enabling issues-based and enquiry-based teaching and learning for pupils aged 9–13

² See <https://erasmus-plus.ec.europa.eu/projects/search/details/2015-1-UK01-KA201-013537>. Accessed 25 April 2024.

in a range of curricular disciplines (e.g. STEM, geography, languages, art). Many educators consider GIT to be one of the most promising means for implementing curriculum reform, with learners working collaboratively to construct their own analyses and artistic and scientific representations of real-world data sets. However, GIT is often seen as too complex for teachers to be able to access its wide-ranging potential in lessons.

The PhenoloGIT project created an educational and technological solution that allowed teachers and pupils innovatively to use open-source GIT + mobile learning + phenological data recording as citizen scientists. This contributed to the large volume of high-quality geographical databases that many national and international organisations are building to facilitate a better understanding of their territories and environments. Most of these data are still unusable or unknown by most classroom teachers. PhenoloGIT enabled the use of these resources in schools, so that they could be made available for educational ends, including the preparation of future citizen scientists in a postdigital world. The intersection of young people with technology has a direct impact on their relationships with other people and the natural environment.

There were clear benefits for each of the partners from the project outcomes. The two universities involved, in England and Denmark, gained opportunities for research-informed teaching and technology-enhanced learning. Inherently postdigital, the project empowered pre- and in-service teachers to engage and encourage their pupils to engage in citizen science activities, thus expanding the frontiers of participatory research, knowledge production, and public engagement (Peters et al. 2020). The two publicly-funded EdTech innovation centres involved, in Spain and Lithuania, were able to provide multilingual open-access resources and in-service training.

This has implications for the postdigital political economy. Provision of tools to generate and share knowledge can be argued to be an example of what Peters et al. (2020) term ‘knowledge socialism’. The Spanish school involved generated and made available citizen science resources for use in collecting phenological data using the PhenoloGIT app. This kind of collaboration enacts the intersection between phenology (and ecology more widely) and the human/digital nexus, reflecting their indivisibility in the postdigital world (Jandrić et al. 2023a).

Shaking the Kaleidoscope

Flipping the Kaleidoscope Metaphor on its Head (Benjamin Green)

Mesjasz (2015) has cautioned against the ‘abuse’ of complexity science and its related terminology by those who reduce complexity within their work to little more than metaphor or analogy. Notwithstanding, the call for contributions which preceded this article enlisted the metaphor of the kaleidoscope ‘to describe a need for different theories, or an intersection of multiple theories, to unpack and understand the complexity of postdigital citizen science’.

However, according to Sir David Brewster (the inventor of the kaleidoscope) in his *A treatise on the Kaleidoscope* (1819: 17), '[t]he fundamental principle, therefore, of the Kaleidoscope is, that it produces symmetrical and beautiful pictures, by converting simple into compound or beautiful forms, and arranging them, by successive reflections, into one perfect whole'. Rather than clarifying complex forms through component images, the kaleidoscope casts a simple image into a beautifully complex and multifractal unified form. Thus, utilising this metaphor as an analytical tool to develop a multifaceted understanding of 'the supercomplex nature' of social phenomena (Kuhn et al. 2023: 895) highlights a flawed understanding of the intended purpose or function of a kaleidoscope. As argued by Knox (in Kuhn et al. 2023), given that the task of the kaleidoscope is to convert the simple into the compound, a kaleidoscopic metaphor for scientific inquiry might suffer from an assumption of 'supercomplexity' as 'intrinsic' to the object of inquiry (in this case, citizen science). In other words, the issue here is that this metaphor might lead to a focus on complexity of form rather than 'the object of study itself' (Knox in Kuhn et al. 2023: 924).

In *Fractal Leadership*, Karatzogianni and Matthews (2023: 4–5) incorporate an understanding of *kaleidoscopic whirl*, as a 'frothy'³ property of a whole that prevents systemic understanding through the identification of discrete component properties. It foregrounds *fractal whirl* as critical to understanding the 'nebulous and often competing discourses', decentralised leadership structures, and individual conversations which make up the 'amorphous and shifty nature' of contemporary youth protest movements (Karatzogianni and Matthews 2023: 5). This difficulty reflects a core facet of complexity theory, wherein the nonlinear nature of complex social systems is understood through *emergence*—an unplanned feature of a system that cannot be reduced to a linear aggregation of the underlying components (Baggio and Parravicini 2019; Törnberg 2011; Walloth 2018; Green 2023).

There are those who argue that citizen science resists a simplified definition (Hakley et al. 2021). However, it is undeniably reducible in form—laypersons engaging in individual or collective scientific inquiry. Nevertheless, a related paper aims to develop a 'deep reimagination and reconfiguration of citizen science in and for the postdigital condition' (Jandrić et al. 2023a). Attaching a postdigital qualifier to the concept of citizen science also entails a concern for understanding scholarly research through 'multi-, inter-, and transdisciplinary approaches' (Jandrić, et al. 2023a). In consonance with this postdigital impetus, Wells outlines that transdisciplinary thinking 'draws on multiple disciplines and transcends disciplines in pursuit of real world, complex, multidimensional inquiries' (2012: 123).

However, garnering a transdisciplinary understanding of citizen science through an inverted process of kaleidoscopic inquiry can only lead to a 'frothy' or 'fractal' postdigital conceptualization that lacks a unified form. Specifically, a more appropriate approach would be to begin from a simplified and taken-for-granted understanding of citizen science, progressively adding subsequent layers of refraction until 'the object seen by direct vision is in a state of perfect junction with the images

³ See <https://www.workersliberty.org/story/2017-07-26/has-politics-become-fractal>. Accessed 25 April 2024.

of it formed by reflection' (Brewster 1819: 35). This is to say that the task of building a complex, transdisciplinary vision of citizen science necessitates collective inquiry into a simplified rather than complex form.

As it stands, there does not currently exist a methodology of transdisciplinarity that is capable of uniting the disciplines through epistemological, structural, and conceptual shifts (Green 2022). Nevertheless, if utilised appropriately, i.e. if flipped on its head, the metaphor of the kaleidoscope may allow for the reconstruction of ostensibly simple, taken-for-granted concepts such as citizen science into more appropriately multifaceted, critical, emancipatory, and inclusive transdisciplinary wholes.

Towards this aim, the grounded theory, as a methodological inquiry into a complex social phenomenon that foregrounds an iterative approach to data collection, coding, analysis, and eventual theory development (Charmaz 2014; Corbin and Strauss 2015), seems the most prescient approach for postdigital scholars seeking to collectively develop a complex, transdisciplinary conceptualization of citizen science. Thus, a flipped kaleidoscopic approach to grounded theoretical inquiry may allow postdigital scholars and citizen scientists to work collectively towards an iterative reimagining of a beautifully complex, transdisciplinary vision of citizen science (as well as other concepts such as wisdom, the good life, being), developed and utilised towards the common good.

Conclusion: A Postdigital Citizen Research Collideascope (Michael Jopling)

The preceding critical exploration of the potential of the flipped kaleidoscope for postdigital citizen and humanities, earthed methodologically by grounded theory, captures something of its potential for the future interdisciplinary practice of citizen science and humanities. The two key elements would seem to offer mutual benefits. The citizen research element (used here as an alternative to the slightly cumbersome formulation of 'citizen science and humanities') provides a pragmatic, empirical foundation for postdigital explorations of the social-technical challenges identified previously. The conceptual plurality of the postdigital multiplies the ways in which citizen research and its data can be interpreted and used.

However, this conclusion does not seek to make sense of the multiple lenses and mirrors that have been revealed and applied to citizen research. Instead, it is here to suggest that the kaleidoscope is used in a manner closer to Barthes' (2007) notion of 'the neutral', where meanings, rather than interpretations, are developed and transformed. As Canetti (1989: 40) asserted: 'Interpret nothing, explain nothing. Give those who want to rack their brains something to do'. This also has the benefit of approaching the openness and call for wider participation of citizen research. We should remember perhaps that a kaleidoscope is both a tool for learning and an instrument of play.

In the spirit of play, the kaleidoscope might also be regarded as a ‘collideoscope’,⁴ in which the perspectives provided come together both to support and undermine each other, offering new ways of approaching (or even interpreting) citizen research. I would like to end by suggesting three ways in which this notion of collision can be useful. The first returns us to the colliding, inclusive hybridity of the postdigital, which this article has attempted to embody, and which might expand the possibilities of citizen research in terms of methodologies, conceptual foundations, and participatory potential.

The second emphasises the ‘always already’ of postdigital citizen research, which draws on the collision between the old and the new, exemplified also in the contributions to this article which pinpoint how Indigenous and local knowledge precede and might enhance citizen research. Combined with postdigital perspectives’ entanglement of the digital and the predigital, the final collision is of simultaneity. The perspectives, lenses, and mirrors presented in this article exist at the same time and alongside each other, intersecting to offer a critique of citizen research and a means of widening, democratising, and problematising it through the meaningful engagement of non-specialists.

Open Review 1: Rethinking Relationships (Cheryl Brown)

This collective paper takes the reader through criss-crossing pathways which explore and grapple with postdigital citizen science and humanities. Beginning with the intention to provide multiple views and ending with an acknowledgement that these perspectives can collide in complementary and divergent ways, the paper opens up conversations on this topic.

In grappling with who is a citizen, Juha Suoranta critiques the notion of citizenship status and how it is conceptualised in relation to nationhood. Others not viewed as citizens in a political and legal sense are children and young people (C&YP). Viewed as lacking rationality and competence their insights and experiences are often disregarded. The term citizen is also human-centred, and as Catherine Price notes, there is a need to include the more-than-human world too. This dilemma has been recognised in the Aotearoa New Zealand where a river’s relationship to local iwi (kin-group) and long-term protection and restoration was recognised by making it a person in the eyes of the law (New Zealand Parliament 2017).

These issues raise questions about how, in the postdigital age, values of openness and inclusivity are operationalised. Participation is also typically conceptualised from the individual standpoint. Many of the contributions in this paper foreground community participation and engagement with Muhtaseb noting this depends on how a society prioritises individualistic over collectivist goals. Co-design and

⁴ The image of the collideoscope is borrowed from a song by The Dukes of Stratosphear (1987). Their combination of tribute, pastiche, and devotion in recreating the music of the late 1960s 20 years later (in a world that did not seem even slightly interested) should remind us that the postdigital has precedents which only emphasise its historical evasiveness.

collaboration as approaches were foregrounded by contributors in relation to children and teachers, non-experts and experts, between experts, and between human and more-than-human.

These discussions imply that a reframing of the concept of citizens might further open up opportunities for wider inclusion. The paper does offer some suggestions for this, for example, changing the terminology to people's science or community science. However, as Matthews notes, this will require introspection of academia and our role as experts. A principle which could be helpful here is the te ao Māori concept of *ako*.⁵ This describes a teaching and learning relationship, where the educator is also learning from the student. Citizen science could benefit from rethinking the relationships in a way where reciprocity is a core value and intention.

I found the problematisation of participation in the recent book on postdigital participation in education (Weich and Macgilchrist 2023), a useful thinking tool in these deliberations. Participation has, in the recent past, been unquestioned and seen as a 'good'. Enabling participation is seen as empowering inclusion. Research on marginalised and indigenous communities' lack of participation in citizen science barriers is complex (Benyei et al. 2023), and some choose not to engage due to difficult political contexts. As Fei Yan notes, in authoritarian societies, participation may put citizens at risk.

Other issues include lack of trust and lack of motivation where communities' purposes are in contradiction to researchers' purposes (Benyei et al. 2023). It is also critical to consider the nuances between taking part in an activity (in this case people contributing their time and knowledge to science and humanities) and having a say in the processes of what you are taking part in and how. This raises questions like whose knowledge systems or theories of knowledge are we privileging? Georgina Tuari Stewart and Shane Orchard note that Indigenous and local knowledge precedes mainstream Western knowledge systems and processes. As Stewart (2021a, b) notes elsewhere in a debate about Mātauranga Māori (Māori knowledge), the relationship between science and Indigenous knowledge is not a binary.

These are just a few of the aspects that stood out for me in this paper although there are many more that deserve interrogation. Whether viewed through the lens of a kaleidoscope or collideoscope, the contributors' ideas provide opportunities for reimagining and reimagining postdigital citizen science and humanities through critical cross-disciplinary interrogation.

Open Review 2: A Problem of Prestige (Richard Watermeyer)

The metaphor of the kaleidoscope offers a representation of citizen science as a commitment to disruptive visualisation that vandalises the certainties of knowledge orthodoxies and disambiguates the messiness of knowledge production. It articulates the intervention of 'inexpert' publics, mobilised by digital 'technologies of

⁵ See <https://tereomaori.tki.org.nz/Curriculum-guidelines/Teaching-and-learning-te-reo-Maori/Aspects-of-planning/The-concept-of-ako>. Accessed 25 April 2024.

elicitation' (Lezaun and Soneryd 2007) that prosecute their participation as interlocuters of scientific discourse, as a means of reseeing the world. In the various preceding accounts, we find a valorisation of 'lived experience' and localised and Indigenous wisdom as legitimate parts of a visual soup that feeds the collective imagination and aspiration for the repair of the social-scientific settlement.

The postdigital organisation of citizen science, which in cognisance of the boundary transgressions necessary for the resolution of hyper-complex problems incorporates the humanities into its toolkit, is advocated not only for its contribution to *making* science but also for its contribution to *unmaking* social conventions. Throughout, the kaleidoscopic capacity of postdigital citizen science is celebrated for its democratising potential and its potential for elevating and licensing the voice of the marginalised and discounted, the oppressed, and subaltern. It is commended as a crucible from which critical pedagogues and critical social scientists might proliferate and collectivise in reconstituting knowledge as an egalitarian endeavour that collapses hierarchies and the exclusions they impose.

Postdigital citizen science is celebrated for its potential in exposing and elevating otherwise neglected and marginal concerns while also reinvesting scholarship with a public consciousness and an activist agenda. It is also championed for its early cultivation of scientific citizens and its value in enriching the curriculum and seeding a lifelong enthusiasm for science. Less conspicuous throughout these accounts, however—the contribution from Dodonov aside—is the value of citizen science in the amelioration of policy and through dialogical interchange, perhaps because this nexus remains stubbornly analogue and less amenable to digital mediation.

Yet for all the cogency of the claims made herein and the myriad virtues and justifications attributed to the kaleidoscopic intervention of citizen science, its transformative capacity may ultimately yield to the tyranny of a prestige economy which dominates science and renders it the jurisdiction of tribal elites who remain highly protectionist of their sovereign territory. In fact, despite the obvious moral motivation and productive advantages of public collaboration, scientists may be routinely disincentivized from joining forces. Their reticence has multiple explanations among which feature an elevated sense of precarity in an era where public agnosticism of experts and the politicisation of science (particularly post-pandemic and on the wave of populist politics, disinformation, and post-truth) are compounded by a fetishisation of accountability, metrics, and demands for impact.

Where scientists' value is calculated by the proficiency of their acquiring positional goods—measurable impact being one such—and their careers thus ensured, any dilution of their claims of capture might only be avoided. Citizen scientists might then find themselves exploited where their relationship with scientists is rationalised (by scientists) on the basis of their facilitating productive gains. Who then serves whom and in whose best interest? This question extends, as Yan suggests, to the potential of citizen science in authoritarian states (patent and tacit) and the control of knowledge flows.

Yet the ethical complexity of postdigital citizen science, which manifests not only in the power imbalance of novice and expert—and how the former may find themselves misappropriated—but also in the terms of inclusive and authentic representation as considerations of care, is hesitantly treated. The credibility of an

undergirding moral imperative to citizen science is thereby impaired. Methodologically, Simmons and Clarke also point out that there is no *one-size-fits-all* method for knowledge co-production/engagement. Even the most holistic problematisation will require investment and competency in the application of not one but many kaleidoscopes and technologies of elicitation to ensure equality of perspective.

The disruptive value of digital citizen science as a route to epistemic justice and other knowledge benefits requires ethical reflexivity and political pragmatism in tempering the seductions of ideological triumphalism and technological determinism. It is such a dialectical approach that will allow knowledge actors to widen their aperture without losing focus.

Open Review 3: The Genre is the Message (Petar Jandrić)

Traditions are hard to break. Humans are beings of habit and ritual, and as the folk wisdom says, most people become more conservative as they grow older. Global academia is built on ritual and ruled by old people, up to recently, almost exclusively white men. Small research advances that dutifully cite the elders get nods of approval; anything that disrupts their peace is rejected or at least frowned upon. I do not want to be mean towards the elders, especially because I am only a few years shy from becoming one of them. Conservative approaches make a lot of sense, as traditions are also dangerous to break. For instance, as noted by Green, traditional scholarly disciplines are here for a good reason, and we still haven't reached useful and sustainable transdisciplinarity.

Somewhat paradoxically, however, tradition-breaking is the key to knowledge development. Very little knowledge has been developed by scratching each other's backs. Knowledge is created from disagreement, and tactful management of that disagreement, in global (and as of recently postdigital) scholarly dialogues (Jandrić et al. 2019). Contrary to our proverbially dry appearance, we researchers reside at the fringes of convention; we are travellers building the road towards the unknown.

Building on several recent innovations in academic writing (notably, the collective social sciences and/or humanities article (Jandrić et al. 2023b) and the theoretical kaleidoscope (Kuhn et al. 2023)), this article tinkers with the tradition of scholarly publication. 'Postdigital Citizen Science and Humanities: A Theoretical Kaleidoscope' creates its own genre, so much so that it simply does not fit any article category offered by the publisher and scholarly databases. As an editor, I take pride in publishing such an article. I am fully aware that this article will be frowned upon at least by some parts of the academic community. Understanding that knowledge is borne from disagreement, however, I relish the possibility of learning from those critiques.

My concerns are predominantly epistemic. Will our disruption of traditional academic writing bring about true knowledge development, or will it remain a theoretical and practical dead end? Will this, and many other similar articles, stand the only test that matters—the test of the history of ideas? Does this article produce new and really useful knowledge about postdigital citizen science (see

Jandrić 2023), or is it merely an exercise for those privileged enough to indulge in writing experimentation?

Without the possession of a crystal ball, I'll try and stick to what we've got here and now. 'Postdigital Citizen Science and Humanities: A Theoretical Kaleidoscope' presents thoughts and ideas written by more than 20 academics, each of whom knows their field quite well. The reference section is a few lines short of 200 sources, which makes it a useful resource for anyone who wants to learn about postdigital citizen science. For me, this contribution alone justifies the article's publication.

I find the theoretical kaleidoscope approach useful in one more way. Reading the contributions, I feel unexplainable but very tangible synergy, and that synergy helps me form my own ideas. Of course, synergy always contains a bit of magic, probably best expressed in the math teacher's nightmare Eq. $1 + 1 > 2$. In a postdigital perspective, however, magic is not a bad word. As I wrote a few years back, 'humans are not only beings of logic and emotion—we are also beings of myth and faith' (McLaren and Jandrić 2020: 255). For me, and this is admittedly a very personal statement, the magic of human interaction is much more real than the magic of the free market or Jesus Christ. If these examples of magic have their own dedicated publications, then why should this version not as well?

Finally, and very practically, this article is a part of a larger research effort. It is conceived as a part of a forthcoming Special Issue, 'Postdigital Citizen Science and Humanities: *Survive, Resist, Flourish*', edited by Michael Jopling and Sarah Hayes. Alongside standard academic articles, it will be published shoulder to shoulder with at least one or two similarly designed collective articles written by citizen scientists. As a part of a larger whole, this article may contribute to an even larger dialogue and perhaps an even larger synergy.

There is no way that I can predict what this article may bring to our studies of postdigital citizen science and humanities and/or postdigital research in more general. I am very cautious in my interpretation, because I understand that expecting too much would be vain and counterproductive. However, I also understand that expecting too little would be paralysing. To avoid the conundrum of expectation, I will end this review with four wishes. I would like this article to help those who want to learn more about postdigital citizen science. I hope at least someone else feels the synergy and its effects. I would like this article to initiate good scholarly discussion. Finally, in the spirit of postdigital citizen science, I hope this discussion expands towards those who are traditionally excluded from the ivory tower of the academia. If only one of these wishes is even partially realised, the publication of this article is more than justified.

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