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EBIRD, EXPERTISE, AND THE TECHNOLOGICAL MEDIATION OF CITIZEN SCIENCE

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Abstract

Technological advances in application development and open science continue to revolutionize and create new forms of citizen science. However, as of day, the role of technology in citizen science has remained relatively unexplored. In this essay, we pose the question of how citizen science apps shape the practice of citizen science, looking specifically towards the popular birding app *eBird* as a case study. Through the citizen science practices co-shaped by eBird, this essay will dive into the functions of the application, how it can be regarded as shaping human-technology relations and the impacts this has on the relationship between citizen (scientist) and expert. After building the case for eBird's influential role in citizen science with regard to birding, the discussion pivots towards the future of citizen science as a democratic process shaped by the technologies used to gather and share scientific data. This essay concludes by asking how a more democratic understanding of citizen science can be developed through both empowering citizens to not just participate in data gathering, but also to help interpret it in new and informed ways with the citizens' own interests in mind.

1 CITIZEN SCIENCE AND EXPERTISE

In recent years, the topic of citizen science has received increasing attention, particularly in the environmental and biological sciences (Follet & Strezov, 2015). As citizen science, wherein non-specialist citizens are involved in the scientific process, has become more widespread, scholars have started asking questions about its merits and legitimacy as a form of scientific inquiry, and about the ethical issues that arise in the practice of citizen science (Elliot & Rosenberg, 2019; Rasmussen & Cooper, 2019). However, as of today, the role of technologies involved in citizen science has remained relatively unexplored. In this essay, we pose the question of how citizen science apps shape the practice of citizen science, looking specifically towards the popular birding app eBird as a case study. We consider both how eBird mediates the relationship between its users and the practice of birding, the practice of citizen science, and the professional scientists themselves.

This first section relates two prominent notions of citizen science to the philosophy of expertise, which is the subfield of philosophy concerned with the question as to what makes someone an expert (Quast & Seidel, 2018). We argue that democratized citizen science, wherein science meets the needs and desires of citizens, presupposes substantive specialist expertise on the side of the citizen. This in turn requires a process of enculturation, which can be understood as immersion in the specialist culture (Collins & Evans, 2007).

1.1 NOTIONS OF CITIZEN SCIENCE

In its widest sense, citizen science can refer to any scientific project that involves citizens. However, in the academic literature two distinct conceptions appear most prominent: Rick Bonney's understanding of citizen science as the voluntary contribution of observational data by citizens to scientific projects, and Alan Irwin's understanding of citizen science as democratic and participatory science that addresses the needs and concerns of citizens, respectively. In the following paragraphs, we briefly describe each notion and show that one of their defining differences is the amount of expertise they presuppose on the side of the citizen.

Many scientific fields, including the field of ornithology, benefit greatly from voluntary contributions by citizens. These contributions offer a wealth of data that would otherwise be hard to acquire, therefore greatly improving the viability of scientific results. Researchers set up projects designed to gather as much observational data from citizens as possible. Citizens provide data that would otherwise be difficult to attain, such as measurements for plastic pollution, rainfall, or bird sightings. In accordance with Rick Bonney's notion of citizen science, which is known as contributory citizen science, the citizen is a source of data for scientific projects (Bonney, 1996).

Another understanding of citizen science was introduced by Alan Irwin, who used it to describe a need for science to address the concerns of citizens, and to involve citizens in the production of scientific knowledge (Irwin, 2002). In contrast to Bonney's contributory notion of citizen science, Irwin does not consider citizens as beneficial to the scientific project per se, but rather considers science as a way to improve the lives of citizens. The role of the citizen is considerably broader than merely being a source of data. In order for science to address the needs of citizens and involve citizens in the production of scientific knowledge, citizens and scientists must be continuously engaged in conversation. Thus, rather than a data-collector, Irwin's notion, which is known as democratized citizen science, considers the citizen as more akin to a co-researcher.

One important difference between contributory and democratized citizen science is the role that is assumed on the side of the citizen, especially with regard to expertise. Whereas in contributory citizen science the citizen is asked to do so much as push the record button, in crude terms, democratic citizen science requires close engagement and conversation. Evidently, the second presupposes more expertise on the side of the citizen than the first. This difference will be explained and illustrated in the remainder of this section.

1.2 EXPERTISE

In this subsection, we consider what it means for someone to be an expert, or to have expertise. To do so, we first briefly survey so-called reputational and relational notions of expertise, before introducing Harry Collins' and Robert Evans' notion of *Substantial Expertise.*

1.2.1 SUBSTANTIVE EXPERTISE

Expertise can be understood as something reputational, something relational, or something substantive. If you are inclined to say that someone is an expert solely based on them having the reputation of an expert, then you will likely hold a reputational view. Alternatively, you might hold that being an expert is more about how an expert relates to the people around her, such as being able to assist others with specific problems (Goldman, 2018). In this case, an

expert is not merely someone with a reputation as expert but is someone who possesses more knowledge about a given topic than most others.

Although the relational approach appears to be applicable in many cases, there remain reasons to think that expertise should be understood as something substantial. Consider one's ability to speak their native language fluently. It is intuitive to say that a person possesses a considerable amount of expertise with regard to speaking their native language. However, when considered from the perspectives of reputational or relational expertise, the fluent speaker should not be understood as an expert as they do not have that reputation or relation to others in their social environment. Harry Collins and Robert Evans formulate a substantive notion of expertise in their book Rethinking Expertise (Collins & Evans, 2007). They define expertise as "the real and substantive possession of groups of experts" (Collins & Evans, 2007, p. 2).

According to this definition, expertise depends neither on one's reputation as an expert nor their relation to others, but rather resides in something substantive that can be acquired through membership of an expert-group. The particular substance that putative experts acquire through the membership of an expert-group is tacit knowledge, as opposed to formal knowledge. Whereas formal knowledge consists of explicit information, tacit knowledge refers to things "you just know how to do without being able to explain the rules for how you do them" (Collins & Evans, 2007, p. 13).

Acquiring such specialist tacit knowledge requires immersion in the specialist culture, which Collins and Evans refer to as 'enculturation' (Collins & Evans, 2007, p. 24).

1.3 ENCULTURATION AND CITIZEN SCIENCE

Expertise fundamentally depends on the possession of tacit knowledge. Such tacit knowledge is not transferred through explicit information, but rather shared through common practices. To become an expert in a particular specialism, one has to be *immersed* in the specialist culture. We argue that this immersion, known as enculturation, is crucial for citizen science and that democratized citizen science requires enculturation.

One defining difference between contributory citizen science and democratized citizen science is the role that either notion attributes to the citizen. In the picture of contributory citizen science, this role is mostly passive, asking the citizen to perform certain tasks without further involvement. Democratized citizen science, however, demands closer engagement of the citizen with the research project. Consider, for example, the state of AIDS research in the 1980's (cf., Epstein, 1995). Prominent AIDS activists took specific steps to engage with AIDS research, ultimately improving it significantly. Crucially, the activists needed to acquire credibility in the eyes of the specialists, for example by attending conferences, reading and criticizing research papers, and receiving tutoring from specialists (Cooper & Lewenstein, 2019, p. 51). Through all of this, AIDS activists learned the language of the specialism, allowing them to share their needs and interests.

The efforts of AIDS activists in the 1980's illustrates the importance of enculturation for democratized citizen science. It was only through continuous engagement and meaningful conversation between the AIDS activists and the established experts that the research came to meet the needs of the concerned citizens. As such, citizens endured a process of enculturation, whereby they learned the language and practices of the expert culture, allowing them to contribute to and interact with the expert group. This signifies a difference with contributory citizen science, whereby citizens rarely communicate with the expert group beyond engaging with requests for their input. Although these practices are regarded as citizen science, for scientific research to meet the needs of citizens, closer contact between citizens and established experts is required. The next section will consider how technological artifacts, like eBird, come to shape the experience of the citizen scientist.

2 CITIZEN SCIENCE AS A PRACTICE

The following section will dive into the details of what eBird is as a bird observation application, and how it shapes a citizen science practice with its users. Citizens that engage with the eBird application and explore citizen science through it raise philosophically interesting questions. Is there a way of understanding how the roles of citizen and scientist are shaped by these applications? What are some ways that the interaction with eBird can be understood as a form of citizen science? How do the human-technology relationships between citizens and this application shape the practice of citizen science? Research questions like these influences and drive the investigation through this section.

2.1 EBIRD AND PRACTICE

Birders and the researchers that promote birding as a practice have found new applications that try to help birders centralize their data as well as offer supportive advice when birding. One such app is eBird. By centralizing or offering one platform for many birders data in one, publicly accessible database; ebird offers a platform for citizen science researchers and experts to explore the vast amount of data collected by the application. On our devices now, eBird asks us to note the sightings of birds in order to promote more recordings of the natural avian wildlife around the world and gather it centrally. The application was developed by Cornell Lab of Ornithology with the help of the National Audubon Society in 2002 as an attempt to give audiences of bird sightings an easy way to make notes of their observations (Sullivan et al., 2009, pg. 2283). The app has had a resounding success, both in the number of observations gathered exceeding over 21 million recordings, and a large user base of over 500,000 registered people (Sullivan et al., 2009, pg. 2283). In turn, eBird has become a place where researchers can access open-source data from a population of users that span the globe, have diverse backgrounds of notes and stories of their sightings, and have accurate recordings of time and place for the data. User data that is collected, which is a name and email address, is never used for commercial purposes and GIS data is not made public (How Can Your EBird Data Be Used?, 2022). The sheer amount of data from bird sightings, and the mass number of users donating their data, has resulted in observations costing less than three US pennies per entry in eBird's annual budget (Sullivan et al., 2009, pg. 2283).

eBird use consists of a participant downloading the local "checklist" of birds in their area based on their GPS location from the app. This checklist isolates an area to reduce the number of choices a user has to sift through in their list when going birding. People that go birding with this app also have the ability to record "unusual" (species) reports that are normally sightings of one species and are sometimes accompanied by a personal note about the occasion from the user (Sullivan et al. 2009, pg. 2284). Not only are sightings valuable, but so are the observations of missing species. "Absence" data is verified by users as they answer a question at the end of their birding experience, which asks if they are reporting a "complete checklist" that reports all the sightings they saw to the best of their ability (Sullivan et al., 2009, pg. 2284). Birds that are not checked off the list are also recorded as not being present, which enables the collection of non-detections as more data for probabilities in sightings.

By obtaining sightings, recording bird calls, taking photos, and recording personal experiences, users of eBird are participating in increasingly democratized scientific practices (Cavalier & Zachary, 2016, Preface v-x). The combined capabilities of both the app and of the smartphones also lend to richer data quality for databases such as more images, sounds and locations (Sullivan et al., 2009, p. 2283). These birders are not only contributing significant data to ornithology but are also doing so voluntarily. Users of this application are rewarded in small ways, by contributing to the communities they form within the application, such as recording a species first in an area, ultimately receiving recognition from fellow users (Sullivan et al., 2009,

p. 2285). Encouraging more participation in birding this way means more diverse user submissions, and more data that could lead to sensitive environmental indicators about environmental processes or ecosystem health from bird sightings.

From a philosophical perspective, the eBird application mediates multiple relations to the practice of birding. The eBird app shapes or mediates the relationships of citizens and the communities in eBird by hosting their conversations and events. Moreover, eBird shapes the practice of birding between citizens and the world around them. The work done in postphenomenology has developed a vocabulary for better translating these large concepts into more concrete frameworks of human-technology relations. In order to better understand and expound on these human-technology relations, the next section will describe and develop a mediated understanding of eBird and its users.

2.2 MEDIATING BIRDING

Many people practice birding in different ways, whether it is a competitive sport to see the rarest sightings, or casually noting the neighbor's new guests found in their feeders. The practice is capable of being romanticized as a dichotomy of both close measurement and far away desires; and as a balance, "between the curious animal at the near end of the binoculars and the wild animal at the far end." (Rosen, 2011). Whether birding is done through binoculars, applications, or forms of notetaking, mediation theory offers us language and the ability to analyze experiences through the technological relations that mediate the practice. By appealing to this conceptual framework, we can reveal the relations that are mediated when users work with eBird, how the practice of birding is influenced, and how citizen science is shaped by technologies.

eBird as a mobile application shapes the ways in which people go birding. To be clear, amateur birders for a long time have rarely used anything beyond a pencil and a notebook to record their work and perhaps a camera if they feel the need or want to capture a moment. Thus, the introduction of an application changes the ways in which birding will be done by more than half a million people that engage with it. Each time the app begins, the user is faced with starting a new 'checklist' and an option to set a start time. Once the user begins a checklist, the GPS position of the user is calculated, and a feed or suggested list of birds known to be found in the area is brought up. With a simple design, the designers of this checklist system encourage and trigger specific behaviors among bird watchers, such as staying organized or attentive to their surroundings. The strategy not only lends to subtle suggestions of what to look for around you in the world, but also tries to not directly interfere with the experience of birding such as with loud notifications that might scare away birds or requiring any input beyond a counter (Tromp et al. 2011, p. 16).

Already, we find a new mediating relation to the world; one where the ability of a single birder to know what is highly probable to be around them is found through a hermeneutic relationship. In other words, eBird, as an application, signals to a user not only that they are in a world of birds, but that the users also 'know' what is around them. We are thus experiencing the technology of eBird as representing the world around us and trusting the information it lends to us as reliable. Some philosophers have keenly pointed out that this trust from the relation we have to the app leaves open the room for misinformation (Gertz, 2019, p. 68). Moreover, these hermeneutical relations with eBird often occur in public spaces, where the relation may in turn shape what is at stake in political discussions: something citizen sensing will also engage with in section 3 of this paper (Verbeek, 2020). From this relation, eBird seemingly attempts to turn away from the reliable information problem by leaving open the possibility of reporting rare sightings and allowing users to add birds that would not commonly be found in their GPS coordinates. Interestingly, in this way, eBird opens up to the possibility of misinformation on the database side as well. A user does not need to be lying that they saw a

bald eagle in the middle of the Netherlands, they could simply be confused and mislabel a bird. They are, after all, just trying their best as citizen scientists.

Furthermore, apps like eBird form an embodied relation by shaping the way in which we view ourselves as birders with extended abilities. eBird allows for personal profile lists of bird sightings, alerts for rare new finds nearby, and a gamified experience of who has seen the most birds in the online community (Sullivan et al. 2014, p. 33; Gertz, 2019, p. 68). In line with supposed community desires, eBird develops an embodied relation with the user; where they begin to see the world through the app and the app draws away from their attention but shapes what they see. So too, where eBird grabs attention, like a quasi-other, and forms attention in order to both entertain the idea that one should go birding, but in turn triggering our senses to be on high alert for a bird sighting (Wellner, 2014). Here, a hermeneutic relation may actually be enhanced or supplemented with an alterity relation via the interactive application of eBird (Wellner, 2014, p. 314). The alterity relation reflects the aforementioned quasi-otherness that cellphones and applications alike shape through notifications and attention-grabbing techniques. For the app developers of eBird, the attention grabbing has been hugely successful and warranted a lot of new insight into how many people see birding as a practice of gathering information for the sake of being the best birder of the month/year/whatever. Moreover, there is a new dependency that arises between users of the app and the empowerment it tries to foster, which can be recognized with the embodiment relation (Gertz, 2009, p. 67; Rosenberger, 2017). The concern comes from users who now believe and become reliant on having an app at their side for every birding interaction. Due to eBird, one may raise concerning questions about just how many eBird users would still go birding or actually develop new knowledge of local birds without such pre-made area specific checklists. The relations discussed here raise concerns about how eBird shapes the ways in which citizens do citizen science, which will be deliberated next.

2.3 CITIZEN SCIENCE AS A MEDIATED PRACTICE

Citizen Science has many definitions, crosses many disciplines, and has impacted numerous areas of science. eBird outlines their view on citizen scientists as each birder having, “unique knowledge and experience”, where eBird’s goal is, “to gather this information in the form of checklists of birds, archive it, and freely share it to power new data-driven approaches to science, conservation and education.” (About eBird, 2020) For eBird, these unique experiences that birders have should be understood as being shaped by the application itself, such as by the relations discussed in the previous section.

Citizen science through a lens of mediated experiences can be broadly painted as a person going out into the world to collect facts with tools at hand. Many citizen science projects are demanding and require a lot of time for observations of animals, their behaviors, or other findings in the natural world. For instance, eBird already assumes that users have taken the time to learn prior knowledge of what many birds in their area look like and can identify them without any additional assistance from the application (Oliver et al., 2020, p. 1695). Here too, eBird has the presence to shape how citizen science forms with what could be views as contributory citizen science. Citizen science with eBird then, relies on both prior knowledge of birds in the area, and some expertise in the practice of birding. In this way, eBird does not seem to facilitate the expert and citizen science to work together on birding or data gathering. Put in another way, there are no experts in the application helping people become better at citizen science data gathering. Meaning that whatever relationship there is between eBird users and experts, it must be mediated through eBird.

eBird influences its user base by the shaping of relations between citizen scientists and the experts that the citizens implicitly do observational research for. The mediated relation between citizens and scientists through the eBird application is less in-depth or comprehensive

than one might expect from such a popular app. The application does not bring together ornithologist or experts and the citizen, but instead allows for a funnel of data to be delivered to the servers of eBird. These servers then distribute and model the information, and answer requests from many NGOs, government organizations and companies (Sullivan et al., 2004, p. 36). What is exposed is a value for creating ease of data gathering and sharing on the user side, and open access to this curated data on an organizational side. Perhaps, too, a chance for more democratized data gathering chances for the future, wherein science meets the needs and desires of citizens. Unfortunately, relationships between citizen scientists and professional experts are less intimate and fall on a more surface level of giver and receiver experience. In turn, it is a contributory form of citizen science that is embraced and rewarded.

From section 1, the prospect of harnessing and fostering enculturation becomes more apparent. On the one hand, eBird brings with it a large network of birders, professionals, and hobbyists looking to add their own data to the library of eBird. On the other hand, the shaped practice of eBird birding lends itself to the more passive and disengaged traditions of contributory citizen science. In turn, the success of an app like eBird comes at least partially from its ability to relegate the demands of writing down and recording information by hand to a mobile device, which while convenient, raises questions regarding what kind of new birding practices are being developed. The avoidance, or lack of enculturation that develops from apps like these leaves open the gap between both citizen and professional scientists, as well as citizen and scientific practices. In other words, the relations found in the postphenomenological framework not only show the new practices being co-created through the work of birding and the application, but also bring to light new questions surrounding what the future of citizen science should look like.

3 BEYOND CONTRIBUTION

It is important for the future of citizen science to be democratic through empowering citizens by addressing actual problems of the local or global community and creating scientific research to tackle these problems. As discussed in the first section of this paper, this empowering form of citizen science requires a democratized understanding. Therefore, we maintain and actively push all aspects of the development of citizen science to embrace this democratic understanding, including its technological developments. Contributory forms, like eBird neglect engagement between citizens and experts, missing the mark for enculturation, but also co-creates relations between user and application which indicate new practices in citizen science. From this, eBird shapes the relationship between citizens and scientists in such a way that it eliminates the possibility of enculturation, consequently lending itself to a contributory rather than democratized understanding of citizen science. This entails that the data produced through eBird is unlikely to address the needs and desires of citizens, and primarily serves the experts. Raising whether a more democratized form of eBird would be desirable over its current state. It is not obvious that ornithology should address the needs and desires of citizens. Regardless, there are reasons to believe that a more democratized form of eBird and similar data gathering apps would be desirable. Two of those reasons will be discussed here.

eBird has developed databases that constantly stream data, with open access, to its community of researchers and users. The data compiled in these databases are not simply there to be read, but to be used with purpose and intent. Data as a technological artifact is made for purpose and for use in order to make sense of patterns, categorizations, and archiving (Leonelli, 2006). In other words, the data of birds is of a place, time, location, etc., and of a recognized something. This data, then, is something that citizens must account for and while the former characteristics are automated by eBird, the recognition of a bird in time and place is something only a citizen can do. The data then found on the servers and hard drives of eBird's libraries is littered with the experiential comments and notes of citizens from around the world.

These data points contain crucial pieces of context, ideas and experiences of citizens recording their work in birding. Data and the surrounding context form an understanding of the world that the data belongs to, the person that experiences it, and the ways in which it can be understood for further use. For eBird, their contributory method of citizen science captures this information through the notes feature in the app. These notes are tied to the sighting and are stored away to be read for later use. This is especially useful when a sighting is 'rare' or 'special'; where the hope is that citizens will report where the bird was and what it may have been doing behavior-wise, and letting researchers know of a unique sighting. Moreover, the reports could be used to see unknown migration patterns, new habitat creation, or rural to urban movements of bird species. These experiential data are not simply 'neutral' or 'objective', they are shaped by both the technical features of the app itself, such as character limitations, but also by the experience of the citizen at that time. In turn, the data sent in by citizens can be used and interpreted in many ways as well. Unfortunately for citizens and researchers, because the contributory form of citizen science by eBird does not allow for engagement of data, the app only encourages data dumping and little community connections to researchers, but no interpretation by the citizens. eBird does not discourage these connections, but it is rather the active shaping of birding practices through the app design and use that lends to this contributory form.

Mobile applications such as eBird have presented themselves as powerful tools for citizen scientists and have quickly become one of the most prominent modes of citizen science research (Lemmens et al., 2021). It is not unlikely then, that eBird as one of the earliest and most popular citizen science applications in existence shapes the future of citizen science. The next section will shed light on both a practical example of what data gathered, analyzed and owned by citizens looks like as well as a bridge into the possibilities for a democratized citizen science.

3.1 DATA FOR THE CITIZEN

The value of non-specialist perspectives discussed in the previous section defends the uncommon notion of citizen scientists' interpretations of data as valuable to the problem-solving capabilities in science. While it is true that specialists as professionals in their field of study can take advantage of data donated by citizen scientists, like in the case of eBird, we believe there should also be a promotion of citizen scientists using and interpreting their locally collected data for their own interests. Research by Anna Berti Suman and Marina van Geenhuizen (Suman & van Geenhuizen, 2020) shows that the work of citizen scientists is moving forward into new ways of using data collected in local communities as both problem-solving tools and as challenges to professionally made, inaccessible estimations. Additionally, recent developments in postphenomenology generates a framework to discuss how the interactions are mediated by the technologies used to create the citizen scientist-informed disputes.

In their work, *Not just noise monitoring: rethinking citizen sensing for risk-related problem-solving* (Suman & van Geenhuizen, 2020), Suman and van Geenhuizen look at new developments in a subfield of citizen science called 'citizen sensing' and the new ways it has been used to produce mutual understanding and problem-solving amongst the citizens collecting data (Suman & van Geenhuizen, 2020, p. 547). Their research describes how the information collected by citizen sensors is valuable to the movement towards democratization of decision-making in the broader community, as well as promoting the co-creation of scientific knowledge, which in turn impacts policymaking (Suman & van Geenhuizen, 2020, p. 547). The investigation starts at Amsterdam Schiphol Airport, where a new expansion produces a large noise burden for nearby homes and businesses. The noise complaints made by local citizens were ignored by the municipality, with the governments' justification being that noise cannot be measured because of "environmental factors" and only measured with mathematical models

they obtain. Dissatisfied citizens then take to voluntarily adding sensor microphones to their home's roofs, collecting noise from the nearby planes as best they can, and push back against the "information monopoly" held by the local authority. In the end, the citizens not only were able to gain the attention and dialogue of institutional actors but were also engaged in the actual comparison and verification of data with the NOMOS Schiphol sound monitoring system (Suman & van Geenhuizen, 2020, p. 555). Both systems even produced similar results, and both have dashboards open to the public.

Ultimately, this story brings together the components of a grassroots movement of citizens moving beyond just data collection or participatory observation. Citizens work together as non-specialists to deliver a new interpretation of the community they live in with data they collect and decipher to the best of their ability. From a mediation perspective, the sensors used to collect the facts about the world, and the monitoring data dashboards that aid citizens to read and interpret that same data allow for the shaping of their own concerns. The new sensors not only manage the perceptual relationships between citizens and phenomena they want to research, but also the way in which they make sense of their own observations of their community (Verbeek, 2020). In other words, citizen science and citizen sensing practices mediated by technologies shape the ways in which both issues arrive from new information and the ways in which citizens begin to see new ways of envisioning their community. Explicating further, the critical mechanism of enculturation for citizens to develop the tacit knowledge required to share their unique and situated perspectives with the social community of specialists.

The Schiphol airport example is interesting for both eBird, expertise and the discussion on mediation in citizen science. eBird as an application could, in the future, take on a more action-oriented approach to its role in the birding community. In other words, eBird is in a position to help citizen scientists not only use the tools they have to simply observe birds, but to also shape the ways in which motivated birders use and interpret data in their own best interests. Examples like the Schiphol airport show that data collected about the world can be shaped by the ways in which people choose to use it. There is an intrinsic relation of technologies mediating citizens' interpretive relationship to one another and the very space they interact with (Verbeek, 2020, p. 6). One does not have to reach very far to see that eBird can be used in environmental policy, rare species data collection, or the link between making better citizen scientists through ornithologists' expertise if facilitated in the app.

4 CONCLUSION

Without recognizing the mediating role of technologies in the relationship between citizen scientists and specialists, one could postulate that there will be a lack of mutual understanding why issues of concern to the public are different from the specialists' research. In other words, the relationship between citizen scientists and researchers would be better developed through acknowledging that citizen scientists in research necessarily add value from their unique perspective. Thus, research reliant on citizen science should embrace the democratic understanding of citizen science and work towards both empowering citizens to not just participate in data gathering, but also to help interpret it in new and informed ways, even with the citizens' own interests in mind. Fields new to citizen science should heed this warning as advising better approaches to the mobilization of engaged volunteers and donated data.

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No new data generated or analyzed.

Contributor Statement

John Walker and Luuk Stellinga devised the paper, the main conceptual ideas, proof outline and drafting. Dr. Catharina M. van Leersum aided in editing, revising and guiding publication.

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