East Asian Science, Technology and Society: An International Journal (2019) 13:181–193
DOI 10.1215/18752160-7542643

Citizen, Science, and Citizen Science

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1 What Do We Talk about When We Talk about Citizen Science?

The term *citizen science* has become very popular among scholars as well as the general public, and, given its growing presence in East Asia, it is perhaps not a moment too soon to have a special issue of *EASTS* on the topic. However, the quick expansion of citizen science, as a notion and a practice, has also spawned a mass of blurred meanings. The term is ill-defined and has been used in diverse ways. To avoid confusion, it is necessary to categorize the various and often ambiguous usages of the term and clarify their meanings.

As in any taxonomy, there are as many typologies as the particular perspectives, parameters, and criteria adopted for classification. There have been helpful attempts at classifying different modes of citizen science (Cooper and Lewenstein 2016; Wiggins and Crowston 2012; Haklay 2012). However, they focused primarily on the different approaches or methods in citizen science. Ottinger's two categories of citizen science—"scientific authority driven" and "social movement based"—foreground the criteria of action and justification, but they unnecessarily juxtapose science and society; in any case, they may be too general and leaving out too much at the same time.[1]

Acknowledgment Several papers were presented at the conference "Disciplining or Empowering Citizenry Through Citizen Science: Historical and Normative Perspectives on Knowledge and Power" (2016). We thank Institutum Iurisprudentiae, Academia Sinica, for supporting the event.

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[1] We agree with a new article on the topic of citizen science that appeared too late to be adequately considered here (Strasser et al. 2018). We encourage readers to consult it. The thrust of our argument is different from theirs, however. For us, a fundamental aspect of any type of citizen science is its built-in concept of citizenship and the politico-scientific community it imagines. We maintain that this perspective will enable us to better understand citizen science in differing political communities and realities. Moreover, it also usefully highlights the tensions between the empowering and disciplining features of any citizen

In contrast, our classification will emphasize the different conceptions of citizen and citizenship in how we think about citizen science. We believe that this move can help us contextualize the ideas and practices of citizen science in the diverse socio-political conditions found in East Asia and beyond (Leach, Scoones, and Wynne 2005). To explain that point, we'll begin with a few observations. First, the current discourse on citizen science tends to glide over such concepts as state, citizen, and the public and to assume that the reader will understand what they mean. This confidence originates in part from the fact that the default political framework of the discourse is usually Western (particularly Anglo-American). As a result, one often easily accepts a commonsense notion of participatory liberal democracy as the reference framework. However, one cannot assume that that is the de facto political framework for discussion of citizen science.

Second, because not all states and societies are organized along the models taken for granted in the dominant discourse mentioned above, how do we think about citizen science in a variety of political contexts? In East Asia, for example, there have been an array of political models, and so the accompanying tenets of citizenship, political authority, and legitimation been jumbled. If anything, participatory liberal democracy is an exception. This doesn't mean that we should not uphold normative political values and standards. We should—and inevitably we all do. But it does suggest that one can benefit greatly from a historically informed and socio-politically sensitive view of citizen science.

Third, citizen science is not the same as popular science, amateur science, lay science, vernacular science, public science, the popularization of science, and other related items. To be sure, there can be overlap between citizen science and many or all of these other categories, but there is a fundamental difference. When we talk about citizen science, we cannot get around the concept of citizen (and its cognate concepts such as citizenship and citizenry). Citizen is a political concept, category, and entity. When one uses the term *citizen science*, one is willy-nilly making a political statement. One is defining citizenship, potentially drawing political boundaries around it, just as one may be trying to widen participation in science.

And, finally, the kinds of science involved in citizen science vary widely—from reporting roadkill by smartphone to operating telescopes, from monitoring air quality to writing computer programs.[2] There are even citizen-science projects in particle physics (Barr, Haas, and Kalderon 2016; Gnida and Jepsen 2015). This ever-expanding diversity suggests that it would be futile to insist on an institutional or epistemological unity of citizen science or to argue that citizen science is epistemologically distinct from other forms of science. Such modes of knowledge production as crowdsourcing and open-access collaboration certainly pose interesting epistemological questions, but they are not confined to citizen science (Kasperowski and Hillman 2018; Strasser et al.

science project. We believe that this perspective is a necessary step toward a productive discussion of citizen science in East Asia (and beyond).

[2] See also Tuts 2010; and "Taiwan Roadkill Observation Network," roadkill.tw/about (accessed 11 September 2018). There are also journals and websites dedicated to the topic. See, e.g., "Citizen Science: Theory and Practice 2016," theoryandpractice.citizenscienceassociation.org/ (accessed 12 February 2019). In addition to academic studies, there is a minor explosion of popular books on citizen science, e.g., Cooper 2016; Hannibal 2016; Busch 2014; Russell 2014; Drollette 2012.

2018). Citizen science is, rather, moving mosaics of many mutually constituted elements—science, citizens, politics, community, and organizations of knowledge production and practice. With the underlying rationale of citizenship and citizen engagement, the idea and practice of citizen science is inevitably a statement and exercise of citizenship.[3]

2 Modes of Citizen Science

These observations help dispel confusion and clear the ground for further analysis. They suggest that it is important to take ideas of citizen and citizenship seriously in thinking about citizen science and that, precisely for this reason, it is necessary to take the history, genealogy, and political topography of citizen science seriously. Based on this premise, we shall categorize the usages of citizen science into four modes or types. The types are not static, nor are they mutually exclusive. Yet, the differences between them are significant. They highlight the various notions of citizen and citizenship built into the formulations of citizen science. They also underline the social and political goals and meanings in which scientific activities have been proposed and practiced. The section titles below highlight the central imaginings of the specific kinds of citizen science (CS).

2.1 CS1—Cosmopolitan Community of Knowledge

The most common definition of citizen science refers to a kind of collaboration between professional scientists or experts and volunteers who are amateurs or just interested participants. The volunteers might or might not be knowledgeable about the topic. The key feature is that they are willing and able to join the collaboration and they do so not as expert specialists in the project. The imagined community of this collaboration is based on a sense of cosmopolitanism, common good, and the republic of science.

A well-known example of this type of citizen science is the citizen-science projects of the Cornell Laboratory of Ornithology. Beginning in 1966, the CLO called the birding community for help in conducting bird censuses and other ornithological field research. Over time, and through various campaigns, the CLO has built a huge database, now available to the public online. According to their website, "More than 400,000 people contribute to the Cornell Lab's citizen-science projects each year, gathering data on a vast scale once unimaginable. Scientists use these data to determine how birds are affected by habitat loss, pollution, and disease."[4]

[3] Given the fact that citizenship is central to many of the most consequential political controversies today—consider, for example, Donald Trump's United States in addition to the comment from Britain's Teresa May in 2016, when she remarked, "If you believe you are a citizen of the world, you are a citizen of nowhere." It is all the more important for us to take this aspect of citizen science seriously. Indeed, even organizations such as the European Citizen Science Association, partly supported by the European Commission, are based on a shared imagery of politico-cultural community and identity.

[4] See "Mission: Citizen Science," Cornell Laboratory of Ornithology, www.birds.cornell.edu/page.aspx?pid=1664 (accessed 11 September 2018).

In this formulation, citizen science refers to voluntary, collaborative, complementary, and broad-based participation in scientific activities, and the participation is often initiated by a scientific institution (or the scientists). There can be multiple reasons that the scientific establishment pursues citizen science. The most common one is to increase the ability to collect data, multiply manpower, and expand equipment capacity. There is often a division of labor. The volunteers serve mainly as collectors or sensors. Professional scientists guide amateurs. Amateurs assist professional scientists. In this scenario, the experts can devote their time, energies, and resources to specialized research while the hundreds or thousands of volunteers can help solve other, less technically demanding problems. Many science projects that enlist backyard astronomers fall into this category.

In his article in this issue, Jeremy Vetter provides an early example of this kind of citizen science. To gather meteorological information in the nineteenth-century American West, it was necessary to build and rely on a wide network of volunteer observers who regularly sent their observational data to the weather services in the region. Other historical examples include natural history and seismology.[5] In these cases—as well as in their modern equivalents—the assumed role of the volunteers was to assist, rather than to challenge or critique, the scientific establishment. They were supposed to work together in a kind of division of labor.

Of course, a scientific institution may launch a citizen-science project for other or additional reasons—including considerations of public relations, educational outreach, and publicity. For example, there are scientific factors behind NASA's effort to recruit backyard astronomers to track asteroids or analyze images of Martian surface—NASA can certainly use extra pairs of eyes—but such citizen science projects are also PR campaigns to drum up public interest and support.[6] NASA's budget depends in part on its ability to engage the public by outreach and high-profile operations.

The relationship between the scientific establishment and the volunteers or citizen scientists can be complex. On the one hand, the scientific establishment wishes to maintain its authority and the hierarchy of knowledge production, as both Vetter and Shun-ling Chen argue in this issue. On the other hand, citizen scientists are hardly passive collectors and sensors. They have their own ideas, interests, and motives. Amateur volunteers gain opportunities to participate in scientific research. They can make valuable contributions, achieve personal satisfaction, and receive public or scientific recognition. In doing scientific work, they must also exercise judgment and form interpretations. In the process, there can be tensions or conflicts between experts and citizen scientists—though such occurrences are assumed to be incidental rather than intrinsic to this mode of citizen science. In the field sciences, for example, collectors on site might invoke their local knowledge and challenge the authority of elite scientists in faraway places (Fan 2004; Coen 2012; Shuttleworth 2015).

Citizen-science projects have mushroomed in recent years. Both the scientific establishment and volunteer groups have busily introduced collaborative projects. New technology (e.g., social media) and modes of knowledge production (e.g., open

[5] See Barrow 2000; and "Christmas Bird Count," *Audubon*, www.audubon.org/conservation/science/christmas-bird-count (accessed 11 September 2018).

[6] "Citizen Scientists," NASA.science.nasa.gov/citizenscientists (accessed 11 September 2018); Ferris 2002.

collaboration) have encouraged this rapid expansion of citizen-science projects. Some have literally turned work into play (e.g., gamification). It is notable, however, that as the scientific elite accepts citizen science as part of established methods of research, more citizen-science groups seek greater autonomy or less hierarchical arrangements.

The goal of the Citizen Science Alliance and other similar networks is to promote collaboration among scientists, educators, and others to "further science itself, and the public understanding of both science and of the scientific process."[7] The stated goal is to build a "distributed community of citizen scientists" for the advancement of science. In this kind of citizen science, citizenship is membership in an idealized open scientific community. Here citizenship is not associated with the state or territoriality, but with a cosmopolitan community of scientific commonwealth. It is necessary to remember that this lofty vision, as several articles in this issue show, doesn't represent the reality (see, e.g., Chen in this issue). There are critical questions about the distribution of credit, modes of collaboration and governance, and possible reification of scientific authority. Nevertheless, as a vision and a model, it has proved widely influential.

2.2 CS2—Science, State, and Citizen

Of course, citizen science projects can also be implicated in traditional macro-politics. An obvious example is the Operation Moonwatch. In the 1956 International Geophysical Year, the Smithsonian Astrophysical Observatory rolled out the program for recruiting amateur astronomers to help track satellites (McCray 2008). This was in the thick of the Cold War and the space race, and the program immediately became a powerful moment of political significance, symbolizing Cold War rivalry and scientific nationalism. In such situations, citizen science takes up another set of meanings. It directly intersects with the state. Much of the literature on citizen science leaves the state in the background or underestimates the role of the state in making both science and citizenship. A citizen-science project like Operation Moonwatch is not simply any form of broad participation in science, but one that has to do with the ideology, institutions, and functions of a state. In this model, science, state, and citizen are cocreated and mutually constituted.

Indeed, in the United States, the Smithsonian Institution, the National Weather Service, the Fish and Wildlife Service, NASA, and numerous national and local organizers of citizen science projects are government agencies (see, e.g., Vetter in this issue). It is the same in other countries. After all, science has long been a benchmark of the constitution of modern citizenship. With the rise of nationalism in the nineteenth century, science education and popularization have become part of the making of the modern citizenry. The dynamics among science, citizen, and state only magnified in the twentieth century, across the ideological spectrum. For example, the Soviet Union erected science and technology on the pedestal of communist modernity, Jawaharlal Nehru championed science and modernization for a newly independent India, the United States scrambled to revamp its science curriculum after the shock of Sputnik, and Britain promoted "Public Understanding of Science" in the mid-1980s (see, e.g., Andrews 2003; Aronova 2017; Rudolph 2002; Bodmar 1985; and Miller 2001).

[7] "What Is the Citizen Science Alliance?" Citizen Science Alliance, www.citizensciencealliance.org/ (accessed 11 September 2018); "What is the Zooinverse?" Zooniverse, www.zooniverse.org/about (accessed 11 September 2018).

In much of Asia, modern science and technology arrived with the might of Western imperialism and represented, above all, power. They also meant survival in the intense competition among nations in a Darwinian world order—hence, the strong belief in "saving the nation through science" (Wang 2002; Mizuno 2008). To become modern, the people of a nation had to become scientific citizens—a process that was both disciplining and empowering. This anxiety was reflected in the mentality of technocracy and the emphasis on science and engineering in school education in East Asian developmental states. In a different form, the anxiety was also reflected in the campaigns for science dissemination and mass science in Mao's China (Fan 2012a; Fan 2012b; Schmalzer 2016; Matten 2018).

To call attention to the interdynamics among science, state, and citizen is not to adopt a state-centered perspective (which we should do well to avoid). Rather, it is to recognize the fact that citizen science is not immune from traditional macro-politics and that historically, the state has been an important force in shaping science and citizenship. Indeed, we are so steeped in this legacy that we often don't even notice it. When we urge cultivating the science literacy of citizens (提升公民科學素養 in Taiwan), we more or less follow the historical tradition—even when the intention is to advocate public participation in science and technology policy or research.[8] This example suggests the substantial connections between CS2 and CS3. Both wish to raise the level of interest, competence, and engagement of citizens with science and technology—although their goals may be quite different.

2.3 CS3—Democracy and Justice

This mode of citizen science strongly advocates public participation in science or matters concerning science.[9] The central argument is that science is too important to be left to elite scientists. Because the public has a stake in science and what scientists do, it has the right and responsibility to take part in decisions about science. There is usually a strong sense of justice and social activism built into this mode of citizen science. Employing this notion of citizen science, scholars have, on the one hand, effectively critiqued establishment science and technology in modern society and, on the other hand, suggested better ways of incorporating science and technology into society. Increasingly, more citizen science groups have also taken a similar stance. The

[8] In contrast, in China, the term *gongmin kexue suzhi* 公民科學素質 (the science literacy of citizens) denotes a state-centered and top-down mode of science communication. The Chinese state recently issued a document of national standards of gongmin kexue suzhi, though it proved controversial. See Chen 陳學雷 et al. 2016; Tang 唐琳 2017.

[9] It is possible to create a separate category of citizen science that describes the public engagement of scientists as citizens. This tradition also has a long history, for example, scientific internationalism in the early twentieth century (famously Albert Einstein). More directly related to our topic, in the late 1960s, scientists in Britain and in the United States formed organizations for political activism concerning scientific and broader political issues—for example, the Union of Concerned Scientists and Science for the People, both founded in 1969. Compared to the United States, there had been a longer and stronger activism of leftist scientists in twentieth-century Britain that included the generation of J. D. Bernal, Joseph Needham, and J. B. S. Haldane. In 1969, the British Society for Social Responsibility in Science was formed, with Maurice Wilkins, a Nobel Prize winner, serving as its chair. The recent literature on expertise, expert culture, and responsible science and engineering is also relevant. Since our focus is not on professional scientists, we will not include this category in my typology here. See also Cronin 2010; and Ottinger 2013.

essence of this formulation is that science and technology should be an integral part of the public domain of a democracy.

It might be helpful to start with an example. The Love Canal controversy in the United States in the 1970s displayed certain salient features of CS3 (Mazur 1998; Blum 2008). Love Canal was a toxic waste site on which a working-class community was built. Before long, the residents became convinced that the buried chemicals were causing serious health problems in the community. They took it upon themselves to canvas cases, gather data, and draw conclusions. With the information, they organized a grassroots environmental/antipollution movement. Spearheaded by determined working-class housewives, the protest challenged the complacency and arrogance of the government, industry, and scientific elite. The Love Canal incident projected a powerful image: grassroots action, gender and class, community versus the power that be (à la David and Goliath), citizen science, and environmental justice (e.g., Ottinger 2010; Hess 2016). Many citizen-science movements have followed this narrative.

In East Asia, the central ideas of CS3—such as democracy, public participation, community, resistance, social epistemology, knowledge production, and political engagement—have strong socio-political relevance. Together they represent a collective imagining for a more open and just socio-political system in a late- or postauthoritarian era. One of the prominent sites for CS3 in East Asia is environmental monitoring or, more broadly, citizen sensing—in which citizens mobilize themselves to monitor radiation, chemical contamination, water quality, air pollution, and other environmental factors. Of course, citizen sensing includes activities of CS1 (Gabrys 2016; Wynn 2017) and even CS2 (Fan 2012a; Fan 2018). For example, citizen scientists often work with scientific institutions to monitor the local environment or collect data for tracking climate change. Yet, in pursuing what they take to be better environmental governance and justice, CS3 citizen scientists may carry out their own citizen-sensing projects independent of or even in opposition to the political and scientific authorities, though they might do so with help from some professional scientists.

After the Fukushima disaster in March 2011, radiation became a serious public health concern in the affected areas in Japan. An international network of volunteers, including scientists, activists, and venture capitalists, cofounded Safecast, an NGO that encouraged ordinary people to monitor radiation in their neighborhoods with simple DIY devices.[10] People could install them on their houses and cars, so that they would be able to measure the levels and distribution of radiation on local spots. Radiation varied notably from one spot to another, depending on many factors. Since the official measurements and periodical announcements did not provide real-time and hyperlocalized data, Safecast offered an alternative and complementary means for gathering and sharing data (Abe 2014; Kimura 2016). The Safecast website now provides aggregated data of radiation worldwide. In other East Asian countries, there are similar "citizen-sensing" projects, though their main concern seems to be air pollution. In Taiwan, for example, citizen scientists use simple devices such as AirBoxes to monitor air quality in a real time and hyperlocalized condition, as discussed in Wen-Ling Tu's detailed study in this issue. They argue that their data are more accurate and meaningful than the official ones (for those tend to be general, average, and with

[10] See "Open Environmental Data for Everyone," Safecast.blog.safecast.org/ (accessed 11 September 2018).

longer intervals).[11] With their own data, citizens can and do challenge the government's reports and decisions.

The political situation in China is very different because it is an authoritarian state. There have been numerous incidents of environment-related protests and conflicts, such as the anti-PX protests in Xiamen, Dalian, and Shanghai (Wasserstrom 2013; Haas 2016; Lora-Wainwright 2016; Lora-Wainwright and Chen 2016; *Economist* 2014).Yet, the environmental problem that attracts the widest attention is air and water pollution, due in part to the growing presence and environmental consciousness of the urban middle class. Severe air pollution haunts major cities in China, and the middle-class urbanites are frustrated with the lack of effective actions by the government. The smash-hit documentary *Under the Dome* (2015) revealed a brewing dissatisfaction. The official data have long lost their credibility, and citizens are taking action on their own. They have developed projects, from the quirky FLOAT (using kites to measure air pollution) to smartphone apps such as Blue Map (for sharing information about air quality).[12] Of course, environmental activists and independent NGOs still face serious political risks in China. When, in 2016, an environmental activist, Shu Liu, publicized the data of industrial pollution in Hunan Province, she was arrested and charged with the crime of "revealing anti-espionage state secrets."[13] This doesn't mean that citizen science and environmental movements in China are all struggling for civil society and democracy. Often it is like arm wrestling under the roof of authoritarian capitalism, a system that a majority of Chinese probably still support. The central government, the local government, the industry, and the local citizenry engage in a tough negotiation of will, resources, moral appeal, and power. The goal of citizen science is often to prompt responsive and effective government actions rather than to demand a participatory procedural democracy as is usually defined.

Although the political systems are different, it seems that many projects of CS3 include basic elements of citizen rights, socio-political justice, moral economy, and a sense of proper political processes and governance. These ideas manage to exist even in states that fall outside the spectrum of liberal democracy. Given the many different types of government in East Asia and beyond, it is necessary to pay attention to the various political parameters involved in citizen science.

2.4 CS4—Civic Commons and Techno-Social Infrastructures

The rapid expansion of new technoscience, such as cybertechnology and biotechnology, has created new capacities and possibilities that cannot be contained within the traditional frameworks discussed above. With the new technoscientific development, new ideas, practices, and socio-political actors have emerged, and these factors may require a new conceptualization of citizen science.

This is not to say that new technoscience must go hand in hand with a new citizen science.[14] The three modes of CS discussed above can all utilize and benefit from new

[11] See "'Gong min ke xue' ziji de kongqi ziji ce" ("'公民科學' 自己的空氣自己測").

[12] See, e.g., Beaumont-Thomas 2015; "FLOAT Beijing: Citizen Generated Data on Air Quality"; Barness 2013; Ely and Tyfield 2013; Liu 2015; Weinfurter 2014.

[13] See "Pilu wuran shju huanbao NGO fuzeren Liu Shu beibu."

[14] All of the issues discussed in this essay, including the tensions described here, are related to what has been loosely called "sociotechnical imaginaries." See Jasanoff and Kim 2015; Abraham and Rajadhyaksha 2015.

technoscience. For example, information technology is key to most crowdsourcing or citizen-sensing projects of any type of CS (Hoffman 2016; Tu, this issue); it enabled projects like Safecast as well as OpenStreetMap, which enlisted volunteers from all over the world to map the impact of the 2015 Nepal earthquake (Clark 2015; Meyer 2015). In fact, the cultures of new technoscience can be surprisingly traditional and have little to do with citizen science. Take, for example, the several related trends and subcultures of innovation—makers, tinkers, biohacking, and garage science. In the United States, most of them haven't developed into civic movements per se. More often than not, they simply echo the American romance of self-made inventors and innovative entrepreneurship (Turner 2008; Markoff 2005; Levy 1984; Issacson 2014).

Nevertheless, new technoscience has certainly fostered new kinds of citizen science or new movements of civic technoscience (Kera 2012; Wildschut 2017). Consider the many open-source and open-science projects. Such cyberactivism tends to challenge the established structure of knowledge production and distribution in technoscience—whether it is about software programming or access to scientific information. The participants try to destabilize, modify, or circumvent traditional institutions by demonstrating citizens' ability to take control of technology and articulate a view of techno-social life (Delgado and Callén 2017). They intervene by developing new collaborative processes and building new tools that would facilitate the reconfiguration of existing political and socio-technical institutions. In doing so, they also seek to inject the ideas and visions of their civic tech commons into fields that are traditionally dominated by institutional hierarchies. Thus, these movements, by their actions, often dig into the socio-techno infrastructures. The hacks, fixes, or technical solutions they produce to address the infrastructural problems often reveal their interest in remodeling or shaking up the establishment—and this marks a major difference between CS4 and CS1.

Such communities (of civic hackers or whatever the participants identity themselves with) are often formed around the idea of a public or a civic common of stakeholders—an imagery not dissimilar to the cosmopolitanism of the Republic of Letters. (In this, we see the tangled relationship between CS4 and CS1.) Ideally, everyone shares and contributes and takes responsibilities in pursuit of the common good. Ideally, the common is where such values as equality and cooperation flourish. Participants gather and hack through collaboration and tasking; the process is fluid, open, and ad hoc rather than structured and hierarchical. And, again, ideally, such a community functions as a "recursive public" in which members can cultivate individual capabilities as well as collectively reproduce a shared culture and mode of practice that distinguish them from mainstream society and its model of production (Kelty 2008; Delgado and Callén 2017). But, of course, it is worth pondering if the imagery of a recursive public unnecessarily privileges and circumscribes the technosocial community (of geeks as termed in Kelty 2008). The imagery allows an already elite community (at least socially and technologically) a high degree of independence and autonomy. Is it a good thing for society at large? After all, what matters most may actually be the intersections of such communities, if they exist as imagined, and other commons as well as the socio-political continuum.

Most civic tech or civic hacking communities work with the existing socio-political entities, though they may also try to modify or remake them when possible, based on their own ideas and values (e.g., open government). The examples of g0v, EDGI, and other examples discussed in this issue illustrate these points. It is true that in reality, such communities can be very fragile, transient, and difficult to hold together. Yet, they can

also be effective, utilizing various strategies of gathering, including physical hackathons and online communications. Their networks of collaboration may cut across or evade traditional social and political confines. In imagining a civic common, participants act as subjects of political consciousness who hack for socio-technical and political change.

3 In This Issue

In analyzing the different modes of citizen science, we have tried to do justice to the complexity and diversity of citizen-science movements and their underlying ideas.

We believe that it is necessary to contextualize and historicize these movements and to unpack the built-in concepts of citizenship. The categories and boundaries at issue are not fixed and they overlap, but they are also pertinent and meaningful.

Throughout this essay, we have referred to the articles included in this special issue when appropriate. Here we'll briefly introduce them in order.

Jeremy Vetter goes back in history and provides an early example of lay participation in science that resembled a combination of CS1 and CS2. Nineteenth-century American meteorology relied heavily on volunteer collectors for meteorological data, but the institutionalization of meteorology was also part of the process of state building and imperial expansion that invested in maintaining a hierarchical control of knowledge and information. By analyzing the tensions in the online citizen-science community Galaxy Zoo, Shun-Ling Chen critiques the common, but problematic assumptions about crowdsourcing and other aspects of citizen science. The findings of her inquiry speak directly to CS1, yet they are also relevant to the other types of citizen science. Wen-Ling Tu's close examination of air monitoring and antipollution movements in Taiwan highlights the vitality of CS3 in East Asian societies. It also suggests certain important features of citizen-science movements in the particular socio-economic context of a postdevelopmental state. By way of critiquing SEE, or the Third Wave, Wen-Tsong Chiou argues that it will be a violation of due process if citizens are denied a place in the production of regulatory knowledge simply because of a narrow definition of expertise (an issue central to CS3). To illustrate his theoretical argument, Chiou draws on contemporary cases of citizen science in Taiwan. Finally, this special issue includes an extensive conversation with two civic-tech communities, g0v and EDGI, in which the participants explore the intersections of politics, technology, and civic commons from personal experiences as well as views on current affairs (broadly in connection to CS4). The conversation allows us to hear voices of practitioners of civic technology and citizen science.

In recent years, there has been a spate of popular books on citizen science. Books for a general audience are routinely ignored by academic journals; in the spirit of citizen science, we gladly break from the conventions and include a review essay on several such books.

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