# Chapter 22
# Citizen Science Platforms


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**Abstract** Adequate infrastructure for citizen science is constantly growing and has become increasingly important in providing support to citizen science activities, both nationally and internationally. Many types of citizen science infrastructures exist, with different functionalities. This chapter focuses on current citizen science platforms. The platforms addressed in this chapter are those which display citizen science data and information, provide good practical examples and toolkits, collect relevant scientific outcomes, and are accessible to different stakeholders, ranging from interested citizens to scientific institutions to authorities, politicians, and public media. We present current citizen science platforms in Europe and associated (inter)national citizen science networks and discuss how these platforms have become increasingly vital within citizen science. Based on these examples, we elaborate on challenges for citizen science platforms, such as establishing and financing platforms, designing user interfaces, maintaining platforms, promoting the usage of platforms, etc. We conclude with an outlook into potential development needs of citizen science platforms in the future.

**Keywords** Infrastructure · Knowledge sharing · Public participation · Networks

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K. Vohland et al. (eds.), *The Science of Citizen Science*,
https://doi.org/10.1007/978-3-030-58278-4_22

## Citizen Science Platforms: Important Instruments to Support Citizen Science

With the boom in citizen science, there is a growing need for adequate infrastructures to support citizen science activities. A range of digital infrastructures (e.g. mobile apps, low-cost sensors, games, and gamification) have been developed to facilitate interaction and communication between citizens and scientist and to expand the scale and scope of project and protocol design, data collection, information delivery, data processing, and visualisation (Newman et al. 2012; Bowser et al. 2013; Eveleigh et al. 2014). Furthermore, a wide range of resources, guidelines, and handbooks have been published for data and metadata management (Wiggins et al. 2013; Schade and Tsinaraki 2016), the establishment of data and metadata standards (Cavalier et al. 2015), data quality assurance and control (EPA 2019), and ethical data practices (Lynn et al. 2019). It is obvious from the growing number of new technological developments that citizen science infrastructures are increasingly in demand. One important aspect of citizen science infrastructures is citizen science platforms.

The term *platform* is now in common usage and has begun to creep into many fields across the sciences, humanities, governance, and more (Ansell and Gash 2018). A platform may refer to a technology (e.g. computing platform, web platform); physical objects and features (e.g. diving platform, oil platform); politics (e.g. party platform, European politics platform); the arts (e.g. novel platform, art group platform); and a range of other areas (e.g. economic platform, business model platform) (Wikipedia Contributors 2020). What we might once have called a meeting, conference, partnership, or a network may now be branded as a platform – as in the case of the collective awareness platforms (CAPS)[1] for sustainability and social innovation (Bellini et al. 2016); the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Bongaarts 2019); and the Knowledge base for the Sustainable Development Goals (KnowSDGs) platform, from the European Commission (EC), among others. For the purpose of clarity, we use the term *citizen science platforms* in this chapter with the following definition. Citizen science platforms are web-based infrastructures with one single entrance point that contain one or several of the following functionalities: (1) present active citizen science projects and activities; (2) display citizen science data and information; (3) provide overall guidelines and tools that can be used to support citizen science projects and activities in general (e.g. recruitment strategies including motivational and marketing approaches, data quality assurance and control methods, guidelines for dealing with data security issues, resources, and opportunities to network with other relevant activities and upscale the project results); (4) present good practice examples and lessons learned; and (5) offer relevant scientific outcomes for people who are involved or interested in citizen science.

[1] https://ec.europa.eu/digital-single-market/en/caps-projects

Using this definition, the earliest citizen science platform can be tracked back to Zooniverse and a project called Galaxy Zoo in 2007. The project asked the public to help the research team, based in the Department of Astrophysics, Oxford University, to classify images of fully formed galaxies based on their shape. Since the day Galaxy Zoo started, Zooniverse has become the world's largest and most popular people-powered research platform and hosts more than a hundred citizen science projects. Since then, other platforms presenting multiple projects have appeared, such as SciStarter (US) in 2011, *Bürger schaffen Wissen* (Germany) in 2013, *Österreich forscht* (Austria) in 2014, *Schweiz forscht* (Switzerland) in 2014, the Australian citizen science association in 2014, and the Danish citizen science network in 2018. In the last few years, the number of national citizen science platforms increased significantly.

Today, there are many citizen science platforms being developed and made accessible for a range of stakeholders, including citizens, scientific institutions, public administrations, policymakers, and the media, with an overall aim to mainstream citizen science projects and activities at city, regional, national, and international levels. According to Sprinks et al. (2015), citizen science platforms allow nonscientists to take part in scientific research across a range of disciplines. What these platforms ask of volunteers varies considerably in terms of task type, level of user required, and user freedom (Sprinks et al. 2015). Lichten et al. (2018) addressed the fact that citizen science platforms host a range of projects to help with project building and hosting capabilities (e.g. CitizenGrid, Zooniverse). These platforms are a useful resource for members of the public who want to discover projects and choose projects to participate in or for researchers who want to create projects (Lichten et al. 2018). Many project-based citizen science platforms have been developed for a range of end users who have a variety of aims and goals (e.g. hackAIR, CAPTOR). According to Sturm et al. (2018), citizen science platforms can be developed as a technical framework designed for one or more applications to run and to store data and information. Citizen science platforms can also be designed with a functionality that enables the participants to interact with the project data (e.g. adding and/or verifying), such as mapping and sharing observations of air quality (e.g. hackAIR, Luftdaten.info), measuring biodiversity (e.g. iNaturalist), and in many fields across the sciences, humanities, and more (e.g. Zooniverse). In addition, citizen science platforms can function as a mutual learning space providing useful resources about citizen science, including tools and guidelines, good practices, and training modules, such as CitSci.org (Lynn et al. 2019), SciStarter, and the Austrian citizen science platform *Österreich forscht*. Another category of citizen science platforms is comprised of those platforms that are commercially available, such as SPOTTERON and CitizenLab, which combine both technology aspects and tools. Looking at the different categories, we can summarise that citizen science platforms seem to be important tools to share citizen science knowledge, facilitate mutual learning and multi-stakeholder collaboration, get inspiration, integrate existing citizen science activities, develop new citizen science initiatives and standards, and create social impact in science and society.

The present chapter focuses on citizen science platforms that provide services for existing and potential citizen science projects and activities with the ultimate goals of (1) providing multi-level intermediation between local citizen science projects and national or international resources and public administrations; (2) exchanging knowledge and know-how of creating synergies in order to use resources efficiently, such as the combination/integration of data and/or the presentation of citizen science projects to interested stakeholders, including the public; and (3) promoting multiple, ongoing stakeholder collaborations, facilitating the adaptation of many collaborative citizen science projects over time. In general, this chapter on citizen science platforms as a meeting point for citizen scientists has a lot of synergies with other chapters in this book, in particular, Lemmens et al. (this volume, Chaps. 9 and 23) about citizen science in the digital world of apps (e.g. an app can be a platform or a part of a platform); Garcia et al. (2020, this volume) about citizen science guidelines (citizen science guidelines need to be included in citizen science platforms); Tauginienė et al. (this volume, Chap. 20) about ethical considerations (ethical considerations have to be included in a citizen science platform to assist potential citizen scientists and others working with citizen science); and Balázs (this volume, Chap. 8) about data quality (a citizen science platform that displays citizen science data needs to do a quality analysis before the data are published).

## Current Citizen Science Platforms in Europe

In this section, we give an overview of current citizen science platforms in Europe, with a few concrete examples that meet our definition of citizen science platforms.

Currently, there are many citizen science platforms in Europe. They can be categorised into five types, including (1) commercial platforms for citizen science initiatives; (2) citizen science platforms for specific projects; (3) citizen science platforms for specific scientific topics; (4) national citizen science platforms; and (5) EU citizen science platforms (see Table 22.1).

An important point is the fact that commercial platforms are offering their services (ultimately) for profit, whereas the other types of platforms are offering their services either for free or only covering their costs. Also, a commercial citizen science platform often brings together a willing buyer and seller to facilitate a bilateral market exchange, while other types of citizen science platforms have great potential to orchestrate a multilateral (as opposed to bilateral) collaborative relationship (as opposed to market exchange) (Ansell and Gash 2018).

### *Type 1: Commercial Platforms for Citizen Science Initiatives*

Commercial platforms offer their services to customers for profit. Several commercial platforms for citizen science (e.g. SPOTTERON and CitizenLab) have started

**Table 22.1** Types and examples of citizen science platforms in Europe

| Type | Available resources | End users | Examples |
|---|---|---|---|
| Commercial platforms for citizen science initiatives | Data collection tools | Scientists | SPOTTERON |
| | Data infrastructure including handling and storage | Citizen scientists | CitizenLab |
| | Data protection and security | Individuals or institutions that want to start citizen science initiatives | |
| | Toolkits for communities and user motivation | | |
| Citizen science platforms for specific projects | Information on the topic | Scientists | hackAIR (collective awareness about outdoor air pollution) |
| | Toolbox on how to collect data | Citizen scientists | Galaxy zoo (crowdsourced astronomy) |
| | Option to upload data | Individuals or institutions that want to start citizen science initiatives | CAPTOR (collective awareness about tropospheric ozone pollution) |
| | Data visualisation | Public media | Zooniverse (any type of scientific project that relies on collective intelligence) |
| | Links to similar initiatives | Policymakers and decision-makers | Foldit ('solve puzzles for science') |
| Citizen science platforms for specific scientific topics | Information on the topic | Scientists | *Artportalen* (species observation system, Sweden |
| | Instructions on how to collect data | Citizen scientists | SPOTTERON (air quality measuring system) |
| | Option to upload data | Public media | The 'big butterfly count' (butterfly counting system) |
| | Data visualisation | Policymakers and decision makers | |
| | Links to similar initiatives | | |
| National citizen science platforms | Information on citizen science in national language | Scientists | *Iedereen wetenschapper* (Belgium) |
| | Access to a large number of national citizen science activities | Citizen scientists | *Scienza Collaboratva* (Italy) |
| | Tools and guidelines | Individuals and institutions that want to start citizen science initiatives | *Österreich forscht* (Austria) |
| | Collaboration opportunities on specific citizen science topics | Public media | *Bürger schaffen Wissen* (Germany) |
| | Additional information | Policymakers and decision-makers | *Citizen Science Portalen* (Denmark) |

(continued)

**Table 22.1** (continued)

| Type | Available resources | End users | Examples |
|---|---|---|---|
| | Access to national citizen science network | National citizen science network | *Schweiz forscht* (Switzerland) |
| | Organisation of events | | *Ciencia Ciudadana en España* (Spain) |
| EU citizen science platforms | Tool to be used to launch data collection activities (including citizen science contribution) to extend the evidence base for European policies | Scientists | JRC citizen science platform |
| | Resources about citizen science, including tools and guidelines, best practice, and training modules | Citizen scientists | EU.Citizen-science |
| | | Public media | |
| | | Policymakers, decision-makers | |
| | | EU citizen science networks | |

over the last couple of years. Most of them offer services in programming and designing websites and/or apps for citizen science projects, data handling, and storing infrastructure in combination with data protection, security services, and community services (e.g. gamification toolkits, online interaction). They mainly target citizen science project leaders (i.e. scientists, institutions, citizens that want to start their own projects, etc.). These project leaders benefit from the professional handling in programming and web design of commercial platforms to create easy to use, attractive, and reliable technical infrastructure for their projects. In Box 22.1 we provide an example of a commercial platform for citizen science initiatives, SPOTTERON.

**Box 22.1: SPOTTERON**
SPOTTERON is a well-known commercial citizen science platform in Europe. SPOTTERON has coevolved with the Austrian citizen science community since 2014 and offers several packages of website and app development and hosting, together with optional add-ons that focus on community services, interactive maps, and data quality. Over the years, SPOTTERON has developed a whole ecosystem of apps and functions, which is strengthened by its business plan. In this plan, add-on functions financed by one project are made available for free to all other projects that use SPOTTERON. Furthermore, SPOTTERON offers the creation of image and event videos. Today SPOTTERON hosts a wide range of projects that, in addition to Austria, now also come from Australia, Switzerland, and Sweden.

### *Type 2: Citizen Science Platforms for Specific Projects*

Citizen science platforms have also become popular as a central tool in research and innovation projects. In this context, the platform serves as central element for citizen scientists to both contribute with and access data/observations. Many existing citizen science platforms have been developed as a task and/or overall outcome from a specific project. For example, some citizen science platforms (e.g. hackAIR, CAPTOR, SOCRATIC, POWER) have been developed under the EU H2020 ICT call for Collective Awareness Platforms for Sustainability and Social Innovation (EU 2015–2017). In Box 22.2, we provide an example of a citizen science platform for a specific project, hackAIR.

**Box 22.2: hackAIR Citizen Science Platform**

The hackAIR platform has been created by six European partner organizations as a key element of a EU-funded project of the same name on Collective Awareness Platforms for Sustainability and Social Innovation (2016–2018). Although it has officially ended, the hackAIR platform is still in use and has been adopted by the CAPSSI initiative. The hackAIR platform is a repository of air quality information from open data sources, displayed on a map. It is an open technology platform that participants can use to access, collect, and improve air quality information in Europe. At the moment, it displays air quality data from OpenAQ, Luftdaten.info, and low-cost air quality sensors (Liu et al. 2019). OpenAQ aggregates physical air quality data from public data sources provided by the government, researchers, and other sources. Their application programming interface (API) provides easy access to official air quality data, the same data that powers the European Environmental Agency (EEA) official Air Quality Index (AQI).[2] Luftdaten.info has designed a do-it-yourself (DIY) air quality sensor which is promoted to interested individuals. Their API automatically uploads data from all Luftdaten.info sensors to the hackAIR platform. It is possible for citizen scientists to contribute with their own air quality measurement data through the hackAIR restful application program interface (REST API).[3] A tutorial is available on the web pages for building measuring devices and uploading measuring results to the hackAIR platform.

During the project phase (2016–2018), it was also possible to take pictures of the sky with the hackAIR smartphone app (Kosmidis et al. 2018). Its technology enabled the estimation of air quality based on sky-depicting images. This data was also made available through the hackAIR platform.

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[2] https://www.eea.europa.eu/themes/air/air-quality-index/index

[3] https://api.hackair.eu/docs/

**Box 22.2** (continued)
Another tool to estimate particles pollution levels was the hackAIR cardboard sensor. This was a low-cost sensor that was easy to build with a milk carton and petroleum jelly. A picture of the jelly, taken with a macro lens attached to the smartphone camera, was then analysed in the hackAIR app, and the results were also uploaded to the hackAIR platform. The last category of data that was uploaded to the hackAIR platform was data on personal perceptions of air quality. A function in the hackAIR app made it possible to submit information on how the user perceived air quality right wherever they were. This data was also visualised on the hackAIR platform.

### *Type 3: Citizen Science Platforms for Specific Scientific Topics*

Citizen science platforms for specific scientific topics are those platforms that have been developed with a special focus (e.g. air pollution, water quality, biodiversity, etc.). These platforms are used as a repository for different data types that are used not only by interested individuals but also by scientists and authorities. Here, we give two examples, *Artportalen* (Box 22.3) and Luftdaten.info (Box 22.4).

**Box 22.3: Artportalen**
*Artportalen* is a Swedish species observation system. On *Artportalen*, the users can submit sightings for all plants, animals, and fungi in Sweden. The platform has been developed by the Swedish Species Information Centre at the Swedish University of Agricultural Sciences,[4] on behalf of the Swedish Environmental Protection Agency. Data from *Artportalen* are used by professionals and NGOs for conservation activities but also by the Environmental Court and Ministries (Personal communication). By 25 October 2019, more than four million observations had been reported since the beginning of the year.[5]

**Box 22.4: Luftdaten.info**
The platform Luftdaten.info is a good example of a local bottom-up initiative that has been grown into a platform on air quality data that is recognised

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[4] https://www.slu.se
[5] https://artportalen.se/ReportingStatisticitizenscience

**Box 22.4** (continued)
worldwide. The OK lab Stuttgart[6] utilised their coding skills and capacities to develop DIY air quality sensors to measure particulate matter (PM) in outdoor air. The platform contains information on air quality, building and coding instructions for DIY air quality sensors, and instructions on how to connect the sensor to the Luftdaten.info platform. The platform displays data from all users on an online map with options to filter $PM_{2.5}$ and $PM_{10}$ values, AQI, temperature, relative humidity, air pressure, and, recently, noise.

The platform publishes news related to air quality and noise and information about upcoming workshops where interested citizens can build their own sensors. The platform also offers support for all users. This platform had spread over the whole of Germany and is now well established, with 'sister' platforms in many other European countries, such as Belgium, Bulgaria, and Sweden.

### *Type 4: National Citizen Science Platforms*

In several countries across Europe, national citizen science platforms have been developed by different stakeholders with the ambition to present the diversity of citizen science projects in the respective countries. In many cases, they are hosted by or offer access to national citizen science networks, which have the overarching goal to foster citizen science in their respective countries. A key property of all these platforms is that they use their respective national language to communicate projects or information on citizen science to interested users (e.g. citizen groups, the general public). The focus of these platforms lies in the presentation of many citizen science projects and activities for interested users. Additionally, they also offer general information on citizen science, tools, and guidelines, and, in many cases, they also organise events (e.g. networking events, conferences, workshops). Furthermore, some of them also offer the opportunity to collaborate in working groups on specific topics, such as legal or ethical aspects in citizen science. They target diverse stakeholders, such as interested citizens, project leaders, institutions, media, policymakers, and decision-makers.

Such platforms entered the stage early on in the German-speaking countries (Germany, Austria, and Switzerland) with *Bürger schaffen Wissen*, *Österreich forscht*, and *Schweiz forscht*. In the following years, Belgium, the Netherlands, Spain (*Ibercivis*), Denmark, and Sweden (ARCS) also established such platforms, while several other countries are still in the development stage (e.g. Portugal and Italy). In Box 22.5, we provide an example of a national citizen science platform, *Österreich forscht*.

[6] https://www.codefor.de/stuttgart

**Box 22.5: Österreich forscht**
*Österreich forscht* is the platform associated with the national Citizen Science Network Austria. The main focus of *Österreich forscht* is the presentation of a wide variety of current citizen science projects (*Projekte*) to an interested public. Additionally, in a project archive, individuals who want to start a new citizen science project can find information on and can get into contact with project leaders from successfully completed projects. Potential participants can find brief information about current projects from various disciplines and are guided to the respective projects' websites. As a complementary feature, the projects can also be filtered according to topic, location, and form of participation. Project leaders can find information on working groups (*Arbeitsgruppen*), they can collaborate on and open calls for proposals and funding opportunities (a subsection of *Allgemeines*), as well as access guidelines, tools, and publications (*Literatur*). Media representatives can find general and up-to-date information on citizen science. Policymakers and decision-makers and institutions, who are mainly interested in the network and its members, can also find information on the network's goals, etc. (*Netzwerk*). Furthermore, *Österreich forscht* also serves as the main portal for the annual Austrian Citizen Science Conference (*Konferenz*).

## *Type 5: EU Citizen Science Platforms*

There are currently two citizen science platforms at EU level. One has been developed by the EC's Joint Research Centre (JRC) (see Box 22.6). The other one is still being developed by the project EU-Citizen.Science at the time of writing (see Box 22.7).

**Box 22.6: JRC citizen science platform**
The JRC Citizen Science Platform is a service for science and knowledge through research with the aim of providing independent scientific advice and support to EU policy[7] by connecting scientific knowledge where the JRC acts as an EU *science hub*. To support this function, the JRC started the process of creating a citizen science platform. The aim of this platform is to improve the relationship between citizens and European policymaking by offering new ways to contribute to the supporting scientific processes.[8] Currently, in its initial phase, the JRC Citizen Science Platform is investigating smartphone

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[7] https://ec.europa.eu/jrc/en

[8] https://digitalearthlab.jrc.ec.europa.eu/about-campaigns/57830

**Box 22.6** (continued)
apps as a tool for engaging citizens in citizen science processes and, thus, gather evidence for European policymaking by targeting areas with clear policy relevance (e.g. invasive alien species in Europe). The JRC Citizen Science Platform is applying a value chain approach, including the following steps: (1) innovation in data gathering; (2) validation and quality control; (3) analysis and data management of the data gathered from new data sources; (4) integration of new knowledge in established decision-making processes; (5) communicating policy-related reactions to this knowledge; and (6) monitoring the impacts of these reactions (closing the loop).

The JRC Citizen Science Platform is currently focusing on invasive species, offering citizen scientists all over Europe to participate with their own smartphone apps. All contributions will be visible on a web-based map as soon as they are registered. The long-term aim of the JRC Citizen Science Platform is to expand the citizen science activities to other topics that are identified as supporting policy needs.

**Box 22.7: EU-Citizen.Science**
The citizen science platform of the project EU-Citizen.Science is still under development. The project is funded under the EU Horizon 2020 Framework Programme for Research and Innovation and runs from 2019–2021. The aim of this project is to build a central platform for citizen science in Europe to share useful resources about citizen science, including tools and guidelines, best practices, and training modules. The platform will make knowledge created by citizen scientists in Europe visible and accessible and encourages platform visitors to learn more about citizen science and eventually initiate their own citizen science activities. The long-term plan is to hand over the platform to the European Citizen Science Association (ECSA) for maintenance and continuation after the project ends. The project team consists of 14 partners and 9 third parties, including the ECSA. Currently (October 2020), the actual platform is online but still in the testing phase.

## Connections Between Citizen Science Networks and Platforms

### *The Role of Citizen Science Networks*

As mentioned above, today, many countries across Europe have national citizen science networks that host their associated national citizen science platforms. Often such networks can act as catalysts for citizen science in their respective countries,

since they bundle up diverse and sometimes widespread initiatives and showcase the diversity of citizen science (Pettibone et al. 2017). Due to the networks' appeal to a broad target audience, the associated platforms often offer very elaborate information on citizen science, suitable for many different interests and backgrounds, forming national citizen science information hubs. The citizen science networks usually combine different scientific disciplines and aim to (1) promote the recognition of citizen science in science and society; (2) create social impact through transdisciplinary work, bringing together science and society; (3) establish new citizen science initiatives; (4) establish a platform for knowledge exchange and mutual learning; and (5) improve the quality of citizen science initiatives and enable research on citizen science (Pettibone et al. 2017; Richter et al. 2018; Dörler and Heigl 2019).

In order to meet these aims, citizen science network activities must be carried out continuously. A good way to do so is to set up working groups for different topics, as has been done in Austria with working groups on 'Quality criteria for citizen science projects', 'Open biodiversity databases in citizen science', 'Citizen science in schools', 'Legal aspects of citizen science', 'Open science trainings', etc. Keeping the participants of the citizen science network engaged in these working groups will increase the benefit not only for the network itself but also for each participant. Physical network meetings once or twice a year will also help to keep the work ongoing and foster data/information exchange.

As the citizen science networks grow, their tasks and responsibilities grow too, resulting in citizen science platforms that offer more services and new modes of interaction and cooperation. To pick up the example of *Österreich forscht*, when Citizen Science Network Austria decided to establish quality criteria for citizen science projects on *Österreich forscht* (Heigl et al. 2018a) collaboratively, it involved feedback from citizens, offering to post their feedback in a section called *Diskutier mit!* (Join the discussion!) on the platform.

Another main task of most citizen science networks is to organise events. For example, Citizen Science Network Austria has been organising the annual Austrian Citizen Science Conference since 2015, with about 200 registered participants each year. This conference is the central event to promote personal exchange within the citizen science community in Austria. In recent years, this exchange has also been recognised internationally. Therefore, representatives of the German and Swiss networks are now participating in the scientific committee of the conference to further deepen the knowledge exchange. In order to make the contents accessible to a broader international community, proceedings from these conferences were published in an open access format (Heigl et al. 2016; Dörler et al. 2017; Heigl et al. 2018b).

Furthermore, another goal of citizen science networks is to pause and reflect on the current state of citizen science and to outline a strategy for its future at national and international levels. In Germany, there is a growing importance of citizen science networks in science and policy. From a purely normative perspective, citizen science networks are driven by scientific questions and curiosity, contributing new knowledge, and aiming to provide benefits for contributors and added value for

society. Citizen science and its networks offer new pathways of cooperation and mutual learning between lay and professional actors and between citizens, scientists, politicians, and the private sector, and it opens new ways for doing research (Vohland et al. 2019).

### *Impacts of Citizen Science Platforms*

Since most citizen science platforms are still in their infancy and at an early developmental stage, there is little information on the impact of such platforms available. As mentioned before, platforms can act as catalysts for citizen science in a country by bundling diverse and widespread initiatives and therefore inspiring others to start their own projects. However, to the best of our knowledge, a systematic evaluation of the impact of such platforms has not yet been undertaken.

In the case of *Österreich forscht*, we have some information on aspects that can describe the impact of such platforms. In 2017, the coordinators of *Österreich forscht* asked all the project leaders who had listed projects on the platform how many participants they had. The result was that more than 100,000 citizen scientists were participating across all the projects in 2017, a huge number for a small country with only eight million inhabitants. Furthermore, cross-project collaboration has been facilitated several times by organising networking events and conferences within Citizen Science Network Austria.

## Challenges and Successes

### *User Interface and Experience Design of Platforms*

The main challenge for citizen science platforms lies in their usability and design (Giuliana 2017; Leeuwis et al. 2018; Skarlatidou et al. 2019; Pejovic and Skarlatidou 2020). They need to work smoothly and look modern. In a world where a plethora of platforms, apps, and websites are courting users' attention, competition is fierce, and without proper design or functionality, platforms will not be used. The *design rules*, especially for designing *interfaces* for the institutional framework in which many stakeholders' interactions are orchestrated, are key to ensuring a degree of integration or at least effective adjudication (Hagiu and Wright 2015; Ansell and Gash 2018). Furthermore, studies showed that participants find the more guided, less autonomous user interfaces frustrating, while the less complex, repetitive user interfaces result in greater data coverage (Sprinks et al. 2015).

According to Ansell and Gash (2018), a key design issue is the relative openness of the platform. With respect to collaborative platforms, greater control over access and participation can reduce transaction costs and facilitate negotiation and coordination, but it can also undermine legitimacy, discourage fresh ideas, and limit

possibilities for synergy (Ansell and Gash 2018). Boudreau (2010) discovered that devolving a degree of control over the platform can produce positive innovation effects and create a community and by doing so lowering transaction costs, increase reach, and enable some level of control by users (Janssen and Estevez 2013).

The engagement of volunteers on citizen science platforms can be considerably influenced by an intuitive and motivating user interface (Giuliana 2017). An investigation has shown that it is very difficult to create a general design approach, ideally applicable to any citizen science platform, since every citizen science project has individual resources, requirements, and objectives (Giuliana 2017). It is important to convey a concept which can be adapted to individual cases, such as collaborative citizen science platforms and human-centred conception of platforms (Giuliana 2017; Ansell and Gash 2018). In addition, it is important to be aware of the continuous process of adjustments while implementing a complex online platform. The technical components should always be state of the art (Giuliana 2017). It is essential that citizen science platforms leverage the complementary strengths of humans and machines to take full advantage of the onslaught of data being experienced across the disciplines (Trouille et al. 2019). Furthermore, it is essential to observe how the platform is adopted by its users and whether some functionalities are not used or if others require revision.

### *Establishing and Financing Platforms*

There are several decisions that need to be made when establishing a platform. Defined decision-making processes need to be established that help determine the focus and the target audience of a platform. Technical requirements need to be identified and addressed in the development phase, often by hiring a commercial supplier of citizen science platforms. Responsibilities in setting up and running a platform need to be negotiated or delegated. All these decisions can be made either bottom-up (e.g. a network of members on equal footing decides in a democratic process) or top-down (e.g. an institution or funder decides what will be the focus of the platform).

When choosing a bottom-up approach, all members are invited to be involved in the decision-making process and can develop a sense of ownership for a platform, ensuring the use of the platform by its members. However, the process of reaching a decision can be difficult and tedious, and such a platform can lose its flexibility when numerous stakeholders are involved. Furthermore, the financing of such a bottom-up platform can also be challenging when no decision on a hosting institution can be reached.

A top-down approach enables a fast decision-making process and very often also good funding opportunities. However, creating ownership in such a platform is more challenging when there is no collaborative approach applied.

Based on communication with (national) citizen science platform operators, the most prominent challenge is the acquisition of financial support, not only to establish

a citizen science platform, but even more, to maintain the platform and its services in the long run. The *Österreich forscht* platform receives permanent funding from the University of Natural Resources and Life Sciences in Vienna. This, however, seems to be the exception. In most cases of national citizen science platforms, it is a challenge to obtain permanent funding. It could be advantageous to establish and keep close contact with public authorities and try to promote the national citizen science platform as a fundamental prerequisite for national citizen science projects and activities.

Challenges to finding funding sources are also relevant to project-related citizen science platforms where the funding usually ends after finalising the project. Thus, a business plan for exploiting the platform beyond the project's afterlife must be designed. For commercial citizen science platforms, funding is a question of commercialising and promoting the products as efficiently as possible.

To conquer the challenges of establishing and financing a citizen science platform, building on an organisation theory approach, the concept of collaborative platforms (Ansell and Gash 2018), defined as organisations or programmes with dedicated competences and resources for facilitating the creation, adaptation, and success of multiple or ongoing collaborative projects or networks, could be a solution.

## *Communication and Up-Scaling of Platforms*

To effectively draw attention to citizen science platforms requires a detailed examination of the project's target groups and tailor-made communication channels; platforms must act in a strategic manner (Ansell and Gash 2018). One key strategy for approaching target groups is to build on pre-existing efforts and motivations, for example, the importance of 'starting where the people are' – that is identifying issues that are of immediate concern to different target groups (Cheadle et al. 2005; Ansell and Gash 2018). A closely related strategy to communicating and up-scaling of citizen science platforms is customising different activities for different stakeholders. Ton and Vellema argued that 'platform facilitators need to maximize the possibilities for spin-off activities with sub-sets of members in the early stages of platform development, even when these may not be the most important activities in the long term for the group as a whole' (2010, p. 2). Borys et al. observed the strategic importance of the 'ability to generate social multiplier effects, such as through the involvement of stakeholders in "different forms of dialogue and partnerships" and "effective channels of communication"' (2012, p. 17).

Based upon the experience of *Österreich forscht* and other citizen science platforms in Europe, external communication from citizen science platforms is usually aimed at four different target groups: (1) people who want to participate in a project without necessarily having a scientific background; (2) people who are conducting a citizen science project or planning one (e.g. scientists); (3) science

journalists; and (4) policymakers and authorities. These four target groups differ significantly in the *communication channel* that should be chosen to reach them.

***Target Group 1*** People outside the scientific community are usually the most difficult to reach for citizen science platforms because the so-called general public is very diverse. Therefore, a mix of communication channels has proven its worth here. A large part of the population aged 40 years and above is still reached preferably via *traditional media* such as newspapers, magazines, television, and radio. People younger than 25 can mainly be reached via *social media*. People between 25 and 40 can be reached by various channels. In general, the citizen science platform's *website* is the central hub for citizen science projects and activities and should be designed using plain and understandable language to present projects and citizen science activities.

***Target Group 2*** To reach this group of people, *personal communication* has proved particularly effective. At conferences and networking events, people belonging to this target group can learn about the different methods and ask questions directly. Personal contact was particularly important for *Österreich forscht*, as a certain amount of trust had to be built up with project leaders so they would join a fledgling platform. Project leaders can also be reached very easily via *Twitter*. Here, however, attention must be paid to the chosen language. If the communication is mainly in the respective national language, the platform will be perceived as less international. On the other hand, the respective national language can provide for a national community with information more effectively than by using English.

***Target Group 3*** For science journalists, the first entry point is usually the website. If the information here is well prepared, it is already a good basis for further communication. Journalists are always on the lookout for a new story. Therefore, the website should include specific contact details where platform coordinators can be reached for interviews. The platform coordinators should therefore have a good overview of current developments in the projects listed on the platform in order to be able to provide information quickly and competently and to connect to the right people.

***Target Group 4*** For policymakers, public administrations, and other authorities, it is important to obtain up-to-date information with clear policy relevance. Information from citizen science platforms can either contribute to establishing contact between a specific project/citizen scientists(s) and the target group or to obtain information on ongoing activities with sociopolitical relevance for the respective area. Citizen scientists can use the information about the citizen science platform to approach policymakers and authorities, emphasising the relevance of both citizen engagement and citizen science for their community.

Moreover, social media in general have a high potential for spreading project ideas and receiving attention by a wide audience (Giuliana 2017). Media can be approached actively, by promoting specific citizen science initiatives in different contexts, for example, if there has been much attention on water quality of a special

lake, one could actively promote citizen science and citizen science projects where citizen scientists examine water quality and report back through an app. Robson (2012) investigates how *social networks* can be used for recruitment and promotion of a citizen science projects. Her results are based on a series of campaigns promoting the citizen science platform Creek Watch, including a participation campaign through local organisations, and a social networking campaign through a *Facebook* page and Twitter account. She concludes that social media campaigns represent a worthwhile method to increase the awareness of a project and reach participation goals.

## *Maintenance of Platforms*

The maintenance of the citizen science platform can be a challenge even if funding is secured. Based on communication with national citizen science platforms operators, it seems to be challenging to keep the platform updated and to engage people to contribute to projects and other content on the platforms. The amount of citizen science projects is continuously increasing, and it requires quite some work to get an overview over ongoing activities and expand platform content. Here, it helps to have a national citizen science network where members can contribute with citizen science projects and content/news to the platform. However, it is also a challenge to motivate the network members to contribute. Transparency, two-way communication, and a *do-ocracy* approach[9] proved to be key elements in *Österreich forscht* involving members in the maintenance and regular update of citizen science platform. The literature on platforms indicates that the more developers and users contribute to a platform, the more others will also want to affiliate and contribute (Weber 2012; Ansell and Gash 2018).

Quality is another challenging issue. Ideally, platforms promote value-creating collaborations, which then feedback to motivate wider participation (Nederlof et al. 2011; Ansell and Gash 2018). To make a citizen science platform as useful as possible, both the citizen science projects and activities it displays, but also the additional materials available on the platform – such as information about citizen science, information about how to start a citizen science project, as well as information on ethical or juridical issues (Lynn et al. 2019) – need a certain level of quality (Heigl et al. 2018a, b). In addition, communication about the citizen science platform must also be of good quality to ensure consistent information uptake. Professional support could be the solution for these issues. Platforms strive to provide a stable and structured framework in which more dynamic and adaptable processes can evolve (Ansell and Gash 2018).

[9] https://communitywiki.org/wiki/DoOcracy

## Conclusions

The rapid developments within citizen science in the last decade have resulted in the need for infrastructures to support citizen science activities. Progress in technologies means that most citizen science activities require Internet access and probably the use of smartphone apps for data collection and upload, information access, data processing and visualisation, and the communication of ideas and results. This requires stable and effective infrastructures with easy access – offered by citizen science platforms. Citizen science platforms can catalyse and foster stakeholders' collaborations and facilitate citizen engagement.

In this chapter, we have described different types of citizen science platforms, their characteristics, and challenges. Citizen science platforms seem to be a useful concept especially for national citizen science networks to display citizen science activities and useful information in their local language. Citizen science platforms have the potential to make science more visible and accessible to interested citizens but can go beyond pure provision of information. National citizen science platforms can be used to provide local, regional, and national authorities with necessary data and information on key (emerging) topics on national (and international) agendas. Citizen science platforms are also suitable for scientists to collect more data on citizen science and to conduct research on citizen science and for interested citizens to develop, lead, contribute, or participate in citizen science projects. Citizen science platforms tend to operate in a context of distributed citizen science activities, which means they can serve as an umbrella for many diverse citizen science activities and stakeholders and produce positive feedback effects by bringing together stakeholders with synergistic knowledge, skills, resources, and perspectives. Citizen science platforms also promote integration by creating interfaces that integrate diverse citizen science activities into an interacting system. Further, as a *meeting point* and *exchange hub* of citizen scientists, citizen science platforms have great potential to facilitate the maintaining, further implementation, and development of citizen science methodologies in similar citizen science initiatives.

It is not possible to predict how long the concept of citizen science platforms will succeed, but those involved must (1) ensure the technical components are always state of the art, (2) associate platforms with information and communication technology, and (3) keep a certain openness and flexibility in place to adjust quickly to the needs of citizen science and technology. Future development needs of the citizen science platforms should be focusing on (1) more collaborative types of platforms which facilitate multiple, ongoing stakeholder collaboration; (2) a more human-centred conception of platforms, providing useful data and information to reach a wider audience of end users; and (3) striving to provide a stable and structured framework and methodologies and act in a strategic manner, in which more dynamic and adaptable processes can evolve.

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