ECSA's characteristics of citizen science

Introduction

Citizen science is a common name for a wide range of activities and practices. It is possible to understand it by considering the characteristics of those activities and practices, which are described in this document. These are found in different scientific disciplines – from the natural sciences to the social sciences and the humanities – and within each discipline, the interpretation of citizen science can be slightly different. Yet despite these differences, citizen science is an emerging area of research and practice, with evolving standards on which different stakeholders are developing methodologies, theories and techniques. It is, therefore, useful to establish some level of shared understanding, across disciplines and practices, as to what to expect from an activity or a project that is set out to be a citizen science one.

There is little doubt that a project with an open call to a wide range of volunteers to take part in either data collection or data analysis of a clearly defined research hypothesis will be recognised as citizen science. However, this is only one type within a large set of activities, practices and forms of participation, resulting in diverging views about what is – and isn't – citizen science. Because of these differences in disciplinary and cultural contexts, attempting to define a universal set of rules for exclusion or inclusion is difficult, and might even limit the advancement of the field.

Instead, this document attempts to represent a wide range of opinions in an inclusive way, to allow for different types of projects and programmes, where context-specific criteria can be set. The characteristics outlined below are based on views expressed by researchers, practitioners, public officials and the wider public. Our aim is to identify the characteristics that should be considered when setting such criteria (e.g. a funding scheme), and we call upon readers to determine which subset of these characteristics is relevant to their own specific context and aims.

These characteristics build on (and refer to) the ECSA 10 principles of citizen science[1] ("the 10 principles") as a summary of best practice – and projects are expected to engage meaningfully with them. Where it is especially pertinent, we refer to them in the characteristics below.

The rest of the document covers the characteristics of citizen science under five sections: (1) core concepts; (2) disciplinary aspects; (3) leadership and participation; (4) financial aspects; and (5) data and knowledge. Further explanation and background are provided in the 'ECSA's characteristics of citizen science: explanation notes' document. Note that we use the terms 'scientific research' and 'research' interchangeably – and we explain these terms from the perspective of citizen science practices.

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1 See ECSA (2015) 'Ten principles of citizen science', DOI:10.14324/111.9781787352339

1. Core concepts

Science and research. Citizen science practices cross disciplinary boundaries: some belong to fields widely acknowledged as scientific research, while others fall under the general term 'research', especially in the arts and humanities. Citizen science can describe many of these activities, especially when they comply with the 10 principles. We use 'scientific research' to refer to research in the sciences, the social sciences, the humanities and the arts.

What counts as scientific research? In common with research practice in general, citizen science can address a topic that is basic or applied, inductive or deductive, local or global. In specific contexts, it is appropriate to identify a subset of activities (to explicitly include environmental monitoring, or focus on hypothesis-driven research). To ensure rigour, the research should aim to follow protocols and practices in line with the disciplines within which the research is framed.

Intention and framing. In many fields, but particularly the medical and health sciences and the social sciences, there is a subtle difference between citizen science activities and traditional practices that view participants as subjects of research, or as participants in a survey or workshop. Therefore, the decision to call an activity citizen science should include an articulation of which aspects justify this, for example by referencing the 10 principles.

Hypothesis-driven research, monitoring, inductive and exploratory and scientific database creation. Research involving citizen science can take many forms, and the roles of the participants can include, for example: identifying a research question; collecting or analysing data to support or refute a hypothesis; monitoring environmental or health conditions for management or policy outcomes; and the creation of generic data within a domain to support a wide range of research questions (such as digitising art collections, observations or mapping). Activities can also include inductive and exploratory approaches that are based on qualitative knowledge production. In a citizen science project, it can be appropriate to focus exclusively on some of these activities (e.g. only hypothesis-driven) in specific contexts, for example when this is required by funding agencies.

Roles and responsibilities. In citizen science, there are contexts in which it is appropriate for citizens, scientists and other project stakeholders to be considered as equal partners in the research process, and cases where the appropriate contribution is limited to data collection or providing resources. Contributors need to be aware of the act of participation, with the deliberate intention of being involved in the project. Transparency regarding the different roles and expectations in the process is recommended, and participants should be made aware that they are contributing to research. This is especially important if participants are only taking over small or micro-tasks that require little engagement, but the overall contribution to a clearly defined scientific process or research is important.

Subject or participant? In some disciplines, such as the medical and social sciences, the shift from being a research subject to becoming an active researcher should be made clear. The nature of

such studies means it is common that citizens themselves, their behaviours, challenges and health issues are under examination. But citizens can also take an active role in, and even initiate, the above activities. It is possible that the people who take part in such projects can be subjects and participants at the same time, depending on the intentions and framing of the research.

Ethics. The aims and intentions of citizen science projects and the research they involve should be communicated clearly and openly with participants and other stakeholders. If involvement is consensual and fully understood by participants, it may be considered citizen science. Special attention needs to be paid to transparency in community- or self-initiated projects that operate outside organisational ethical practices. In any case, all actors must adhere to a code of research integrity and quality issues when they participate in a research project.

2. Disciplinary aspects

Disciplinary views. Citizen science is applicable across all scientific disciplines, alongside a variety of disciplinary traditions and research methods. While it is well embedded within ecological, meteorological and astronomical research, there are many areas of natural sciences and engineering that are yet to develop an approach for citizen science activities. Within these **scientific and technological** disciplines, there is a need to take into account methodological practices, standards and conventions when designing citizen science activities.

However, special attention must be paid in several areas. In the **arts and humanities**, the research approach, problem formulation and methods of data gathering and interpretation can differ from natural sciences, and it is important to acknowledge this variety. In the **social sciences,** participatory forms of citizens' engagement have been used extensively. For example, participatory action research and related practices make it difficult to draw a clear line between these practices and citizen science. Any research that is framed as citizen science is likely to be explicit about how it needs to be assessed as such (e.g. by using the 10 principles), and should consider how participants are moving beyond being subjects of the research.

Medical sciences and human health. Projects investigating human health (physical or mental) can present different challenges to assess as citizen science, due to their varying levels of active engagement, the purpose of knowledge production, data sharing, the level of expertise required to assess medical information, and the involvement of commercial activities. In such cases, the organisational context needs to be considered: the same activity (e.g. a trial of an intervention) can be done by a hospital or a commercial actor, and therefore be assessed differently. While in other domains, sharing personal data is sometimes problematic, in the health domain it is almost a prerequisite to participation.

3. Leadership and participation

Individual project, community-led project and researcher-led project. Citizen science projects can be led by researchers or scientists, or can be led collaboratively by a community to address a particular issue. Projects can also be run by an individual, who will carry out the whole project alone. All are potentially consistent with citizen science, and the decision on each project can be made by examining its context and practices.

Research-performing organisations, public bodies and institutions, non-governmental organisations. Citizen science initiatives can be supported and run by different types of organisations. While commercial activities need special attention, activities that are run by public bodies (e.g. environmental monitoring) and non-governmental organisations (e.g. health charities) could be part of citizen science, and it is not mandatory to include professional scientists or research-performing organisations.

Commercial activities. If a direct commercial benefit is the main aim of an activity, and of results from the use of data (e.g. via paid data services for the sole personal benefit of the person who shares the data and further commercial use beyond services for the data provider), it is generally not considered as citizen science. This also applies if motives for activities are perceived solely to support a marketing or business strategy, rather than supporting a unique research goal and a justified involvement of citizens. However, commercial activities that are in line with the 10 principles and are transparent could still be considered as citizen science.

Degree of engagement. Active engagement that requires citizens' cognitive attention during participation in the research process is favoured over limited interaction. It is also preferable to engage citizens in several phases of the research process. Minimal participation, for example volunteers sharing computing resources or social media habits without actively engaging in the research itself, or downloading an app that automatically collects data for scientific purposes, could still be considered as citizen science under certain conditions. Examples include when a project actively aligns with the 10 principles, or supports the production of scientific results that would not have been possible without the informed decision of volunteers to contribute.

Small scale vs large scale. Citizen science projects can include a single person carrying out a research project and publicly sharing their knowledge on a non-traditional platform (e.g. a blog) while adhering to scientific standards (e.g. peer review). It can also consist of a small group of participants, or be open to large-scale participation in various phases of the research process. Projects may aim to achieve large-scale participation, or to contribute significantly to knowledge through personal effort, depending on the context and the discipline. Depending on the aim of the project, all scales could be considered as citizen science.

Professionalism vs volunteerism. When citizen science is understood as a collaboration between professional and volunteer scientists, the question arises: what is 'professional' and what is

'voluntary'? The interpretation of these terms varies widely and depends on context, culture and the field of enquiry. It includes aspects such as professional skill sets, remuneration and timescales of involvement. For example, volunteers with a scientific background or professional scientific role in other capacities can still be volunteers when they apply their skills in their free time. They can engage in scientific activities full time and still be understood as volunteers under certain conditions (e.g. when the effort is beyond their professional roles).

Science engagement and science education. Citizen science projects can have educational outcomes for participants involved in various phases of the research process. Intended learning outcomes for participants are a favourable aspect in citizen science. However, for a project to be classified as citizen science, educational goals or science engagement/outreach should not be the only focus, to ensure they are aligned with the research goals. Hence, achieving higher awareness of and engagement with scientific processes can be one aim (intentional or unintentional) of citizen science projects – but should not be the main aim.

Links to decision-making. Citizen science projects may include an intervention into the current state of affairs, such as local decision-making. This might happen in activities that fall under banners such as participatory action research, community science or addressing environmental injustice. Concerns over motivational bias in the project results can emerge in such cases, and it is recommended to pay attention to the implementation and documentation of the relevant disciplinary standards to demonstrate rigour.

4. Financial aspects

Financial support for scientific research. Pure financial support to a project, such as crowdfunding, subscription fees and donations, is not considered citizen science, as no participation in any phase of the scientific research takes place. Careful consideration of the consistency with citizen science should be made if the financial contribution is a prerequisite to a form of participation in the scientific research phase of the project.

Payment to take part in a project. Requesting financial contributions from citizens to participate in a project, for example to finance data-measurement kits, can be consistent with citizen science. But consideration should be made as to how this may affect social inclusion (e.g. excluding poorer participants) and bias participation.

Incentives to participate in an activity. Projects that incentivise participants can qualify as citizen science, but this is dependent on the context and form of relationship between project leaders and participants. Incentives could take different forms, such as small payments in crowdsourcing activities, or providing bikes to facilitate mobility in a place with high deprivation. However, the type or amount of the incentive should be taken into account before considering its consistency with citizen science. Acceptance of incentives/payments to participants in the citizen science context depends on the culture/country and the social/economic status of participants.

5. Data and knowledge

Data and knowledge generation. Citizen science, scientific, academic and policy-oriented research can include different forms of data and knowledge generation, including novel data generation, creation of new analyses, or production of new knowledge in written and other forms. The knowledge produced in such projects should aspire to disciplinary standards, such as appropriate data quality and quality assurance, the peer review of project publications and materials, or policy-relevant evidence that is fit for decision-making.

Data ownership and use. Citizen science is commonly perceived and placed within the open science domain, such as by complying with open data-sharing, open access publications and full transparency of data ownership. However, there may be cases in which data use is limited to certain stakeholder groups, outcomes are not made public, or publications generated are not open access, particularly with regards to privacy concerns. It is preferable for participants to own the data they generate, and they should be made fully aware of why, when and how it is used by others.

Data quality. Citizen science raises questions about data quality, which can be addressed in a range of ways, such as well-developed protocols, good design of the task to fit the purpose, and good participant support. Similar to research activities generally, data quality is a key aspect that warrants attention throughout the entire process of knowledge production.

Local and lay knowledge-sharing and application. Citizen involvement in producing and interpreting data gathered locally by community members, to raise local awareness and action, is a common model of citizen science. The active participation of professional scientists or researchers, and the sharing of results outside the local community, are not mandatory, as long as the project adheres to established research principles and practices.

Opportunistic vs systematic data collection. Different scientific research projects can use and benefit from datasets with a wide variety of characteristics. Some analyses need a systematic and rigorously created dataset, while in others, opportunistic or partial information is fit for purpose. Citizen science can contribute to both. The project's specific context, research aims and disciplinary practices will determine where activities fall on the spectrum of opportunistic to systematic data collection.

The use of **digital data-collection tools** in the medical and social sciences can be seen as a social survey or as participatory data collection, and therefore part of citizen science. The intention and framing of the project, as well as adherence to the 10 principles, can help in deciding if such use is a citizen science activity.

Sharing personal and medical data. In the medical and social sciences, the boundaries of citizen science and data-collection practices can be challenging. Sharing personal and medical data can be part of citizen science, but this depends on the framing and intention of the project, and on a consideration of whether those taking part are subjects of research or participants who are shaping and carrying out different stages of the project. The inclusion of practices that are in line with the 10 principles can assist in establishing this.