Research Ideas and Outcomes 8: e97122
doi: 10.3897/rio.8.e97122



Guidelines

# Guidelines for Research Ethics and Research Integrity in Citizen Science

Eglė Ozolinčiūtė‡, William Bülow§, Sonja Bjelobaba§, Inga Gaižauskaitė|, Veronika Krásničan¶, Dita Henek Dlabolová¶, Julija Umbrasaitė‡

‡ Office of the Ombudsperson for Academic Ethics and Procedures, Vilnius, Lithuania
§ Uppsala University, Uppsala, Sweden
| Lithuanian Centre for Social Sciences, Vilnius, Lithuania
¶ Mendel University in Brno, Brno, Czech Republic

Corresponding author: Eglė Ozolinčiūtė (egle.ozolinciute@etikostarnyba.lt)

Reviewable v 1

Received: 03 Nov 2022 | Published: 30 Nov 2022

Citation: Ozolinčiūtė E, Bülow W, Bjelobaba S, Gaižauskaitė I, Krásničan V, Dlabolová DH, Umbrasaitė J (2022) Guidelines for Research Ethics and Research Integrity in Citizen Science. Research Ideas and Outcomes 8: e97122. https://doi.org/10.3897/rio.8.e97122

## Abstract

Students and researchers might have diverse ideas about and motivations for citizen science (CS) projects. To prevent uncertainty, we address ethical concerns emerging in CS projects and in CS in general, specifically, the transferability of the ethical skills and knowledge gained within academia (e.g. through studying and research conduct). We dedicate these Guidelines for Research Ethics and Research Integrity in Citizen Science primarily to Masters and Doctoral students and their supervisors, to facilitate CS-related research activities (i.e. mainstream CS) in line with the values of academic integrity. Using a pool of 85 papers, we identified nine topics covering 22 customised guidelines and supplemented them with further readings to build more in-depth knowledge.

## Keywords

citizen science, citizen scientist, mainstream citizen science, academic integrity, research integrity, student, supervisor

## Glossary

**Citizen scientists**

Citizen scientists (interchangeable with volunteers, lay-people, citizens, amateurs, the public etc.) are primarily co-researchers and sometimes research subjects who, in collaboration with professional researchers, engage in scientific activities in various ways (e.g. data collection, data aggregation and data analysis) to generate genuine outcomes, such as new scientific knowledge, societal impacts and policy change.

**Extreme citizen science**

Extreme citizen science is a bottom–up approach in which citizen scientists get involved in citizen science at their discretion and determine in what stages of exploration they will be involved (adaptation of the definition of extreme citizen science of Haklay 2013).

**Mainstream citizen science**

Mainstream citizen science is a top–down approach in which citizen scientists co-research with professional researchers in citizen science projects led by professional researchers.

**Professional researchers**

Professional researchers are individuals with relevant scientific educational backgrounds who enquire deeply and intensively in specific fields to learn and generate new knowledge, develop theories and explain processes with real-world applications.

**Research subjects**

Research subjects are individuals about whom data are gathered through observation, interaction, intervention or other forms of enquiry.

## Introduction

### Relevance

The overall purpose of these Guidelines for Research Ethics and Research Integrity in Citizen Science (henceforth, Guidelines) is to facilitate and improve the ethical implementation of citizen science (CS) projects in the European Union context, aiming to address the issues that are crucial for implementing ethical CS in Europe. The target audience is primarily Masters students, Doctoral students and their supervisors as professional researchers, although long-standing citizen scientists might also benefit from reading these Guidelines.

CS is a prevalent approach in a growing number of research fields, such as natural sciences, technological sciences, social sciences, humanities and medicine. It includes a wide range of types of projects in which citizens not only are research subjects, but actively

contribute to research as co-researchers, for instance, by collecting environmental data in their communities, contributing medical data to research projects or helping identify how proteins are folded by playing games (for discussion of these and other examples, see Rasmussen 2021). Citizens may sometimes also take an even more active role beyond that of collecting data by contributing to the study design and the formulation of relevant research questions (Resnik et al. 2015). What distinguishes many of these types of projects is their collective nature and their disposition towards more inclusive and democratised science.

For further discussion of how the definition of CS has evolved over time, see Haklay et al. (2021).

When implementing any scientific project, one needs to consider the ethical values that are the cornerstones of every activity undertaken in academia. It is expected within the academic community that anyone involved in research and higher education should uphold the fundamental values of academic integrity: honesty, trust, fairness, respect, responsibility and courage (ICAI 2021). Similarly, the European Citizen Science Association (ECSA) states that ethical issues are inevitable in any research and that it is primarily the responsibility of those who lead CS projects to act in accordance with good research ethical practice (ECSA 2015). However, there is a lack of formal guidance entirely dedicated to ethical issues in the CS area. The present Guidelines provide guidance on addressing ethical issues in CS, with the aim of creating a bridge between academic integrity and research ethics, on one hand and CS ethics, on the other. In doing so, opportunities for transferring ethical knowledge between these fields are highlighted.

There are many guidelines for research ethics and research integrity, such as the Helsinki Declaration (World Medical Association 2013) and the International Ethical Guidelines for Health-related Research Involving Humans (Council for International Organizations of Medical Sciences 2016). These guidelines are dedicated to studies involving humans as research subjects; however, there is a paucity of guidance on how to conduct research with citizens as co-researchers. For instance, some guidelines related to CS research activities are helpful for implementing CS projects in practice. Such guidelines, for example, *Citizen Science at Universities: Trends, Guidelines and Recommendations developed by the League of European Research Universities* (Wyler et al. 2016), are prescribed for researchers, institutions, funding organisations and CS organisations. ECSA environmental guidelines help maintain an ecological mindset (ECSA 2020). Other guidelines – some yet to appear – are more dedicated to country-specific CS cases and activities (e.g. Guidelines for the Development of CS in Italy; DITOs Consortium 2019), while platforms for German-speaking countries, such as Österreich forscht, may offer specific documents on quality criteria for CS that also embrace ethical issues (Österreich forscht 2020). Some authors distinguish between two main types of guidelines in CS according to their profile: the first type covers “those that refer to general aspects of CS”, such as “lessons learned”; the second type covers specific CS projects (García et al. 2021). Both types of guidelines may include some topics or subtopics related to ethical issues. For instance, the first type of guidelines highlights intellectual property rights, for example, *Best Practices for Managing Intellectual Property Rights in Citizen Science: A Guide for Researchers and Citizen*

*Scientists* (Scassa and Chung 2015). The second type, more orientated towards specific projects, may also cover ethics topics, for example, the Debian Code of Conduct (The Debian Project 2014).

Nevertheless, none of the above guidelines is entirely devoted to ethical issues in CS and neither moral conflicts nor dilemmas are widely discussed in them. Yet involving the public in research raises different ethical challenges from those arising in traditional forms of research. This is most evident when it comes to data management, privacy and confidentiality, ownership of data, intellectual property, informed consent, conflict of interest, power balances and how to prevent various forms of research misconduct (Resnik et al. 2015, Storksdieck et al. 2016, Wyler et al. 2016, Makuch and Acxel 2018, Wyler and Haklay 2018, Eleta et al. 2019, Lynn et al. 2019, Patrick-Lake and Goldsack 2019, Rasmussen 2019, Roy and Edwards 2019, Balázs et al. 2021, Tauginienė et al. 2021). Addressing these issues in the context of CS is important in order to promote and maintain public trust in such research. To achieve this aim, the favourable approach, in this case, is one that emphasises inclusion and collaboration amongst all those involved in CS projects (Resnik et al. 2015, Rasmussen 2016, Wiggins and Wilbanks 2019). Moreover, considering the need to fill in the "ethics gap" (Rasmussen 2016, Wiggins and Wilbanks 2019) or "ethics void" (Patrick-Lake and Goldsack 2019) and to explore the transferability of the ethical skills and knowledge gained in academia (e.g. through research conduct) to CS activities, we developed the present Guidelines to address existing and emerging ethical issues. This guidance document is intended to help apply the above-mentioned values of academic integrity in the implementation of CS activities and should be valuable, especially for the specified target groups.

## Outline of the Guidelines

We structured our Guidelines into three sections: Introduction, Methodological Approach and Guidelines. The Introduction briefly introduces the reader to the relevance of discussing research ethics and research integrity in CS. The Methodological Approach section presents the steps used in desk research during the literature review and how the main topics were selected. Finally, the Guidelines section explores the most relevant topics in the field in more detail. The reference list is provided in a separate section, while suggestions for further reading are provided next to each topic.

The Guidelines have been developed as part of the project "Bridging Integrity in Higher Education, Business and Society" (BRIDGE, 2020-1-SE01-KA203-077973). BRIDGE aims to create linkages of intersectoral integrity by deepening our understanding of integrity in higher education, business and society and by providing relevant skills needed to act in accordance with the values of academic integrity.

# Methodological approach

## Selection of the Topics

At the initial stage, the project team reviewed the scientific literature about linkages between academic integrity and CS using various international databases (*N* = 277) accessible from Uppsala University Library. The first search was made on 12–25 March 2021. Initially, search filters were used, such as language (only English), title (Booleans, such as “academic integrity AND citizen science”, “academic ethics AND citizen science”, “research integrity AND citizen science”, “research ethics AND citizen science”) and type of content (only full-text peer-reviewed publications). That search resulted in 0 items. The further search was, therefore, broadened to include these terms in all fields and to target only open-access publications (Table 1). This search resulted in 421 records, which were scrutinised according to the indication of relevance in the database search and through reading abstracts; 144 records were selected for potential full-text reading.

Table 1.

Search data.

| Search Booleans | No. of records (databases; all fields) | No. of relevant records (databases) |
|---|---|---|
| “research ethics” AND “citizen science” | 351 | 144 |
| “research integrity” AND “citizen science” | 66 | |
| “academic integrity” AND “citizen science” | 4 | |
| “academic ethics” AND “citizen science” | 0 | |
| Total | 421 | |

Later, on 16–17 August 2021, we continued our search using “citizen science ethics” in an independent Boolean search, resulting in an additional 24 records. Overall, the collection of sources consisted of 168 records, which were proportionally divided amongst the team members. The team members were requested to read the full-text sources, identifying the relevant topics and ethical issues of concern and marking the relevance of the sources to the Guidelines (Table 2).

Table 2.

An example of a source’s scrutiny.

| Source reference | Focus of a paper | Key aspects for ethics in CS | Additional notes |
|---|---|---|---|
| Makuch and Acxel (2018) | Article addresses the issues of children participation in CS projects. | Issues: Data quality. Ethical protocols for working with young children (p. 406). | n/a |

In this stage, we evaluated the relevance of the papers to the Guidelines and selected only those sources that appeared to be the most relevant; accordingly, 85 sources were selected (Fig. 1). All sources were carefully perused and the information about possible topics was used in suggesting topics relevant to the Guidelines (Table 3).

Table 3.

An example of categorised possible critical issues for the Guidelines.

| Guideline's topics (critical issues to be considered) | Source |
|---|---|
| **PRIVACY AND CONFIDENTIALITY** | |
| Privacy and confidentiality | Cooper et al. (2019) |
| Details about handling personally identifiable data | Cooper et al. (2019) |
| **RELATIONSHIP/POWER BALANCE** | |
| Relationship between scientist and volunteer | Cooper et al. (2019) |
| Types of collaborations: community mapping and monitoring; community-based participatory research; interest group research | Resnik et al. (2015) |
| Power balance (scientist-volunteer) | Cooper et al. (2019) |

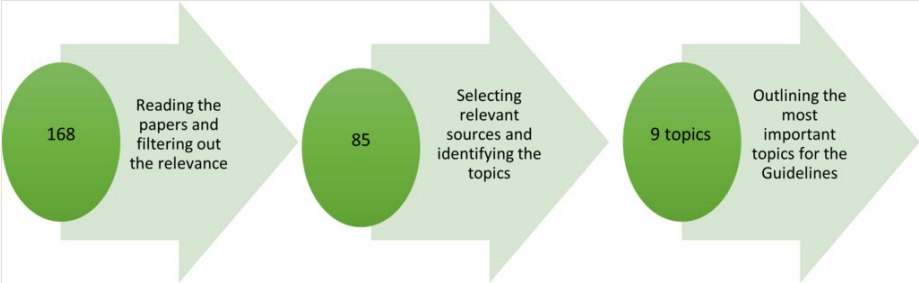


Figure 1. doi

The process of selecting the sources to outline critical topics for the Guidelines.

Eight topics were preselected for further discussion amongst the project members: Common Ethical/Moral Concerns; Privacy and Confidentiality; Relationships/Power Imbalances; Intellectual Property/Data Ownership; Informed Consent; Quality of Data/Data Governance; Conflict of Interest; and Institutional Oversight Process (and platforms). During the discussion, the list was extended to 10 topics to be used as part of the Guidelines structure: Responsible Conduct in Research; Common Ethical/Theoretical Issues; Privacy and Confidentiality; Power Balances; Intellectual Property; Informed Consent; Data; Avoiding Conflicts of Interest; Institutional Oversight Process; and Technological Issues. Additionally, experts in CS from partner countries were invited to complete a survey identifying topics relevant to ethics in CS (Appendix 1, part A). Four

external experts contributed by identifying several issues, for example, inequality, issues of invisibility and displacement of outsiders, informed consent, ethics of citing sources, public participation, ethics of not modifying data and power imbalances.

Overall, the contributions of the project team members and experts helped to create the final list of the nine most relevant topics in the Guidelines (Fig. 1): Institutional Oversight; Power Balances; Conflict of Interest; Informed Consent; Privacy and Confidentiality; Use of Technology; Data Management and Verification of Findings; Intellectual Property; and Ethical Publishing. After the topic selection, readings in CS ethics, research integrity and academic integrity were repeatedly done.

Furthermore, feedback was gathered in a workshop at the European Conference on Academic Integrity and Plagiarism 2022 (Porto, May 2022), a seminar at the Centre for Research Ethics & Bioethics, Uppsala University (Uppsala, May 2022) and during three days of learning, teaching and training events in Vilnius with representatives of all three target groups (May 2022). At the workshop of the European Conference on Academic Integrity and Plagiarism 2022, three topics of the Guidelines (i.e. Informed Consent, Privacy and Confidentiality and Power Balances) were introduced in detail. Attendees of the workshops at the learning, teaching and training events in Vilnius independently outlined the same topics as did the authors of the Guidelines, in this way, confirming their relevance. Attendees of the seminar at the Centre for Research Ethics & Bioethics, Uppsala University, read the draft of the Guidelines and provided valuable comments for their further improvement.

### Limitations of the Guidelines

As the target groups of these Guidelines are Masters students, Doctoral students and their supervisors, our main limitation is that the Guidelines focus on mainstream citizen scientists. These Guidelines are not designed to be applied to extreme citizen scientists due to the missing institutional component. Another limitation relates to web-based links: although all cited web-based links were valid at the time the Guidelines were completed in 2021–2022, with time, some links may have expired and others may only be available once cookies are accepted.

## Guidelines

### Instructions for readers

We provide 22 guidelines. Each guideline refers to a particular topic that is explained in more detail and supported by evidence. To obtain in-depth knowledge of the topic, we strongly suggest that readers, namely, professional researchers as our primary target group, read the references and, where relevant, undertake further reading.

## Institutional Oversight

Guideline #1

*CS research that involves human subjects should undergo ethical review. This also includes CS research that involves personally-identifiable information*.

Guideline #2

*CS research should be considered on a country-by-country basis and in legal terms*.

Various ethical and legal standards that outline ethical principles for research with human subjects emphasise the need for an institutional review board (IRB) or other independent external oversight body, stressing that the research protocol must be submitted for consideration by an ethics committee (interchangeable with IRB) before the study begins (e.g. World Medical Association 2000). This is also applicable to CS projects that involve humans, not only as co-researchers, but also as research subjects. In these cases, the responsibility to obtain ethical approval should be assumed by professional researchers. As stated in the Declaration of Helsinki, the ethics committee in this case must be independent of the researchers, the sponsors or other undue interference. Such a committee should also take into consideration the laws and regulations of the country or countries where the research will be conducted (World Medical Association 2000). While historically associated with the medical sciences, it is now frequently acknowledged that social sciences and humanities should also undergo independent ethical reviews of the sort proposed in the Helsinki Declaration (Jennings 2012, Hunter 2018, Hansson 2020).

Although the details of specific systems for ethical review (oversight) vary between countries, the aim of any such system for regulating human subject research is to protect the rights and well-being of research subjects (Emanuel et al. 2000, Cooper et al. 2019) and co-researchers.

Cooper et al. (2019) voiced some scepticism concerning expanding the current practice of IRBs to include not only research with traditional human subjects, but also the types of CS projects in which citizen scientists participate in research by providing personally-identifiable information, such as observations, photos, sensor data and geolocation data. Ethical reviews should include a data management plan covering the following topics: general information, data description (e.g. what will be collected and reused), documentation, data quality (e.g. how data reliability and validity will be ensured), data storage and backup during the research process, data sharing and long-term preservation (e.g. what data will be open), data management responsibilities etc. The FAIR (i.e. findable, accessible, interoperable, reusable) principles are to be considered in the data handling and data management plan (Science Europe 2021). Given the sensitivity of personally-identifiable information in CS projects, IRBs should be more attentive to the different conditions of various CS projects.

For further information on this topic, we recommend reading the works of Haklay (2018), Rasmussen and Cooper (2019) and Rasmussen (2021).

## Power Balances

Guideline #1

*Expectations and characteristics of citizen scientists should be taken into account*.

Guideline #2

*CS research should involve inclusive dialogue between professional researchers and citizen scientists*.

It is frequently noted that a range of power imbalances within CS projects may result in the exploitation and instrumentalisation of citizen scientists and in related tensions between professional researchers and citizen scientists (Tauginienė et al. 2021). Unlike professional researchers, citizen scientists do not necessarily have the same or appropriate motivations and academic backgrounds, nor are they necessarily paid for their contributions to a CS project on the same basis as are professional researchers or given any credit for their contributions (Resnik et al. 2015, Ward-Fear et al. 2020, Rasmussen 2021, Tauginienė et al. 2021; see Ethical Publishing).

The fact that power imbalances of this sort exist within CS projects does not necessarily pose an ethical issue for citizen scientists. Some citizen scientists who choose to participate in CS might do so merely because they find it rewarding to engage in a scientific project, the specific project genuinely interests them or they believe that the project might help bring about change or influence various stakeholders, including professional researchers and policy-makers (regarding the latter, see Conflict of Interest). However, given these instances, there is a risk that professional researchers, either knowingly or accidentally, might sometimes exploit the goodwill of citizen scientists due to their different expectations about the CS project and its expected outputs (Resnik et al. 2015, Ward-Fear et al. 2020, Rasmussen 2021, Tauginienė et al. 2021). If citizen scientists do not feel that they are being treated fairly or with the type of respect owed to them as persons, this might jeopardise the CS project and undermine future collaboration (Ward-Fear et al. 2020). Additionally, inclusive language is paramount in ensuring smooth communication amongst professional researchers and citizen scientists, touching on matters of, for example, technological literacy, academic style and specific needs ( Rasmussen 2021, Tauginienė et al. 2021). Hence, it is important that professional researchers take proactive responsibility, acting preventatively to avoid the risk of exploiting or instrumentalising citizen scientists participating in CS projects.

Since CS projects differ, what represents an efficient number of citizen scientists per activity in a CS project should be considered. For example, in CS projects that involve a huge number of citizen scientists, it might be rather difficult to have smooth and inclusive dialogue, so structuring the activities and dividing citizen scientists into groups could be ways to ensure that their voices are heard.

In addition, the expectations of citizen scientists play a paramount role in the power balance. As suggested by Resnik et al. (2015), several key questions should be

considered: Why do the citizen scientists wish to contribute and what do they wish to gain from participating in the CS project? How do they wish to be credited and how do they wish to contribute to the CS project? How do they want the information about the CS project, as well as its data and results, to be disseminated? If the CS project results may bring benefits, how will the intellectual property rights concerning ownership of outputs (e.g. data, publications, patents and licensing) be handled? (see Intellectual Property). To ensure the evaluation and balancing of expectations, Eleta et al. (2019) proposed some solutions, for example, employing a facilitation model (i.e. establishing the role of facilitator in a CS project to enhance and support the collaborative link between professional scientists and citizen scientists) and relying strongly on principles of transparency and accountability when balancing the promises and expectations of the stakeholders. Recommended steps can be used as a guiding tool for designing an ethical CS project (see Eleta et al. 2019).

For further information on this topic, we recommend reading the works of Chesser et al. (2020) and Groot and Abma (2022).

## Conflict of Interest

Guideline #1

*All possible conflicts of interest should be disclosed and declared before the start of a CS project, during a CS project and/or afterwards*.

Professional researchers in any field of research may have financial, political or personal interests that sometimes conflict with their ethical and professional obligations as professional researchers (Shamoo and Resnik 2015). Such interests are potentially problematic as they might undermine objectivity and integrity in research. Meanwhile, in CS projects, conflicts of interest can refer to both professional researchers and citizen scientists. Depending on the nature of the CS project, citizen scientists may choose to participate out of curiosity, their commitment to a certain geographical area or because they want to learn more about the topic under investigation (Preece 2016, Rasmussen 2021). Citizen scientists might sometimes have a financial (e.g. have relationships with private, political or non-profit organisations sponsoring research) or non-financial (e.g. personal, political–ideological or environmental objectives) (Resnik et al. 2015, Roy and Edwards 2019) conflicts of interest due to lack of the knowledge and experience needed to properly address the ethical or legal issues in research (Emanuel et al. 2000).

Although established research ethical regulations seek to prevent known or anticipated risks, it is frequently recognised that these regulations are not always suitable or sufficient for CS projects (Rasmussen 2019, Roy and Edwards 2019, Rasmussen 2021). Therefore, there is a need for a new regulatory framework addressing research integrity and preventing or dealing with unethical behaviour in CS projects. It is crucial that professional researchers take responsibility for implementing certain measures in order to prevent unethical behaviour in a CS project. Citizen scientists might sometimes lack the appropriate background and might need additional training in how to handle research data

appropriately (see Data Management and Verification of Findings). The expectations and motivations of citizen scientists should be openly discussed and communicated; professional researchers should provide space for such discussion within the team (Shirk et al. 2012) and allow potential readers and/or end users of the research outcomes to make their own critical assessment (Resnik et al. 2015) and, in doing so, ensure public trust in CS projects.

Professional researchers with conflicting interests might be less careful and critical in their analysis of the data. If such conflicts arise, it is crucial that professional researchers openly declare them in any related publication (Shirk et al. 2012). Failure to disclose a conflict of interest could undermine public trust in research (Resnik et al. 2015) and transparency.

For further information on this topic, we recommend reading Chesser et al. (2020).

## Informed Consent

*Guideline #1*

*Whenever CS projects involve humans as citizen scientists and research subjects, informed consent should be obtained.*

*Guideline #2*

*In CS research, the appropriate protection of vulnerable groups must be ensured. Citizen scientists should benefit from knowledge, practices or interventions.*

*Guideline #3*

*It should be seriously considered what type of consent best fits CS.*

When a CS project involves humans as research subjects, citizen scientists should, with few exceptions, be informed about the research and their participation and be free to choose whether to consent or decline to participate in it. This is crucial in order to show proper respect to research subjects and their right to self-determination (World Medical Association 2013) and it also relates to human rights (e.g. human rights and the protection of human beings are issues on which ethics screening and the assessment of European research projects should focus).

Informed consent involves three criteria: the information criterion, voluntariness criterion and decision-making capacity criterion. In practice, this means that professional researchers should provide accurate and correct information to research subjects about what their participation involves, so that they can make an informed decision. This information should cover the aim and purpose of the study, research methodology, risks and benefits associated with participation, measures taken to protect their rights and integrity and the dissemination of results. The information provided should also be accessible and comprehensible to the research subjects (e.g. using appropriate style and avoiding technical terms). Research subjects should not experience any undue pressure or

coercion (real or perceived) to participate. There should also be an opportunity for research subjects to opt out of participation. Valid informed consent requires that those consenting have the relevant capacity to make informed decisions – for example, small children or people with certain health conditions lack the relevant capacity (Shamoo and Resnik 2015). Following the Helsinki Declaration, research that involves these or other vulnerable groups should be performed with due care for the health and well-being of those individuals participating in the study; members of the vulnerable group should be involved only if they are likely to benefit from this research and if it cannot be carried out in a non-vulnerable group (World Medical Association 2013, Council for International Organizations of Medical Sciences 2016).

CS projects may pose new and unique challenges when it comes to informed consent, since those participating in the research are not necessarily participating merely as research subjects, but also as co-researchers (Resnik et al. 2015, Tauginienė et al. 2021). In this case too, informed consent is required; however, different forms of consent need to be developed depending on the role of participants in a CS project. Acknowledging the networked structure of collaboration in CS and the fact that the choices of participants may evolve during the research process, dynamic informed consent has become a potential solution in CS projects (Eleta et al. 2019, Tauginienė et al. 2021). Dynamic informed consent allows each participant to select (e.g. via a GDPR-compliant online platform) what data s/he wants to provide and under what conditions (Eleta et al. 2019). However, such consent presumes repeated interaction and higher engagement requiring live iteration in order to maintain consent throughout the developing CS project (Tauginienė et al. 2021). Depending on the type of citizen involvement (e.g. see models of participation discussed by Shirk et al. 2012), it is advised to seriously consider what type of consent best fits a given CS project.

For further information on this topic, we recommend reading the documents of the European Commission (n.d.) and European Parliament (2016).

## Privacy and Confidentiality

*Guideline #1*

*Whenever a CS project involves humans as professional researchers or citizen scientists (active or passive providers of data), their privacy and confidentiality should be respected and assured.*

*Guideline #2*

*Professional researchers are obliged to inform citizen scientists of technical details concerning the collection and treatment of personal information.*

Privacy and confidentiality are amongst the key principles of research ethics whenever research involves humans as research subjects and/or citizen scientists. CS projects need to set up procedures securing the privacy and confidentiality of personal data and avoiding

the violation of citizen scientists' right to privacy. Although data privacy laws vary from country to country, they all require the protection of personal information (i.e. information that could allow the direct or indirect identification of a person). It is crucial that individuals' data should be collected, saved and stored in such a way that there is no opportunity to identify research subjects at any stage of the project or research (See et al. 2016). Clavell (cited by Eleta et al. (2019), p. 4) proposed three solutions to avoid privacy and data protection problems in CS projects:

(1) Create transparency, accountability and audit mechanisms, allowing others to verify that the stated policies are a clear reflection of actual data policies. (2) Determine what data can be released and under which conditions (anonymisation). (3) Require only minimal personal information about CS project participants, give sufficient notice of privacy options, provide users the option to hide some of their data and allow citizen users (i.e. research subjects) the possibility to modify and delete their data.

It is advised to uphold the principle of data minimisation (see, for example, European Data Protection Supervisor (n.d.)) for both personal and research data, limiting data collection to what is relevant and necessary to fulfil the purposes of a CS project.

Many ways to protect confidentiality can be used depending on the CS project design (e.g. encoding data, using pseudonyms or using anonymity in aggregate-only forms). In line with the General Data Protection Regulation, which focuses on data minimisation and protection, CS projects have to ensure that personal data and research data are kept separately. The storage of data has to be password protected (e.g. in institutional cloud storage and/or personalised institutional computers) and ensure limited access. Personal data should not be available to third parties. Potential privacy risks, terms of use of collected personal information and agreements about the timeline of the storage and erasure of the data during or after the CS project must be stated before the data collection process starts (Hecker et al. 2018b, Cooper et al. 2019).

Professional researchers have to ensure that all citizen scientists are aware of the privacy and confidentiality details of the CS project and agree to the terms and conditions of the research (see Informed Consent). The level of confidentiality to which the citizen scientists agree is an important aspect of CS projects. The research subjects have to know if their personally-identifiable data will be held fully confidentially or not confidentially (e.g. in case the citizen scientists agree that their participation in the CS project will be publicly acknowledged; Cooper et al. 2019).

Although scientific research as a default commonly presumes the (full) anonymity and confidentiality of data provided by research participants, there can be cases in which default settings might not be the desired solution or might even bring harm (e.g. participatory research on indigenous groups; Svalastog and Eriksson 2010). Therefore, it is suggested that CS projects should be careful about handling anonymity and confidentiality, rather than treating them as unquestioned norms.

Privacy and confidentiality are also related to the use of technology (e.g. mobile devices) for data collection and analysis in CS projects. Bowser et al. (2014) noted that these technologies “may be designed without privacy in mind” (p. 70) and can cause privacy and confidentiality issues for both citizen scientists and professional researchers. According to Eleta et al. (2019), developers of technological innovations to be used in CS projects should consider involving citizen collaborators in co-designing privacy parameters and applying “Privacy by Design” principles, putting the privacy of users first (i.e. the default settings presume the most restrictive privacy options, but enable users to make choices about data sharing). Technology used in CS projects involves a risk of violating the privacy of third parties. It is paramount to know that professional researchers are obliged to inform citizen scientists involved in the CS project of what personal information may be collected, how it is to be shared and what actions should be taken to prevent or limit potential misuse (Cooper et al. 2019).

Technology and privacy issues have been discussed by Bowser et al. (2014), who described the following scenario: A person with whom privacy issues have not been discussed may accidentally be captured in a photo during research. When the photo is linked to other information collected during the project and open access to it is provided, the situation may raise concerns about the privacy and confidentiality of identifiable personal data not only for the person in the photo, but also for the CS project team that did not ensure the privacy of this person. Such risks must be assessed in advance and according to procedures for dealing with privacy, which must be established (see Use of Technology).

Professional researchers should also recall that children could sometimes participate in some CS projects as citizen scientists (e.g. using apps to monitor trees by taking pictures of them). In such cases, professional researchers should take age into consideration and ensure that children under the age of 13 years are safeguarded by parents or teachers, to prevent their personal information from being shared in CS projects (Bowser et al. 2014).

For further information on this topic, we recommend reading the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data and repealing Directive 95/46/EC (General Data Protection Regulation [GDPR]) (https://eur-lex.europa.eu/eli/reg/2016/679/ojhttps://eur-lex.europa.eu/eli/reg/2016/679/oj).

## Use of Technology

*Guideline #1*

*Technical solutions that do not limit inclusiveness and are comprehensible and user friendly should be selected for CS projects.*

*Guideline #2*

*Professional researchers should ensure that all users are informed about the technological solutions used in the CS project and provided with proper technical support.*

*Guideline #3*

*Value trade-offs between usefulness and citizen scientists' privacy should be considered in advance.*

*Guideline #4*

*The selected technical solutions should be transparent to citizen scientists.*

Advances in technology have enabled citizens to make even more substantial contributions to science as citizen scientists (Newman et al. 2012, Ceccaroni et al. 2019). Emerging technologies have influenced the scientific research process by streamlining data collection, improving data management, automating quality control and expediting communication (Newman et al. 2012, Brenton et al. 2018). There are many technologies that help people collect, store, process, share, visualise and analyse data generated by citizen scientists, technologies such as: IT-based platforms, tools and services; mobile technologies; and Internet-based technologies. All these tools and technologies have influenced CS and, as a result, revolutionised how citizens and communities can participate in research (Mazumdar et al. 2018). These technologies also support social interactions between the organisation of citizen scientists and professional researchers, as well as interactions between citizen scientists and their communities (Mazumdar et al. 2018).

When using technology, it is important not only to focus on its benefits, but also to be aware of its potential risks (e.g. threats to privacy and inclusion) and to take actions to prevent them. The use of technology entails risks related to privacy, so proper data management is crucial (see Privacy and Confidentiality; Data Management and Verification of Findings).

Before selecting a technical solution, inclusiveness and non-discrimination should be carefully considered. For example, the technology should not exclude prospective citizen scientists due to its high price and should not be too complicated for some groups of citizen scientists, such as elderly people (Pagliari 2020). This consideration is crucial, especially in CS projects where the involvement of disadvantaged groups is expected.

Citizen scientists should be informed by professional researchers about the use of technology and provided with the necessary support and training. It is important to recall that the use of any application must be voluntary and with full user consent (Klar and Lanzerath 2020, Pagliari 2020). The users must be aware of potential risks (Klar and Lanzerath 2020) and they must be clearly informed of what data are collected, who will access the data, for how long they will be stored and so forth (Hargittai et al. 2020, Pagliari 2020). When selecting a technological solution, the value trade-off between the usefulness

of the solution and citizens' privacy should be considered. Therefore, if several technical solutions are available, preference should be given to the one that best preserves privacy and is the least intrusive (EDPB 2020, Pagliari 2020).

Technical solutions should also be transparent. Open-source technical solutions increase credibility and enable independent auditing (Pagliari 2020). Citizen scientists who will be collecting the data and using the technology should be trained. Proper use of the chosen technical solution is important for the correctness of the data gathered, minimising possible data manipulation, falsification and fabrication (Pagliari 2020).

For further information on this topic, we recommend reading Chesser et al. (2020) and Balázs et al. (2021).

## Data Management and Verification of Findings

Guideline #1

*Citizen scientists should receive appropriate training in data collection and the importance of keeping good research records.*

Guideline #2

*Appropriate methods for data validation should be implemented*.

Guideline #3

*Discussions amongst professional researchers and citizen scientists on questions pertaining to data ownership and future data accessibility should be facilitated*.

As in any other research, both professional researchers and citizen scientists in CS projects need to keep accurate records of the research data, research protocols and research methods used. As Shamoo and Resnik (2015) pointed out, good record-keeping practices (GRKPs) are important to ensure the quality and integrity of research. First, GRKPs enable one's data to be used in tests or experiments, whose results will be properly analysed and written up in reports. Second, GRKPs are important to enable the replication of work by others, such as peer reviewers or other researchers outside the research team. Third, GRKPs are important to facilitate investigations into research misconduct and might even prevent research misconduct. Fourth, GRKPs are important for safeguarding data ownership and intellectual property rights (see Intellectual Property).

A potential issue in any CS project is that the citizen scientists might lack appropriate or relevant training in proper data management and record keeping and, consequently, lack knowledge of these matters (Wiggins et al. 2011, Resnik et al. 2015, Rasmussen 2019, Rasmussen 2021). This might raise doubts as to whether CS projects can live up to the expectations of good research practice (for an illuminating discussion of this type of criticism of CS, see Elliot and Rosenberg 2019). However, even if some might remain sceptical of the results of CS on the grounds that citizen scientists might not have the same

academic training as professional researchers, the relevant question is whether they have sufficient training to perform the tasks at hand (Elliot and Rosenberg 2019). In this context, it is the responsibility of professional researchers to ensure that citizen scientists, when recording or collecting data samples, are properly informed about how to conduct the assigned tasks and that they are educated about the importance of GRKPs.

In addition to educating citizen scientists, Wiggins et al. (2011) identified several methods that can be used to validate data in CS projects, including expert review, photo submissions, paper data sheets submitted along with online entries and uniform equipment. Not all these strategies are equally suitable for all CS projects, so the preferred method for a CS project depends on the scale and nature of the project. However, to facilitate expert review, professional researchers who initiate the CS project also need to ensure that sufficient competence exists amongst the researchers supervising the participation of citizen scientists. This is important to ensure that the tasks of citizen scientists are being performed correctly (Resnik 2019).

One of the key principles in research ethics is openness (Shamoo and Resnik 2015). Sharing data and results is essential to advance research, allow feedback and criticism, facilitate replication and build trusting relationships amongst professional researchers and between professional researchers and citizen scientists. Therefore, while there might be legitimate reasons to refuse to share one's data or results, for example, for reasons of intellectual property or because the data have not yet been validated, the general norm is to share information and data (Shamoo and Resnik 2015). This holds also in CS. It is also important to note that citizen scientists should have a say in how their data are shared. As Resnik et al. (2015) pointed out, citizen scientists may assert ownership over the information and data that they are sharing and contributing to the CS project. This is not unreasonable: the data are theirs as much as they are the property of the professional researchers. It should also be noted that, depending on the nature of the CS project, citizen scientists might favour open data storage, in which case professional researchers should facilitate discussions amongst the citizen scientists of questions pertaining to data ownership and future data accessibility (Resnik et al. 2015) (see Intellectual Property).

For further information on this topic, we recommend reading Balázs et al. (2021) and Leocadio et al. (2021).

## Intellectual Property

*Guideline #1*

*Both professional researchers and citizen scientists should adhere to intellectual property regulations in the country or countries where a CS project will be implemented.*

*Guideline #2*

*Professional researchers should ensure the respect and protection of intellectual property in line with a CS project's needs.*

*Guideline #3*

*Professional researchers should discuss issues pertaining to data ownership and intellectual property with all researchers (both professional researchers and citizen scientists) before the CS project begins.*

The principles of intellectual property (IP) form a very complex system that affects the fields of literature, science, art, film and photography, computer programmes and much more. They are used to protect all creations, works of art, discoveries, trademarks and trade secrets and are applied through effective formal and informal tools, such as protective patents or copyrights (Bainbridge 2009).

Both professional researchers and citizen scientists should understand at least the basic principles of IP and their implementation in practice. In this context, it is important to recognise that IP law and practice may differ between jurisdictions and that both professional researchers and citizen scientists have a responsibility to abide by the IP laws of the country or countries where a CS project will be implemented. It is necessary not only to know how to defend IP, but also to what extent one can work with someone's IP. As Scassa and Chung (2015) pointed out, "the need to manage IP rights in citizen science may be less about ownership and control for the purposes of career advancement or commercial exploitation and more about appropriate management to serve a broader public interest" (p. 1).

Issues concerning IP may sometimes arise in CS projects because citizen scientists may simply assert ownership over the information and data that they are sharing with and contributing to the CS project (Resnik et al. 2015). It is, therefore, crucial that both professional researchers and citizen scientists clearly discuss issues pertaining to data ownership and IP before the CS project starts. Resnik et al. (2015) further suggested that both professional researchers and citizen scientists should negotiate agreements for all stakeholders to uphold. In doing so, professional researchers should be aware of the power imbalances that might exist between professional researchers and citizen scientists within CS projects (see Power Balances).

Citizen scientists often work on a volunteer basis, so their discoveries and outputs may be subject to different rights from those of professional researchers who are employed on a CS project. To avoid potential disputes, Guerrini et al. (2018) noted that CS projects often use Creative Commons licences, which help preserve copyrights, but still allow others to work with the outputs. The easiest way to deal with copyright issues is, once again, to establish the conditions of the rights at the beginning of the CS project (Kieslinger et al. 2018). Contracts can easily clarify expectations regarding involvement in a CS project and the handling of data, results and other outputs.

Only copyright holders or their designated representatives can apply Creative Commons licences to a copyrighted work. If a CS project intends to apply for a Creative Commons licence, professional researchers should, as emphasised in the section on Power Imbalances, involve citizen scientists in inclusive dialogue regarding the ownership of the

copyright (or permission) and the choice of the most suitable licence. Professional researchers should communicate the choice to the whole team and be sure to include the copyright notice in the work. It should be noted that selected licences cannot be revoked even if a citizen scientist decides not to share the material in the future.

For further information on this topic, we recommend reading Bainbridge (2009) and Creative Commons (In press).

## Ethical Publishing

*Guideline #1*

*It should be ensured that both professional researchers and citizen scientists are properly acknowledged in research publications related to the CS project.*

*Guideline #2*

*It is recommended that research related to the CS project be published as open-access and in legitimate research outlets.*

Like the results of any other research, the results of CS projects will likely be published. This raises several questions related to scientific authorship, proper acknowledgement of citizen scientists and where and how to publish one's results.

As noted in relation to the above discussion of power balances in CS projects, professional researchers and citizen scientists may have different expectations about their participation in a CS project. For professional researchers, one expectation is authorship of research publications coming out of the CS project, as this is crucial for academic career advancement. In contrast, citizen scientists may not require, but would be eager to receive acknowledgement for their contributions. Resnik et al. (2015) pointed out that citizen scientists should be given appropriate credit as a way to ensure honesty and accountability in CS work, as well as to demonstrate gratitude to citizen scientists. Ward-Fear et al. (2020) noted that giving appropriate credit is also crucial in order to promote the future participation of citizen scientists in CS projects. Without appropriate credit, there is a risk that some citizen scientists might feel instrumentalised, exploited or both.

There might be cases in which individual citizen scientists have contributed significantly to the research in the CS project and those citizen scientists should have the opportunity to be listed as authors (Resnik et al. 2015) and/or, if requested, be acknowledged in some other way.

Given the nature of CS and its association with the democratisation of science and "Open Science" (Vohland and Göbel 2017, Hecker et al. 2018a), it is advisable to publish CS research outcomes in such a way that they are freely accessible to all who participated in the CS project. Many publishers keep research publications behind paywalls, making them accessible only to professional researchers with institutional affiliations that pay for access for their research personnel. If possible, it is advisable to aim at publishing CS results in

open-access outlets, since this will allow citizen scientists to access the research publications and share them freely with others outside academia. It is also recommended, in line with the idea of the democratisation of science, to provide open access to other research outputs (e.g. research data and codes) whenever possible, considering the privacy and confidentiality of research subjects (see Privacy and Confidentiality).

It is the responsibility of professional researchers to publish only with legitimate publishers. With the changing conditions of academic publishing and particularly following the launch of open-access publishing, there now exist fraudulent – i.e. predatory or fake – publishers. These actors publish scientific work merely for profit, but without any real concern for the quality or content of the work, although they present themselves as adhering to academic procedures, such as those associated with peer review. It is important to learn how to identify such actors to avoid publishing with them and to discourage others from doing so (see Eriksson and Helgesson 2017).

For further information on this topic, we recommend reading the works of COPE (In press), Science Europe (In press) and Think. Check. Submit. (In press).

## Appendices

Appendix 1. Case Collection Initiative on Citizen Science Ethics

**BRIDGE project Case Collection Initiative on Citizen Science Ethics**

Available

11-12-2021 – 15-03-2022

Contact person

Sonja Bjelobaba, employed at Centre for Research Ethics & Bioethics, Uppsala University

This case collection initiative on citizen science ethics is conducted on the behalf of the Erasmus+ funded project “Bridging Integrity in Higher Education, Business and Society” (BRIDGE, 2020-1-SE01-KA203-077973). The main goal of this project is to create a bridge of intersectoral integrity by deepening the understanding of integrity in higher education, business and society and by providing relevant skills needed to act in accordance with the values of academic ethics. Within the scope of the BRIDGE project, we will develop Guidelines for Citizen Science Ethics and educational material with gamified cases and this case collection initiative will help us design that material. We seek to develop hands-on and real-life grounded material; therefore, the contribution of the participants with the experience in Citizen Science (CS) is highly valuable.

We are here asking you questions on various academic and research integrity issues while conducting CS projects or research. When answering, please keep in mind that your answers will serve to create educational material for target groups: Masters Students, PhD Students and Supervisors. Your examples and insights might be used for educational

material as they are or in changed form, adapting them to the project needs. If you agree to participate, the acknowledgement certificate will be provided by our project leader and, in the final report and Guidelines, if you wish, your name will be referenced in an expert list of contributors, amongst those who gave significant input to the final outcomes of the project.

All the information provided in the case collection initiative will be stored at Uppsala University and handled according to the GDPR standards.

Note that it is a good idea to write the answers in a separate document and copy-paste them in the form just in case of any technical problems (the online document does not allow saving and continuing).

If you prefer to fill in this information in a Word format or have an interview meeting online about the identified issues, do not hesitate to contact us via e-mail: sonja.bjelobaba@crb.uu.se.

1. Would you prefer to be indicated as a contributor or not?

Yes

No

Please indicate your name and the affiliation institution or project you would like to be presented with if you agree to be indicated as a contributor.

PART A

2. A.1. Please write below what topics you think are most important when dealing with Ethics in Citizen Science.

## Acknowledgements

We thank project partners Hajrulla Hajrullai and Veli Kreci (South East European University, North Macedonia), Sandra Krutulienė and Sonata Vyšniauskienė (Lithuanian Centre for Social Sciences) and Maryna Zharikova and Volodymyr Sherstiuk (Kherson National Technical University, Ukraine) for their contributions to the literature review. We also thank: Simona Vaškevičiūtė, former analyst of the Office of the Ombudsperson for Academic Ethics and Procedures in Lithuania, for her contribution to the literature review; Jakub Trojan from Tomas Bata University in Zlin and the Institute of Geonics of the Czech Academy of Sciences for his contribution to the survey identifying relevant ethics topics in CS; all other survey participants and all attendees of workshops (held in Porto, Uppsala, and Vilnius) for their valuable feedback and support; and five experts from Lithuania and Sweden for presenting the CS context.

## Funding program

The Guidelines were developed during the Erasmus+ project “Bridging Integrity in Higher Education, Business and Society” (BRIDGE, 2020-1-SE01-KA203-077973). No funding was obtained for publishing this study.

## Hosting institution

Office of the Ombudsperson for Academic Ethics and Procedures in Lithuania.

## Author contributions

EO, SB and IG contributed to the conceptualisation, stakeholders’ feedback gathering, development of the methodological approach, literature review and writing of the final version of the Guidelines. WB, VK, DHD and JU contributed to the literature review, stakeholders’ feedback gathering and writing of the final version of the Guidelines. All authors read and approved the final version of the Guidelines.

## Conflicts of interest

The sole responsibility for the content of these Guidelines lies with the authors. There are no conflicts of interest to declare.

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