Citizen Scientists Investigating Cookies & App GDPR Compliance

CSI-COP

Citizen Scientists Investigating Cookies and App GDPR compliance

Deliverable D2.1

CS Research report. Public report on current methods in CS Engagement

Delivery date: April 30th

LEAD Partner for deliverable: IB (Immer Besser)

Tiberius Ignat, Olga Stepankova, Huma Shah, , Ulrico Celentano, Maayan Zhitormsky-Geffet, Yiannis Gialelis, Robin Pierce, Jordi Vallverdú, Damla Bal, Sanja Persic, Julia Bencze, Daniel Wyler, Deniz Ozdemir

Version: 4.3 (final)

Project funded funding from the European Union's Horizon 2020 SwafS research and innovation programme under grant agreement Nº873169

30 months January 2020-June 2022

This communication is part of a project that has received funding from the **European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169**

Dissemination Level

PU	Public	X
R	Report	X
CO	Confidential, only for members of the Consortium (including the Commission Services)	
CI	Classified, information as referred to in Commission Decision 2001/844/EC.	

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Table of Contents

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Executive Summary

This report outlines the result of exhaustive literature review of the best practices in citizen science engagement, motivation and impact. Additionally, for part of this exploration, the authors followed the seven specific questions from the CSI-COP project and spun off another three.

This way, the project team took into consideration a broader number of perspectives in their quest of finding the most suitable engagement methods, specific to their project.

An important occurrence of this project, a turn that happened in the middle of the task that was set to create this deliverable was the COVID-19 outbreak.

The CSI-COP project will investigate GDPR compliance to better understand how far we are being tracked-by-default as we use the Internet visiting websites and apps on our mobile devices. CSI-COP will engage citizen scientists to address the growing concerns in society around privacy issues, and the methods that attempt to ensure integrity in the collection and use of data. Regardless of background, a community of CSI-COP citizen scientists will be recruited from across Europe and beyond. A series of free-to-attend workshops and a MOOC will be developed with training material to informally educate about GDPR. CSI-COP's community of citizen scientists will be a) fully trained to explore cookies and apps for embedded trackers, b) supported throughout their research, CSI-COP citizen scientists will investigate cookies on websites they normally visit, and apps on smart devices they use daily, and c) encouraged to record and report to the CSI-COP consortium the number and types of trackers they uncover in cookies and apps. CSI-COP's well connected eleven partner consortia made up of seven universities, one non-profit, two SMEs and one Association will promote and support the citizen scientists as role models, with the university partners inviting them post-project as pro-privacy champions. The unique findings on digital trackers uncovered by the citizen scientists will be systematically mapped by CSI-COP consortium producing a taxonomy of trackers. The tracker taxonomy will be used to create an online repository. The repository will be available as an open-access knowledge resource on trackers embedded in cookies and apps. The knowledge resource will be a tool useful for a variety of stakeholders including data protection researchers, GDPR compliance regulators, tech journalists, software developers, parents, teachers, higher education curriculum developers, and any organisation that provides computers for public use such as libraries.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

This deliverable reports on two main areas: ten relevant research questions for CSI-COP (as defined in our project proposal) and on what we identified as the most suitable engagement practices for our project.

In the section called 'Summary of Answers to CSI-COP's Research Questions', we are providing answers to the research questions which will be guiding other areas of execution in our project. The answers are concisely organized in Table 1. (Summary of key findings concerning citizen science engagement) and further expended in Appendixes 1-10, towards the end of the document. Since the aforementioned table is precisely writen to highlight in a streightforward way the answers, we will not repreat them in this Executive Summary.

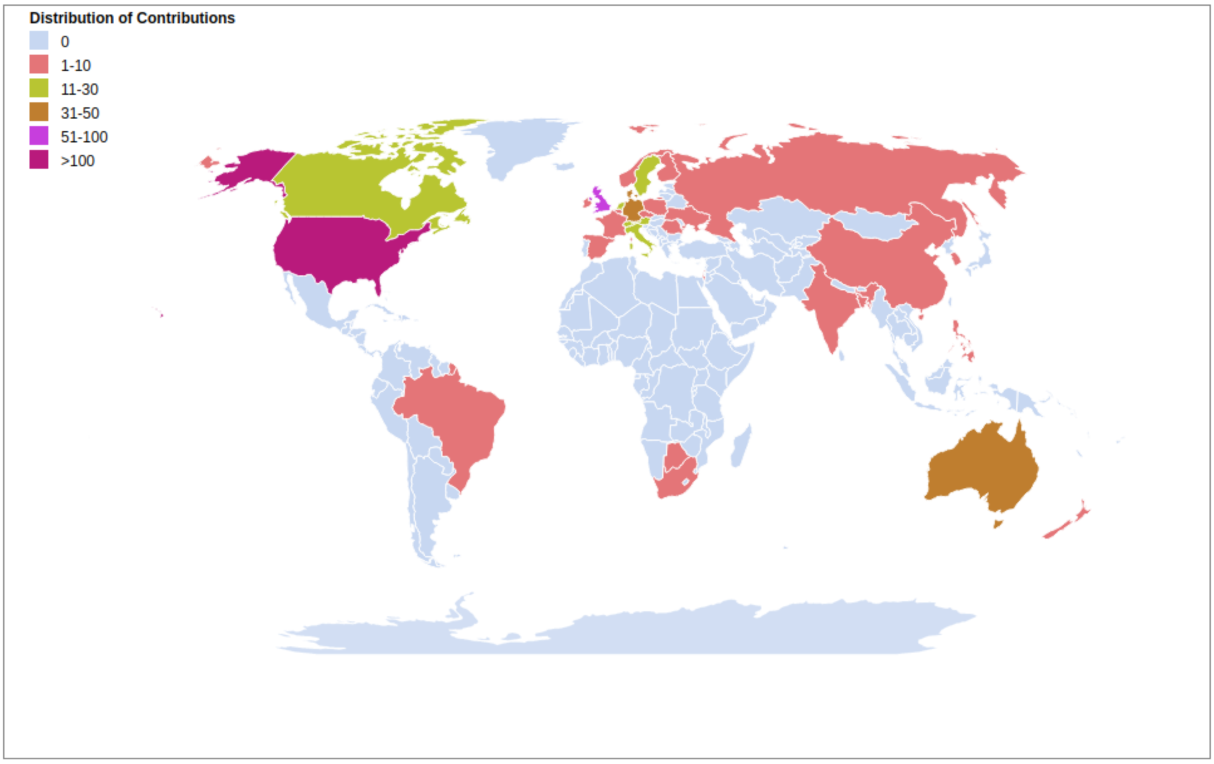
The section called 'Identified Practices and Recommendations from Other Citizen Science Projects' represents the other main area we report on. We identified 18 good practices to inspire and to be used as guidelines by those that are creatinng and developing the volunteers engagement programe within our project. From setting the goals of engagement, to overcoming social imbalances, engage with local experts, deal with mass-media and going through gamification, Dark Patterns and GDPR requirements, these best practices are all going to serve the other workinng packages of CSI-COP.

We are also are making available a number of visual representation about the sources of information that we used in the execution of Task 2.1 within CSI-COP project.

Figure 1 illustrates a map of the spread of these sources. One of our aims was to explore less observed texts and videos from around the world and by the same time to give the right importance to the world recognized citizen science hub centres. It wasn't easy, indeed. A massive concentration of citizen science activities exists in USA, Germany, UK, Australia and a few other countries.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

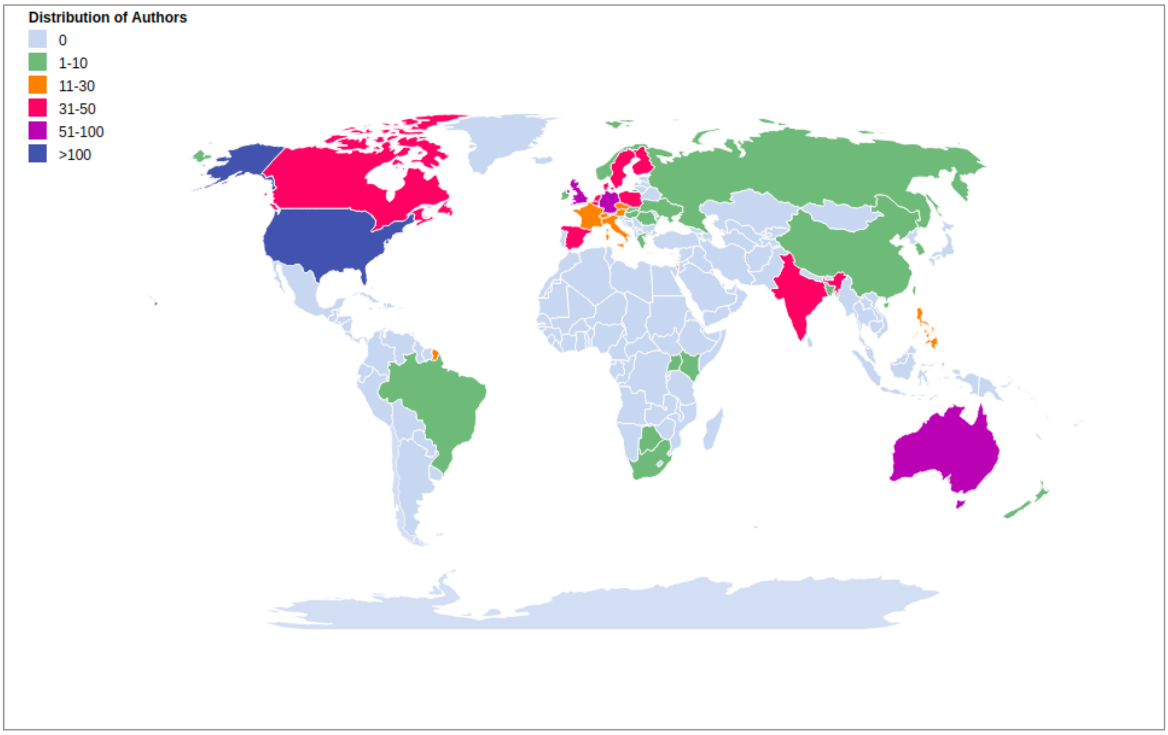
Fig. 1 The spread of information sources for CSI-COP T2.1, around the world



The spread of authors around the world (for the explored sources of information of Task 2.1/CSI-COP) is illustrated in the next map (Figure 2). It shows a bit more diverse distribution and confirms a great global interest that exists for citizen science activities.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

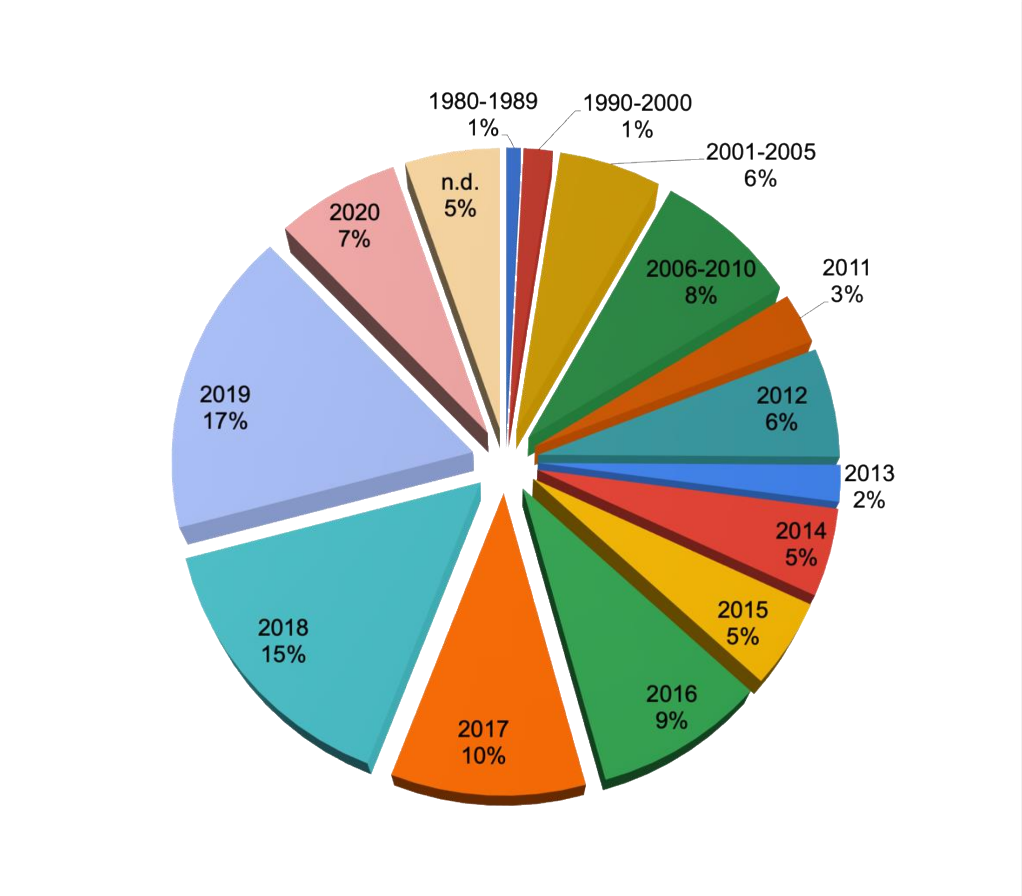
Fig. 2 The spread of authors for CSI-COP T2-1 sources, around the world



In terms of recentness, over 63% of information sources that we used to form our understanding are from the current year and the past five years. The information sources produced during the last decade account for 79%. The next figure shows the complete overview about how recent the sources of our citizen science studies are (Figure 3).

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

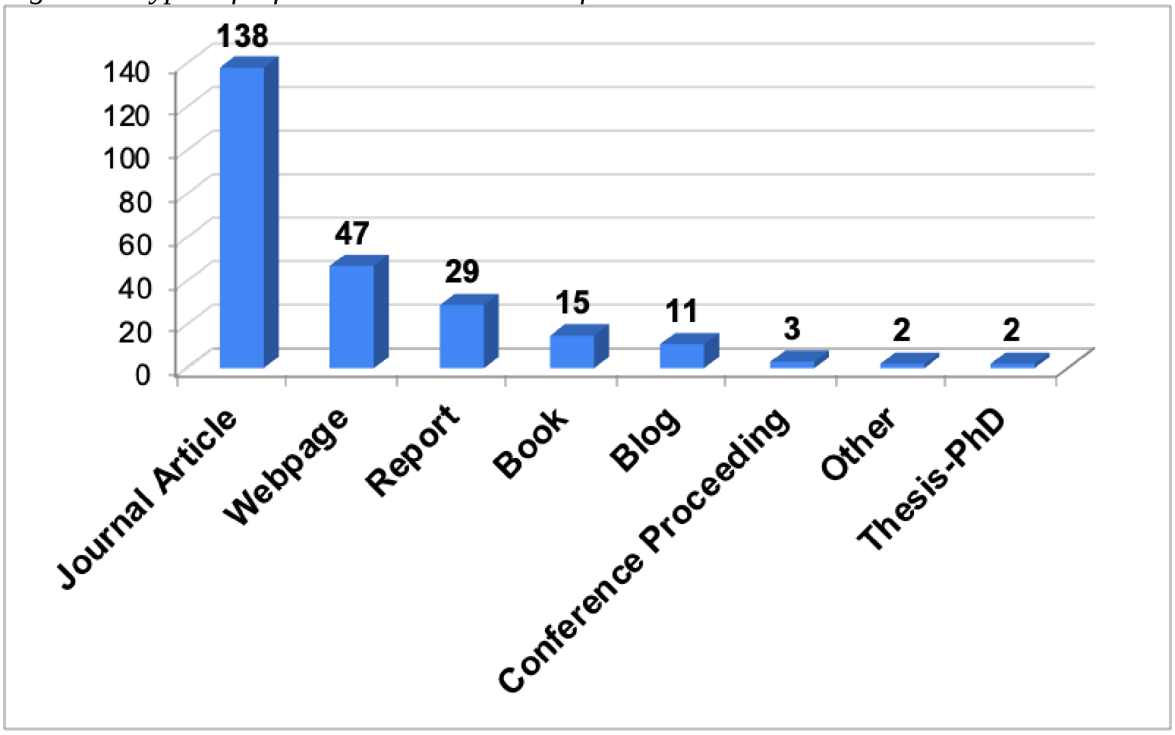
Fig. 3 CSI-COP T2.1 Information sources per year



We used various sources of information: journal articles, webpages, official reports, books (including book chapters), professional blogs, conference proceedings, doctoral thesis and other sources of reliable information. Indeed, the vast majority of what we studies are journal articles (just under 56%), but we are able to confirm that citizen science activity is well communicated through webpages and blogs, too (aggregate number of CSI-COP T2.1 source, 23.48%). There is a significant number of official reports about citizen science research experiences (11,74% from what we studied). Bellow, we represent a fuller picture in a bar chart.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement N°873169

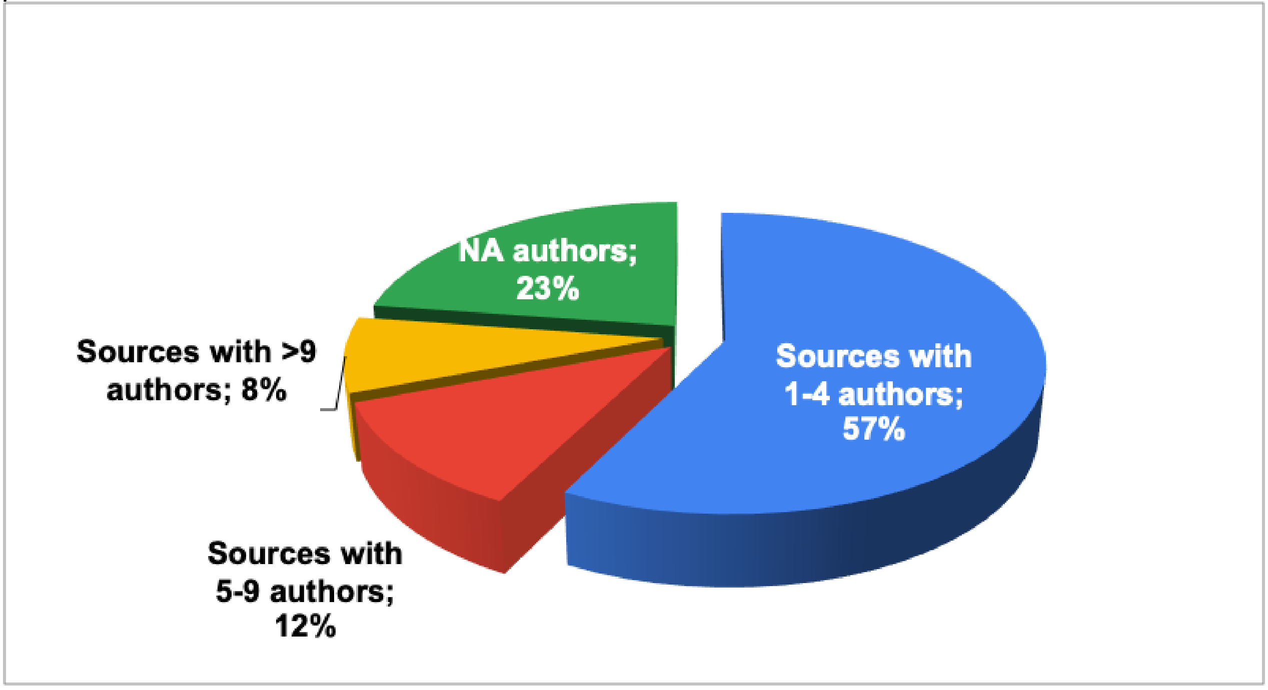
Fig. 4 The types of information sources used for CSI-COP T2.1



Another interesting visualization of our Task 2.1 dataset reflects the level of collaboration that exists in citizen science, measured through the number of authors for publication. This figure uses the publications we studied for completing CSI-COP Task 2.1. Although it is obviously limited to our selection of information sources, we believe this image is giving a general view about the collaboration level that exist in citizen science projects.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement N°873169

Fig. 5 Citizen science collaborations viewed through publication output in information sources used for CSI-COP T2.1



***Keywords*:**

citizen science, cookies, data collection, dark patterns, data protection, data protection laws, digital divide, ePrivacy, GDPR, gender, geographical location, motivation, privacy, privacy-by-default, privacy-by-design, socio-economic factors, tracking.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

The Requirements of Task 2.1 (T2.1)

The Description of T2.1 Requirements

The Task 2.1 of CSI-COP (T2.1) was set to conduct an exhaustive exploration of published articles to find the most appropriate and relevant practices and efficient methods in citizen science engagement that can be applied in the CSI-COP project. The research partners assigned to this task explored peer-reviewed publications, citizen science funded project-deliverables, science in society reports, theses, scientific publications, blogs as well as reports of governmental and non- governmental institutions. The focus of this task will be to review existing citizen science projects and activities, incl. identifying gender, socio-economic and geographical differences to uncover:

1. Whether citizen scientists developed scientific skills and competences
2. If participation acted as a motivator leading to informal and formal science education of young people and adults
3. Whether participation countered perceived anti-intellectual attitudes in society
4. Whether participation raised the scientific literacy of European citizens
5. Whether participation promotes social inclusion and employability
6. Best tools for citizen science reporting and interaction with researchers
7. Best platform for managing citizen science's data collection

During the execution of this task, three additional areas of explorations have been proposed and accepted:

8. Existing types of platforms used by citizen scientists and experiences with them
9. Challenges in management of collected data
10. Online support - requirements and experiences of citizen scientists

These questions are sometimes referred in this report as "the 7+3 questions".

The outcome is this public report (D2.1) that has a particular importance for the Work Package 2 of CSI-COP, in order to create an understanding about which are the effective tools for citizen science,

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

the best practices in citizen science engagement, the motivation in producing new knowledge and technologies and ultimately, for increasing scientific engagement.

Although this report might have a relevant significance to other citizen science projects and studies, it is important to highlight that the research behind this report, as well the report itself was particularly designed and conducted to support the goals and activities of CSI-COP project. Thus, the answers, the identified practices and the recommendations found in this report are having central the needs and the aims of our project.

The findings gathered in this task will be leveraged in WP3 (recruit and training), WP4 (Citizen Science Investigations), WP5 (Citizen scientists co-innovating a repository of digital trackers), and WP6 (communication, dissemination and exploitation).

The CSI-COP Partners involved Task 2.1 which led to this report are: Immer Besser GmbH, Coventry University, University Patras, Tilburg University, University of Oulu, Bar-Ilan University, Czech Technical University in Prague, Universitat Autonoma de Barcelona.

Identified Challenges in Following the Requirements of T2.1

Specific to CSI-COP is the challenge of remaining true to the principle, practices and technologies of *no-tracking*. This includes citizen scientists engagement in the CSI-COP project which impose strict ethical practices. The hurdles we must negotiate in the CSI-COP project aim to ensure confidential categorising of types of participants complying ourselves to the general data protection regulations (GDPR) and other national data protection acts. Protecting the data of the community of CSI-COP citizen scientists will be the utmost priority to ensure that no personal data (n.b. personally identifiable data - PID) is collected. All personal data (age-range, sex, socio-economic, geographical) of the citizen scientists will be kept anonymous, private and secure. This challenge and the decisions we took in its regards led, among other things, to the decision of not developing or implementing an app for the project or to employ extra cautions in using citizen science platforms (which should present the option of *no-tracking*).

Other challenges have been pointed out in 'sister' citizen science projects. For example, NEWSERA citizen science project objective raises this point: "launching a citizen science project requires the

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

creation of a complex ecosystem" with the "participation of quadruple helix stakeholders" (2020). And the CoAct citizen science project considers the challenge of "… underexplored field of Citizen Social Science responding to issues related to Mental Health Care, Youth Employment, Environmental Justice" (2020).

Further challenges include finding the most appropriate citizen science engagement tool. CSI-COP search for answers to the 7+3 specified questions confirmed that there can be no best tool nor best platform fit for all - often we have identified several alternative answers. Each CS project is unique - it sets its own goals; it defines its type of data to be collected and it specifies requirements on knowledge and engagement of its participating citizen scientists. These characteristics have significant impact on the properties of the tool and choice of the platform used by the specific CS project. This report tries to review various solutions used by successful CS projects and to identify (single out) good practices and recommendations from existing literature that proved to have positive impact on engagement strategies for CS projects.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

The Methodology and the Implementation of Task 2.1

Core activities leading to producing this report have been divided into two consecutive phases:

Phase 1. Distributed collection of relevant information resources.

Phase 2. Cooperative writing of the D2.1 text as a consensus report of all partners.

The Phase 1 running in M1 and M2 of the project has been opened by the T2.1 leader who described how the task team will work and interact for doing extensive explorations of Citizen Science literature and various other relevant sources of information. During the first web based meeting it was agreed that the exploration should not be limited to the peer-reviewed literature, but it should pay attention to information provided by further alternative sources of reliable information including but not limited to governmental and NGO reports, reliable Citizen Science blogs, recorded webinars etc. In this phase, each partner institution was expected to work on its own, not to specifically divide the workload per se, but to improve the data gathering process by allowing a collaborative and creative workspace for participating countries to represent their extracted data generated from the gathered resources.

In order to increase the diversity of the sources of information that we aimed to review, we decided that the team members will search for themselves for finding the most relevant knowledge for CSI-COP. The T2.1 leader remained available to recommend further readings if that was needed. The T2.1 Partners were invited to gather their detailed explorations every week to T2.1 leader in a provided pre-defined template (a bespoke tool named Explorer-T2.1) in order to match with the project deliverables while researching for the relevant information for the project.

Each partner that collaborated on the weekly exhaustive literature review studied various citizen science project topics. In return and within 2-3 days, the participants obtained the feedback from T2.1 Leader regarding the pitfalls and the possible improvements for further explorations. Therefore, for each version of the explorations document, a note from the T2.1

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

leader explaining how the methodology was applied was enclosed. That was particularly helpful to consolidate the team while maintainig the methological track of our work.

Additionally, T2.1 leader collated the weekly highlights into collaborative documents to keep track of the progress the team made by consistently investigating alternative and CSI-COP-relevant citizen science concepts. Progressively, such effort aided the participants to come up with their own stimulating novel ideas during the process, which were also recorded and highlighted in the exploration document. Hence, such work aspect was additionally put on to bounce collective ideas to refine diversity of the collected information. As a result, the T2.1 partners were able to make the best of their own efforts and knowledge and in the same time the team cohesion substantially increased.

After 6 weeks of exploration all the findings provided by the task partners have been merged into a single structured document named CSI-COP D2_1_Draft v.1 that was made available to all task partners on the project shared space, as an input for the next phase.

The Phase 2 was dedicated to collaboratively editing of the CSI-COP D2.1 draft using the project shared space complemented by several virtual meetings during which the team of partners discussed the most relevant findings for the CSI COP project and the best ways for presenting them.

In order to carry out systematic literature reviews on citizen science, during both phases the T2.1 partners used extensive number of online databases including Google Scholar, Web of Science, PubMed, IEEE Xplore, Science Direct, Directory of Open Access Journals (DOAJ), as well as pre-print servers and repositories like Zenodo. Consecutively, the gathered resources were sorted out by its content by analysing its title, abstract and keywords information, duplications were solved and necessary elimination was conducted for the information sources which were not eventually needed for the project. Furthermore, in order to match with the project deliverables, concepts including CSI-COP research questions, such as platforms, learning, motivations, best practices, data quality, online support and design principles were separately investigated to enrich the content of the work ensuring this way that the resources are analyzed at full potential.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Finally, T2.1 partners looked for relevant articles in the references of the found papers and those citing them, too.

As a result, we present in this report a list of references and a bibliography list. The list of references reprezents a strict selection and it contains all information sources that we cited. The bibliography list information sources that we read, watched or used in any further way for informing us. The later had a formative influence on opinions of the team partners as they were presented during the phase 2 discussions. Furthermore, the bibliography list has a great potential for further readings, being useful either for the other CSI-COP tasks or for other citizen science projects.

It is no doubt that the included bibliography consisting of over 200 hundred titles does not cover the topic of Citizen Science exhaustively. On the other hand, it is rich enough to be considered as a representative sample which can provide rough estimate of the extent to which citizen science activities occur in different countries or help in identification of possible local kindred partners who could support CSI-COP dissemination strategy. Data extracted from the bibliography list have been analysed with intention to demonstrate the spread of depth of our explorations, including geographical balances and the level of collaboration (measured through authorship collaboration in publications) – the results appear in the maps presented earlier (Figures 1 and 2).

Preparing input for the presented analysis proved to be rather demanding because nearly 10% of the bibliography items had more than 10 co-authors (there was even an item with 37 co-authors and another one with 73 co-authors). Limiting the analysis to just a given number of the first authors would compromise the final results because for some disciplines the co-authors are being presented in alphabetical order, hence we extended the work to all authors.

At the time this report is released, the dataset is stored on the project shared space. CSI-COP is part of the Open Data Pilot on H2020. The data management plan (DMP) and the subsequent actions regarding project's data are due for release after the submission of this report. Please check project's website (www.csi-cop.eu) for more details about how the dataset could be accessed.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Summary of Answers to CSI-COP's Research Questions

The answers for each of the CSI-COP's research questions - addressed through exhaustive search - highlights the best practises to engage, motivate and sustain the participation of volunteer citizen scientists in a myriad of citizen science projects. An element of the most successful methods is fostering learning by valuing the knowledge gained and recognising citizen scientists' contribution to the advancement of science, including acknowledgement in publications. This recognition can also be achieved through further public engagement like involvement in science communication.

The comprehensive question-research can be found in the Appendices at the end of this document. Each question's findings are detailed in Appendices 1-10. The wide findings are fully supported by citations from referenced articles. The citations are listed in the Reference section. In *Table 1* we summarise the answers to each question.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Table 1. Summary of key findings concerning citizen science engagement

Questions for Task 2.1	***Summary of key findings from Exhaustive literature review***
Do citizen scientists develop scientific skills and competencies?	Participation in citizen science projects provides further learning opportunities for inquiring minds, with the activities extending the learning experience. As an informal learning experience, citizen science is notable for involving many of the procedures of formal science, including gathering data, testing hypotheses, and modeling outcomes. Through engagement with professional scientists, citizen scientists gain a valuable opportunity to learn and to generate new knowledge. The advantage for citizen scientists is to gain experiential learning or learning in the context of given tasks. This further enhances knowledge acquisition in citizen scientists. *Read further in Appendix 1.*
Did participation act as a motivator leading to informal and formal science education of young people and adults?	Volunteers participate in citizen science projects for many reasons, such as a **willingness** and a **desire to contribute to science, learn science,** and **for fun**. Studies have shown that volunteers' motivation to participate includes a number of factors such as **values**, **altruism** and concern for others, **understanding**, **social**, **career**, **ego** protective, escape from negative feelings, and **ego enhancement**, personal growth and self-esteem. *Read further in Appendix 2.*

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Did participation counter perceived anti-intellectual attitudes in society?	Limited information is currently known regarding whether the participation by individuals in citizen science projects countered any anti-intellectual attitudes in society. It could be the case that individuals and groups motivated to take part in citizen science projects are those with an already high opinion of science and more open-minded towards scientific experts. Citizen science projects include the aim to increase participants' knowledge about science and the scientific process. Participating in citizen science projects can go a long way to mitigating negative attitudes to science, since the knowledge gained about the scientific topic can change the mindset about what the processes are in involved in doing science following the 'scientific method'. Citizen scientists also learn about the decision-making process, who makes the decisions, when, why and how to resolve issues around ethics and how legal matters are addressed in the scientific method. Engagement can shape citizen scientists' approaches toward science and the environment. *Read further in Appendix 3*
Did participation raise the scientific literacy of European citizens?	Citizen science projects are organized with the aim to establish cooperation with general public in order to accumulate information or extensive data that are necessary in decision making and that would be hard to obtain with limited resources of academia. In some of the CS projects, the expected input cannot be provided without specific skill or knowledge - such projects are offering necessary training to its participants and sometimes even

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

confirm the achieved knowledge level through dedicated certificates. The potential of citizen science projects is the improvement of citizen scientists' contribution while optimising the possibility of discovery and scientific advancement.

Read further in Appendix 4

Did participation promote social inclusion and employability?

It has been seen that citizen scientists starting out as members of a citizen science project, in peripheral roles, progress to a central position in the group, such as a leadership role, which further motivates participation. Such promotion can see citizen scientists taking an active part in the decision-making processes to achieve justice. By also sharing knowledge with each other, citizen scientists are included and become more inclusive by building networks, utilizing IT technologies to communicate and collaborate with government authorities to promote their missions. Participation by a diverse citizen population is an important social inclusion factor that not only enriches the project's capital, but ensures the citizen scientists bring their own particular interest and expertise. In this way, citizen science projects can be seen as enablers for social inclusion for multi-disciplinary and cross-fertilization methods.

Read further in Appendix 5

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

The best tools for citizen science reporting and interaction with researchers	A variety of different applications exist to enable citizen scientists to record their data collection. These include: Anecdata, iNaturalist, Sapelli, Spotteron, Opendatakit, ArcGIS's Survey123, and ClimateScan. An assortment of successful techniques exist to maximise interaction between citizen scientists and researchers. These include 'hitching a ride on existing networks'; offering a fun experience; using social media; through digital storytelling; gamification and nurturing project ambassadors. *Read further in Appendix 6*
The best platform for managing citizen science data collection	The best platforms can include a bespoke developed framework to collect project-topic specific data. In addition, a variety of platforms are available for data collection, management, and sharing that can be appropriately integrated for citizen science projects. One well-known platform is SciStarter. *Read further in Appendix 7*

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Additional Questions and Findings

Citizen scientists' experiences with existing types of platforms	Community-based knowledge creation can emerge from open-source platforms. This model can provide a "**strong group culture** with **clear rules** and **norms**" with "patterns of behaviour" that "**enhance commitment** and **foster high-quality team-work**". This way of considering "**knowledge as socially constructed"** could help to sustain communities of citizen scientists. *Read further in Appendix 8*
Challenges in management of collected data	Challenges include that although the amount of data processed by citizen scientists is significant, it is a small number of contributors that make a large share of the contributions. Additionally, some citizen scientists, as volunteers on projects, may provide less reliable or even wrong results it they have not been adequately trained. Consequently, their investigations might include errors in the data that has been collected. Nonetheless, past citizen science studies indicated that any probable issues that arise during the data collection phase by the citizen science participants did not affect the project outcome in great detail at the end. The overall quality was sufficient enough to carry out future projects. *Read further in Appendix 9*

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Citizen Scientists support requirements	Participating citizen scientists have been shown to prefer that their efforts are appreciated, that their contributions are acknowledged as meaningful and fruitful for the growth of the project. Interest could decrease and can be lost if their work is not rewarded in some sense. Volunteers are more eager to continue in contributing into the project if an efficient management framework is established. This then utilises the best and timely communication channels between the researchers and the citizen scientists. *Read further in Appendix 10*

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Identified Practices and Recommendations from Other Citizen Science Projects

P1: The goals of engagement and how to reach them in CSI-COP

A solid engagement framework is essential for the a priori quality of the project. To achieve it, and to judge its quality, the goals of the engagement must be clearly stated, and the engagement should be designed accordingly. In a recent BSCS Science Learning report 'Designing Citizen Science for Both Science and Education' (Edelson, 2018), a number of goals to reach both scientific and educational objectives have been listed. These core engagement design goals for the scientific outcome are:

1. Scale
   The objective to achieve a large number and broad diversity of participants can be attained by promoting participation through suitable publicity (such as to overcome certain biases (gender, age..), supporting interaction among participants, making the data collection protocol as easy as possible, standardizing protocols across the project, using and incorporating existing data sets and holding suitable community events.
2. Access
   Access to the project activities designed for citizen engagement should be as easy and attractive as possible (see above, 'Scale'). Access to important sources/expertise for data collection and/or analysis of websites requires the project manager to involve enough experts to enable participants to complete desired tasks.
3. Sustainability
   Engagement should be maintained for an extended time. This implies transparent and realistic communication of the project's goals and expectations. Activities should not be overly time-consuming (Latham, 2020).
4. Community empowerment
   The objective can be attained by providing easily accessible and understandable tools that will allow anyone to master the required tasks, and to exchange tips with participants.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

5. Identification with the project
   Similarly, a goal of engagement should be the identification (enthusiasm) of citizens with the project (see also P2). This is achieved by giving them an adequate voice in the project, in particular in decision-making.
6. Data quality and credibility
   Provide established measures for assuring the data quality and credibility by training participants, install tools to verifying (and possibly reject) data, monitoring protocols, requiring sufficient documentation, etc

The core design objectives for learning outcomes are:

1. Cognitive objectives (new skills, understanding of science, etc.)
   Include frequent (informal) exchange notes among scientists and citizens.
2. Affective objectives (new attitudes, stewardship, perceptions etc.)
   Encourage participants to reflect and share their experience with friends, colleagues, media, etc. by providing suitable interactions, like blogs (and encourage comments; answer them), regular meetings and reporting. Citizen Science presents the opportunity to achieve self-efficacy, stewardship attitude and behavior and interest in pursuing science.
3. Intermediate (instrumental) objectives
   The design of engagement should create opportunities for achieving cognitive and affective outcomes and supporting facilitation by teachers or other educators. (Edelson, 2018).

P2: Position the CSI-COP Engagement

It is an important practice to formulate the general pitch of a Citizen Science project. Positioning the engagement of CSI-COP is a strategic decision which sends a general message to prospective citizen scientists intending to participate in the project. It often decides on the citizens' motivation to join, and to identify with the project. In fact, it was pointed out (Cavalier, 2016) that citizen scientists want (and should wherever possible) to be recognized as legitimate partners and partake in decision making. This seems

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

particularly important in the case of CSI-COP where the fundamental issue of privacy is in the centre of interest, and where citizens can leave a lasting legacy of effectively changing the widespread digital practice of tracking-by-default.

P3: Engage through CSI-COP champions

CSI-COP (Prospect) Champions are people of diverse backgrounds who have caught ‘fire’ for the project and inspire others to join and identify with the CSI-COP effort and serve as an example. Such champions are part of other Citizen Science project and have a positive effect. The #Talking Climate Handbook, How to Have Conversations about Climate Change in Your Daily Life (Webster, R. 2019) offers important guidelines to prospective champions to constructive conversations on the project with prospective citizen scientists. A shorter, CSI-COP bespoke version of this handbook, in a form of a flyer could be an effective option to all prospective partners of the project in order to attract possible Champions toward the project website.

P4: Register CSI-COP on Citizen Science platforms (Group B)

General Citizen Science platforms provide a fertile environment for developing a broad engagement program. These platforms offer various functionalities, practical support, suggestions and instructions on how to set up the project; they also make it more visible. Being known to scientists and interested citizens alike, they help expand the range and numbers of participants. In most cases, the platforms are international and open to everyone. They support engagement and willingness of the general public to dedicate themselves to complex projects (Yadav, P. and Darlington, J., 2016, Phillips, T., Porticella, N., Constas, M. and Bonney, R., 2018).

There are numerous platforms available on the web, such as SciStarter, Zooniverse, CitSci, Citizen Science Grid. Project creation is quick and simple and allows easy updates if necessary, without interfering with the work already done by the participants. The scientists – participants interaction is fostered by scientific forums and real-time message exchange

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

systems. All services are free and easy to use, making it a satisfying experience altogether. As part of setting up CSI-COP, the existing platforms should be compared and examined for their usefulness, as discussed in a separate section of this report (see Comparison of Citizen Science Platforms).

P5: Organize Citizen Science Workshops

A world-wide recognized successful practice for citizen science engagement is the organization of workshops. Good practices show the benefit of organizing such workshops, for the various groups potentially participating at the project, such as parents, pupils, retired persons, students, professors and librarians and other specific groups of people. An example of guidelines on how to run workshops is found in The Librarian's Guide to Citizen Science (2019) and in the CS guide for Megathon and Resources for organizers. Partnerships between different groups of professionals, such as librarians and citizen scientists can broaden perspectives, engage new audiences, and result in mutually beneficial outcomes.

Another notable good practice that could serve as a model for CSI-COP is a cross-service approach from the European Commission which organized a workshop entitled Co-Designing Missions with Citizens to support citizen engagement in the identification and development of future EU missions under Horizon Europe (Research and Innovation, 2020). A highlight of the exercise was the precious expertise of international leaders in the theory and practice of deliberative democracy from Australia, Belgium, Denmark, France and the UK. This workshop gathered Mission Boards members, 12 Member State representatives, as well as the Mission task forces of the European Commission to work together with the experts. It was not only intended to build capacity on the engagement aspects but also share the respective challenges each faced in their respective areas and open the dialogue with Member States. In light of the deliberative democracy experts' skills and experience, the workshop successfully resulted in the development of a methodology for Citizen engagement tailored to each Mission Area. The takeaways were very positive in shared understanding, key questions to be discussed, useful networks to activate, as well as concrete activities to be taken forward.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

https://ec.europa.eu/info/news/citizen-engagement-workshop-co-design-missions-citizens-2020-feb-14_en.

P6: The most suitable practice for CSI-COP regarding a possible app

Using online tools can have a very positive impact on a project development. Benefits are particularly obvious in simplifying and systematizing data collection, yielding higher efficiency in collecting, storing and managing data, and an improved data quality; again it is worth emphasizing that the platforms are easy to use and processes efficient, and that 'data-quality' concerns are addressed throughout, including in the project's design and results' dissemination.

The European Commission reflects upon this and acknowledges that more inclusive practices regarding the validity and usefulness of volunteer data are necessary.' (Lantham, 2020). However, using more integrated technologies like apps which because of their complexity often are relegated to commercial providers, raises the issue of privacy and tracking. Therefore, building an app for engaging with the CSI-COP volunteers is not a recommended practice as long as such an app will track users' activity.

However, it is worth further scanning the literature during other project tasks for issues like how citizen scientists interacted with apps, were they made aware of their privacy rights before being asked to use a CS project app and whether Apps can be built, as part of a new project.

P7: Engage with local experts

There can be great benefits from engaging with local experts when developing volunteer outreach at local and at even wider levels. The local experts are most probably already in contact with some groups of enthusiasts via direct interactions (bidirectional) or by having their activity and opinions followed via social networks (unidirectional). CSI-COP could benefit from both the expertise of the local experts and from their existing interactions with people that are concerned of network privacy matters. Given the spread of the CSI-COP

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Consortium, the local experts could also offer a diversity of expertise, understandings, perceptions and local concerns.

To deepen and systematize this interaction, it is useful to organize community events such as workshops, hackathons, seminars or contributing to conferences (CSA Webinar 2019, 2020a, 2020b). The benefits not only include professional knowledge, but also important aspects like the understanding of immediate interests for that community, a possible local jargon that is used to describe the problem the research tries to address, best suitable dates/time for organizing events, and how to access the local mass media which could know the local expert/-s from previous cases.

The other benefit of connecting with the local expert is to gain the local experience which is needed for the project to tune with the volunteers coming from that area. Such particular experience could regard:

- Immediate interests for that community (e.g. situations that are happening / happened in that community, their very local concerns, individuals from their community that were / are affected by the phenomenon)
- A possible local jargon that is used to describe the problem your research try to address to
- Access to local mass-media which could know the local expert/-s from previous cases
- The understanding of the local expert about best suitable dates/time for organizing events

P8: Address the possible imbalances in the distribution of project participants

The number of participants and a balanced distribution among the different groups of people (diversity) is often a decisive factor for the quality of the project. Depending on the research question, an imbalance can strongly reduce the validity of the result, but also the effervescence of a citizen science project. Curtis (2018) is a good source of information for understanding who typically takes part in Citizen Science projects. Typically, the professional scientists are firmly in charge, participants are 80% male, many of them aged

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

31-45 years (women show a wider range 35-50). Another concern is the (geo)social balance and participation of minorities. See (Bonney et al. 2016, West Oakland Environmental Indicators Project, 2013, Ridgeway and Yerrick 2018, Ballard and Belsky, 2010, Skarlatidou et al. 2019) for a variety of such studies. Good and thoughtful planning of the recruiting program, by specifically addressing underrepresented groups systematically in the early stages is important.

However, the balanced participation, although highly desirable, may not always be needed for the research question at hand. The CSI-COP project has dedicated specific task (Task 2.2, 'Gender, socio-economic and geographical factors') for this important research approach.

We thus recommend studying the influence of the diversity factors on the CSI-COP research issues when designing the engagement, in particular the differences between professional scientists and lay people.

P9: Develop volunteer-centric practices

The good practice of customer centricity from business environment could be taken as an example from citizen science projects in general, including CSI-COP. Such practice will develop a positive volunteer experience which leads to volunteers' retention, easier recruitment on a long haul (word of mouth will just work better) and ultimately could contribute to the sustainability of the project, beyond the initial funding period.

A general principle to follow for a volunteer-centric practice is that the researchers and research project administrators should express their gratitude for those who volunteer and take task assignments and for that, they need to create a smooth and positive experience. Any kind of difficulties, complications and other stressful situations should be eliminated. The volunteers should feel right from the beginning that the project designer had their presence (contribution) in mind, the problems of their needs have been anticipated and the final solution represents a wise design for creating a great, positive experience. For most of the volunteers, a joyful experience is the greatest reward.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

A good training programme - as described in the following practice, *P10* – leads to positive experiences among volunteers, but this is not all. A clear protocol increases engagement and creates the fundamentals of obtaining scale. Clear indications for joining a webinar, a field action or simply for registering in the research project are among the basic elements for developing a volunteers-centric practice.

Another way to elaborate volunteer centricity is to set the right expectations on participants' side. Researchers are formally trained to read the description of a research project and could easily understand what the expectations are and what kind of expectations they can set for themselves. Volunteers are not trained for that. They may have completely different backgrounds. Therefore, supporting them to create an understanding about what they should expect and periodically refresh that front is highly recommended.

Further elements of volunteer centricity include being easily available, regularly collect their feedback and consider their input (including surveys), make direct contacts, invite them to test solutions, adapt the tools used to interact with them to better fit their preferences and possibilities.

P10. Training volunteers

Not surprisingly, it has been found that training improves the quality of the citizen scientists' outcomes (Aceves-Bueno et al., 2017). This also reinforces the need for holding study design workshops (Wilderman, 2005). Training must involve scientists (at least in the research methodology) and citizens; often the specific context and tasks of the project require that people not only acquire new knowledge, but also new methods of working. For instance, in the Salal Harvest Sustainability Study (Ballard and Belsky, 2010) harvesters developed a better understanding of the process of scientific investigation in terms of data collecting, reliability, validity, and methodological consistency. Furthermore, individuals who participated in a results interpretation workshop also gained skills in reading and interpreting graphs, drawing conclusions from evidence, and explaining how the results compared to their own observations. Jordan et al. (2011) did find that providing training for participants altered their intentions to change, such as increasing their pro-environmental activities such as

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

volunteering for environmental organizations or educating others about them (Crall et al., 2012). CSI-COP project could find strong analogies with such projects and benefit from their shared experience on the benefit of training.

It is also very important to notice that continuous trainings increase the citizens´ confidence in completing the tasks and help to improve their skills. (Latham and Ceccaroni, 2020).

P11: Involve volunteers beyond data collections

Data collection is just one stage of a research project. The same as scientists, citizens are concerned with the pursued hypothesis, the findings but most probably their biggest enthusiasm stays in the whole research journey. Sometimes the remaining work may even be more difficult than the previous steps (planning, data collection, analysis). In a purely scientific environment, usually one or several papers are published in dedicated journals. In projects with a more immediate interest beyond the specialized scientific community, the situation is more complex. On one hand it might be necessary to verify the data with independent groups (volunteers, scientists). The results of the project should be made available to different groups in different ways to generate and increase the impact. There might be a need to convince policy makers, businesses, legal professionals. This is particularly true for the CSI-COP project which covers the interests of almost everyone. A successful ending of the project requires the engagement of all individuals who share the collective goals (Hano et. al., 2020). Furthermore, Citizen Science projects may need to be maintained for a long time if they address fundamental problems - this puts special requirements on their organization. The famous Krefeld study (Hallmann et all, 2017) took 27 years for the first significant results.

Smoke Sense is a citizen science project conducted by The US Environmental Protection Agency (EPA) that “aims to reduce the public health burden of wildland fire smoke” (Hano et. al., 2020). It has aroused interest among organizations which have a similar purpose. Recognizing that interest, these organizations see the project in support of their missions. Latham and Ceccaroni (2020) identifies common goals with important organizations as

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

highly significant elements of citizen science projects, supporting the engagement of citizen scientists.

Involving volunteers in the multi-phases of the citizen science projects can generate affective connections with the project such as a sense of belonging and responsibility and feeling valued (Latham and Ceccaroni, 2020). An illustrative example of cooperating with volunteers beyond data collections is the long-term pollinator monitoring citizen science project which involves volunteers far beyond data collections (Serret et al., 2019). Strong community network between all the participants was built through the websites because of the fact that any participant could comment on observations of others and notify them of potential incorrect identification or misapplied protocol. Again, the use of new technologies and digital applications proves significant in accomplishing long term citizen science engagement due to its convenience in collecting large amounts of data.

In compliance with Latham and Ceccaroni (2020) to reach continuous engagement of citizen scientists, regular communication with them must be ensured. Online communities, forums, and designated contact points of project partners play critical roles in sustaining participant assistance and care and need adequate resources. Last but not least, giving the appropriate credits to the volunteers provides a continuous engagement as well. (Latham and Ceccaroni, 2020).

In conclusion, the planning of CSI-COP should not only include preparation and data collecting, but also a substantial 'implication' and outreach phase. Apart from publishing the data most efficiently, possible future partners and allies for verifying and spreading the data should be identified and contacted. Participants of the study should be appropriately rewarded/acknowledged and contacts with them kept (Alumni).

P12: Connect with local and regional / national / global mass media

Collaborating with the media, in particular the local media (regional TV or (free) newspaper) offers an excellent multiplicator to Citizen Science activities. Using its wide distribution, it can reach a large audience; further it offers an easy platform for discussions. On the other

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

hand, the medium may benefit by increasing its distribution. Depending on the research question, collaborations with other partners, like local NGO's, professional organizations as well as other citizen science projects can be beneficial (Duzi at al.2019). Overgaard and Kaarsted (2018) also argue that the implicit science communication extends trust to research and results.

A successful example is 'A Healthier Funen', a citizen science project of the University of Southern Denmark (SDU), Odense University Hospital (OUH), and TV2/Fyn (regional broadcaster) on the island of Funen, Denmark (Overgaard and Kaarsted, 2018).

Land-Zandstra et al. (2016) points out another type of media presence within the iSPEX citizen science project on aerosols, by using the dedicated iSPEX app. Here, the media took a role in the project' recruitment phase, when participants were recruited through newspapers, television, science magazines which were also the tools helping participants to understand the project and its purpose. Involving local media helped understand the Citizens concerns and indeed projects on local interests enjoyed a sustained engagement of participants (Latham and Ceccaroni, 2020).

P13: Acknowledge the local differences

Every community has its own characteristics, values and culture which may influence the engagement planning and the outcome of a project, apart from the fact that certain research questions have different local concern. The 'scientific landscape' (presence of universities, academies, learned societies or dedicated research institutes) formed by traditions are different and the knowledge about Citizen Science may vary. Similarly, there are significant variations in the societal behaviours which could be determinant for the engagement with volunteers in different communities.

For instance, in the Czech Republic first projects started only in 2018, (Duzi et al., 2019), Moreover, cooperation with NGO's varies strongly (Hecker, Garbe and Bonn, 2018). These specificities should be considered when addressing local subjects and citizens. And,

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

important for CSI-COP, different countries have different data protection laws and the knowledge of the GDPR might vary accordingly. For instance, in Finland the national data protection law (tietosuojalaki 1050/2018) complements the GDPR in specific ways. Read more about this in P18: Consider both the European GDPR and the local data protection acts.

Thus, the engagement and research plans should carefully look into these differences, in particular laws and attitudes towards the legal frameworks. In countries that have been less exposed to Citizen Science, links to established projects might be useful.

Not least, at the final stages of a project, people in different countries might enjoy different rewards and acknowledgments of their work.

P14: Create a scientific visibility programme

Apart from a broad visibility in society (see P15), results from projects like CSI-COP must be made visible not only in the scientific community, but also at the political level because the results may have direct consequences on regulatory work. Proper communication into the scientific community is important for acceptance, quality of the research and wide international attention. While the (professional) scientists in the project can build on their experience and established networks and conferences, reaching policy makers is often difficult and may require sustained initiatives. It is (also) here that the work after ending data collection (P11) is important.

Scientific community
Since scientific communities are quite specialized while the scope of CSI-COP is wide, the communication may go beyond the traditional ways which are:

- Reflect on the targeted audiences
- Contact international colleagues
- Submit papers to appropriate journals
- Present the project and results at conferences and connect with the participants
- Connect with academic and research libraries (at least those near the CSI-COP Partners)

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Related to the above examples, it is recommended to have a follow-up protocol for continued communication, to further engage with the people that showed initial interest.

Policy making community

Example of actions that could increase the visibility at the level of policymakers are:

- Involve policymakers from the start of the project
- Continue regular communication with policymakers
- Take active roles in public discussions, especially to those that are professionally moderated

Scivil (2019) created the report "Communication in Citizen Science: A practical guide to communication and engagement in citizen science". From this report we learned that entering the media's radar isn't the only way to make your cause more visible, there are plenty of strategies that can successfully boost the visibility. One way is to introduce your project at the conference by connecting with its participants. Large societies and networks are usually on the lookout for a new angle or to inject new life into their annually recurring initiatives. (Veeckman, C. et al, 2019). Connecting with academic and research libraries from where the CSI-COP partners are might be fruitful as they could put you in touch with the right audience. Another good advice is to go local and to partner with cultural centres, museums, or even sport clubs and music societies. Having a follow-up process is a good idea, since that can make you engage further with your audience. Submitting papers, creating leaflets, book-marks and business cards will also give prominence to the CSI-COP project. You can even go for some more unconventional approach like making laptop stickers with a witty message, to be distributed to scientific and professional conferences.

P15: Create a broader visibility programme

Since the community targeted by a CSI-COP is very diverse, the engagement must similarly be varied. For that, a broad visibility program is recommended. Furthermore, it is an effective method, as an ongoing cumulative process through empowering relationships and trust between participants. See (Veeckman, 2019) for some general ideas.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Outside of the scientific themes, there are several community engagement platforms which could inspire CSI-COP and other citizen science projects: A partial list includes:

1. A Community Planning Toolkit for Community Engagement. See Community Places (2014) which also lists the 10 Scottish National Standards for Community Engagement that provide a useful reference point for ensuring a quality and effective engagement process.

2. Another tool is VOiCE - Visioning Outcomes in Community Engagement. It is an IT based tool which supports the process of analysis, planning, implementation and evaluation (VOiCE, n.d).

3. Choosing among several engagement methods could be difficult. Therefore, it is important to use tools that help choose an effective engagement method. Dialogue Designer: uses information on the project to suggest the most suitable method(s) for the needs and budget (Dialogue Designer, n.d).

4. Similarly, Process Planner uses information on the project like scope, purpose, participants, context, follow Up, expected results (People and Participation, n.d.).

Finally, consider specific steps to engage citizens like in these examples

- Engage in a professional manner with appropriate social media accounts (e.g. Dark Patterns); contribute and benefit of their community to recruit in CSI-COP project.
- Connect with public and school libraries (at least those from the institution and from the city where CSI-COP Partners are). Distribute bookmarks to be given with each book that is borrowed.
- Make sure the CSI-COP website gains wide visibility and attractiveness.
- Create leaflets, bookmarks, business cards etc. to be distributed whenever an opportunity occurs; please consider the impact of COVID-19.

P16: A few notes on the practices of "Gamification" or/and "Seriousification"

While the CSI-COP proposal doesn't include a plan to create a game, we give a short overview on why and how games are used in Citizen Science projects (in fact, professional

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

scientists regularly use simulations which are not far from games). This short overview could be especially useful for CSI-COP partners for the cases when their interactions with volunteers could come across with the use of games for scientific purposes.

"Gamification—the application of game elements in a non-game context—is an effective tool with which to enable citizen scientists to provide solutions to research problems." (Sørensen J. J. W. H. et al., 2015, p. 1). Games have helped scientists solve complicated categorizations and even research questions and they are often quite motivating and fun (Crowston K., Prestopnik N., Wang J., 2017). The competitive angle of games provides a further motivation ("who finds the most?") (Ouyang, W., Winsnes, C.F., Hjelmare, M. et al., 2019).

Three circumstances are especially suited for gamification:

- Citizen Science projects that are trying to solve hard problems and search for non-standard solutions - see eteRNA (eternagame.org, n.d.) and FoldIT (Fold.it, 2020).
- Citizen Science projects that collect data for research on human behavior studied in the context of a well-designed game. A good example is research into Alzheimer disease (seaheroquest.com, 2020).
- Gamification is an attractive tool to foster public interest in complex phenomena like the role of science in modern society (www.frankenstein 200.org, n.d.).

Prestopnik and Crowston (2011) sum it up as follows:

- "For participants: The more fun a project is, the more motivated participants will be to continue or expand their participation."
- "For outsiders: The more fun a project seems to be from an outside perspective, the more motivated outsiders will be to sign up and begin participating."

It is worth mentioning a separate concept which refers to the inclusion of scientific tasks into existing games, especially in those played by large communities. This concept is sometimes called "seriousification". The main difference between "gamification" and "seriousification" is that the second is not creating a new, bespoke game. Rather differently, it uses existing games, benefiting from an existing community of enthusiastic players which could solve scientific tasks (e.g. classifications), as part of their game progress. A remarkable example is

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

the participation of 332,006 gamers who did important classifications for Cell Atlas of the Human Protein Atlas (HPA) and contributed to further development of deep learning applications for that project (Sullivan et al., 2018)

P17: Special Recommendation on Dark Patterns and Persuasive Technologies

Since the topic of CSI-COP is dealing with the detection of privacy threatening elements in websites and apps we considered it's very important to draw special attention to a practice that is spreading fast among those that track users' activities.

Henry Brignull introduced the term Dark Patterns which refers to design elements in websites, apps and other digital environments made by purpose to trick, misguide, confuse and hide information from users in digital interfaces (Darkpatterns.org, 2018). Although users care about privacy, online platforms control decisions and encourage them to abandon privacy issues (Waldman A. E., 2019). These well-designed features perversely drive users to allow digital intruders, to overlook further options and information (such as hidden costs) on the device or to purchase more than they intended. Also, they usually distract attention from the fact that users are unwillingly sharing information and even unveil publicly their behavior.

Apart from such privacy and liability issues, dark patterns could also distort the quality of the citizens' contribution to CSI-COP or other citizens by hiding trackers or make them less visible.

Users therefore need a better recognition of dark patterns both in the Internet and mobile applications. Privacy patterns and privacy strategies support privacy-aware development processes for IT systems. Privacy patterns help to detect possible privacy issues during implementation and user interface design by providing a well-structured description of a problem and offering solutions by standardized templates. (Bösch C., Erb B., Karl F., Kopp H. and Pfattheicher S., 2016).

The concept of persuasive technology refers to technology that aims to influence behavior and decision of users through persuasion without forcing them (Frogg B.J., 1990). This

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

technology is now largely used to influence users to take pre-designed decisions and to drive increased attention to certain content. Persuasive technology is the secret ingredient of the success behind social networking; it is the way how Internet influencers are born and grown and how online radicalization happens.

The Stanford Persuasive Technology Lab was established in 1997 to teach ethical persuasive technology methods. Since values of ethics are diverse, ethical guidelines and systems will not fit in all of the cases. However, "a few core values should apply to all persuasive computing designs, such as avoiding deception, respecting individual privacy, and enhancing personal freedom." (Frogg, 1998, p. 230).

Therefore, it is recommended that CSI-COP considers including in its training program a section dedicated to raising awareness about dark patterns and other persuasive technologies.

Another recommendation is to give further considerations during the project to various consequences that dark patterns or persuasive technologies may have on the project itself, such as citizens omitting certain data.

P18: Consider both the European GDPR and the local data protection acts

The CSI-COP project concerns informal education about the rights conferred under GDPR. Best practices will be developed to ensure (and possibly test) no-tracking of the citizen scientists as they are recruited to take part in the project. While citizen scientists investigate cookies and smartphone apps in their own time, we will not ask CSI-COP citizen scientists to download any kind of app to take part in this project. Citizen scientists will co-design and share the taxonomy of trackers found in their investigations and co-innovate the online knowledge resource. This participating style shall motivate the recruited citizen scientists and ensure they feel part of the CSI-COP community leaving a lasting legacy of changing the widespread digital practice of tracking-by-default.

In addition to the European GDPR, data protection legislation exists in the CSI-COP consortium member countries. In the following, we will review privacy and personal data protection regulations and laws in Finland, the Czech Republic, Greece and Israel, to

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

highlight the importance of such local legal framework. The citizens may investigate what specific changes this implies for these countries. It is therefore advised that the citizens in these countries and those that come from other countries are informed about the specifics of their respective laws.

In Finland, privacy of individuals is written in the Constitution and personal data processing was regulated by the person register law (Henkilörekisterilaki) 471/1987. The Personal Data Law (Henkilötietolaki) 523/1999 regulated data protection before GDPR, but it adopted some of its principles, such as permission of data subject and the processes concerning personal data registers (Oy, E.P., n.d.). Currently, the Data Protection Law (Tietosuojalaki) 1050/2018 clarifies and complements the GDPR and abrogates the Personal Data Law 523/1999 ("FINLEX ® - Etusivu", n.d.). Finland applies the Data Protection Law and GDPR also in the cases of GDPR article 2, 2(a) and 2(b), if not covered by other legislation (1050/2018, § 2). On the other hand, law enforcement and national security are kept out of the scope of 1050/2018 and regulated by a separate law (article 2).

In the Czech Republic, the Personal Data Processing Act (denoted as Act No. 110/2019 Sb.) implementing EU Regulation 2016/679 (GDPR) was adopted on 24.4. 2019 and came into effect on the same day. Its English translation is available on the official webpage of the Czech Office for personal data protection (www.uoou.cz, n.d.). This Act replaced the Personal Data Protection Act (Act No. 101/2000 Coll., On Personal Data Protection and on Amendments to Certain Acts) the basic legal regulation governing the protection of personal data and the activities of the Office for Personal Data Protection in 2000–2019.

Greece's latest legislation regarding the General Data Protection Regulation (GDPR) is Law N.4624/2019, which came into force the 29th of August 2019. It was the overdue incorporation into Greek national law of the Directive (EU) 2016/680 and the Regulation (EU) 2016/679 about the protection of natural persons with regard to the processing of personal data and on the free movement of such data. From that date on (29.08.2019) the previous law N.2492/1997 was abolished. The English version of the Greek law is a work in progress, as can be read in the website of the Hellenic Data Protection Authority (HDPA)

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Israel's new Privacy Protection Regulations (Data Protection), 5777-2017, came into force May 2018, implement the data security requirements put forth by the Privacy Protection Act, 5741-1981 which impose new obligations on individuals and entities that collect, store, manage personal data or own databases containing personal data. (Shaked A., 2017, p. 1022.)

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Appendixes

In the appendices that follow, for each of the T2.1 research question we present comprehensive research findings from a broad corpus of literature on citizen science and citizen science projects.

Appendix 1: Do citizen scientists develop scientific skills and competencies?

The question of skills developed encapsulates a very important aspect: do citizens already have scientific knowledge? Knowledge of a science, however, is different from possessing the skills to informally engage in that science and contributing to its progress. Science education is an important goal for many citizen science projects.

Open Knowledge Finland (2017) recommends that as a prerequisite for skills building, digital skills (how to use the Internet, programming, data skills, etc.) should be taught at all school levels.

Citizen science projects show that this is the case, citizens' scientific skills and competencies are developed through participation.

Evidence shows that participation in citizen science projects provides further learning opportunities (Martin, 2016a, 2016b), and extends the learning experience (Price & Lee, 2013). As a means of learning in context, while involved in given tasks, the advantage is experiential learning that enhances citizen scientists' knowledge acquisition (Brossard, 2005). The experiential learning gained from engagement in real-world scientific projects that involve connecting with nature may increase individuals' environmental awareness and concern (Brossard, Lewenstein, & Bonney, 2005).

Through engagement with professional scientists, citizen scientists gain a valuable opportunity to "learn and generate knowledge" (Cappa et al. (2016p. 246). The informal learning experience from participating in citizen science projects, provides a valuable opportunity to understand the procedures of formal science, including gathering data, testing hypotheses, and modeling outcomes. Jordan, Ballard, and Phillips (2012).

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Additionally, citizen scientists learn the importance of validating research results. For example, in iSCAPE Living Labs Citizen Science project citizen scientists used cheap sensors for their research but had the possibility to compare their accuracy when compared with more precise and expensive sensing systems. The comparison showed that results were not substantially different. (Avoinvirta 2018). It could be assumed that this validation gave citizens the feeling of producing results actually scientifically valid and usable.

Leveraging citizen scientists' natural enthusiasm has helped in observing odd auroras leading to enquiries placed to a space physics professor (Näveri, 2020). New observations were made, and citizens gave the new aurora form a name. This was the first time worldwide an aurora was discovered by citizens supporting the professor's discovery of the nature of the aurora type. The citizen scientists were included as authors of the derived scientific article (Palmroth et al., 2020).

Evidence from published papers over the past few years do show gains in participant knowledge of scientific content. For example, participants in The Birdhouse Network (TBN), funded by the US NSF, placed nest boxes in the neighbourhoods and collected data about the birds' bred during spring and summer. Participants in the early years of this project showed statistically significant increases in their knowledge of bird biology (Brossard et al., 2005). The final evaluation report of the BirdSleuth project showed that students who participated in the project demonstrated increased knowledge of bird biology, communication, and identification. They learned to use a field guide as a tool for obtaining information about bird species. Students' definition of hypothesis became more refined, and they showed understanding of key features of scientific investigations and the nature of scientific research. Participants enjoyed the curriculum and felt that they would like to count and study birds again in the future (Thompson, 2007). Student assessments revealed that GLOBE students scored higher in their knowledge of sampling, measurement, and data interpretation than students who had not been exposed to GLOBE. Most youth in WINGS project (62%) did report that participation increased their interest in science, and many reported that it helped them to think more positively about science (Koke et al., 2007; Calabrese Barton, 2012).

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

However, the risk of misunderstood communication or inadequate training could prevent participants in citizen science projects from increasing their knowledge or skills in the scientific field of the projects. For example, studies showed that participants in the invasive plant recognition training did not increase their understanding of how scientific research is conducted (Jordan et al., 2011). Participants in TBN showed little to no change in attitude as a result of project participation (Brossard et al., 2005). In the NISS program, evaluators found no changes in desired behaviours related to improving habitats, engaging in political processes, or feeling empowered to make changes. Adult mentors involved with the Monarch Larva Monitoring Project (MLMP), based at the University of Minnesota, note that the participating youth appreciated the social aspects of the program, engaging in "science bonding" (Kountoupes and Oberhauser, 2008).

Appendix 2: Does participation act as a motivator, leading to informal and formal science education?

There is a variety of reasons that stimulate individuals towards volunteering in citizen science projects. Participants in citizen science projects have collaborated "in exchange of a reward or just for the pleasure of completing the task" (Cappa et al., 2016, p. 246)

Well known motives are: (1) **willingness** and **desire to contribute in science**; (2) **desire to learn science** by involving in Citizen Science; (3) **for fun** and enjoyment through game playing, or another interactive project participation (Tweddle et al., 2012; Nov et al., 2011).

According to Bonney et al. (2016) the main motivations for initial participation are: **easy discovery of interesting citizen science projects**, and the ease and simplicity of launching the project, with quick, easy and secure project setup.

Alender (2016) reported that citizen scientists have "complex motivations" (p.1). Volunteer motivation to participate included (1) **values**— **altruism** and concern for others, (2) **understanding**, (3) **social**, (4) **career**, (5) **ego protective**—escape from negative feelings, and (6) **ego enhancement**— personal growth and self-esteem (in Alender (2016) bid). Studies show that participants' engagement was motivated by trainings and constant follow-

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

up among their peers. Examples include acknowledgement of successful scientific achievements through being named as co-authors in academic publications.

One way to measure the effectiveness of citizen science participation is shown in Cappa et al. (2016): the contribution by a large number of citizen scientists collaborating with professional scientists "potentially **helps expedite research projects**" while "**reducing their overall cost**" of research projects (p.246). These researchers add "the **benefits for researchers and citizens**, citizen science represents a potential means to **raise social innovation** by **addressing problems of social interest** through new aggregations of collaborating individuals" (Cappa et al., 2016, p. 257). In environmental studies, Cappa et al. (2016) inform that engaging citizens "is crucial to sustain the environment", for example, in "monitoring birds, air pollution, and deforestation around the world" (ibid).

To minimise the risk of drop-out and ensure continued engagement through contributions and sustained motivation citizen science "scholars are paying increasing attention to the **study of mechanisms to foster participation"** (Cappa et al., 2016, p. 257). Design elements in computer-mediated projects are crucial (ibid). Motivated citizen scientists participating in projects have been encouraged "**to increase referral intention"** by **attracting** other citizen scientists (Cappa et al., 2016, p. 257).

For a long-term motivation and to ensure engagement for the life of the project and beyond, it is important that volunteers prefer to receive feedback and appreciation for their participation (Jennett and Cox,2014). This is made possible e.g. if citizen scientists have a means to easily measure or observe what they are learning while participating in the project or if the project meets volunteers' fun and enjoyment expectations (Jackson et al., 2015).

Appendix 3: Did citizen science participation counter perceived anti-intellectual attitudes in society?

We know from climate change denial, concerns about any effects from chemtrails and beliefs in some quarters on conspiracy theories, that there does exist in society an anti-intellectual attitude towards science and scientific experts.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Limited information is currently known regarding whether the participation in citizen science projects countered any anti-intellectual attitudes in society. It could be the case that individuals and groups motivated to take part in citizen science projects are those with an already high opinion of science. Another aspect is, that although some may use partial scientific information to form a point of view not borne of robust research, being critical of mainstream scientific practices, can arm civil lay scientists with expertise and knowledge (Callaghan, J. E., & Lazard, L. (2012).

As citizen science projects include the aim to increase participants' knowledge about science and the scientific process, so by opening up research to citizens the practice can change attitudes toward science and the environment. (Bonney, 2001; Bonney, & Krasny, 2004; Brossard, Lewenstein and Bonney, 2005).

What has emerged from different studies, including from 'crowd science', is a blurring of the line between institutional science and civil society. However, such collaborations do not fundamentally challenge institutional hierarchies. Crowd science confers social legitimacy on projects by involving non-experts, so be understood as one manifestation of an on-going shift in the relationship between institutional science and society at large (Scheliga et al. 2018).

The Climate Outreach initiative (2019) noted an issue in people who are strongly opposed to action on climate change. They found that there is no unique guidance for speaking to this audience so the principles of 'real talk' should apply. Better to engage by asking the person with a negative view to reflect on their values and life experience and focus on finding points of agreement and connections. The initiative warned to be aware that actively trying to counter disinformation about climate change can have the opposite effect of strengthening it in someone else's mind. The principle of respecting conversational partners should apply.

Cavalier (2016) found out that "in conversations with various government agencies and non-governmental organizations, **questions about whether citizen science results can be trusted were largely met with rebuff and frustration**. The generalized reaction was straightforward: real challenges with the data quality of citizen science parallel the challenges faced in all scientific work. In other words, the results produced by citizen scientists are not alone in needing to be carefully scrutinized on the basis of their methodology, quality

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

assurance, context, and application. Like all scientific findings, they are best served by careful evaluation on a case-by-case basis, and by integrating many different sources of data.

Cavalier (2016) found that: "… the very establishment of a techno-scientific elite excluded many from participating in science. Medical studies largely tested cures on male subjects over females. Many of the research questions considered tended to be those of interest to well-to-do populations over the impoverished (e.g., vastly more money goes into cosmetic R&D in America than into many deadly diseases in sub-Saharan Africa). Decades of exclusion have not only led to a distrust of the scientific enterprise, but also serious concerns over the legitimacy and accuracy of work that focused on an overly narrow population".

Again, Cavalier (2016) pointed out: "… in some ways citizen science represents a fundamental confrontation with the policy world. It reinvigorates questions about who ought to be involved in making decisions, how they ought to do so, and what norms and expectations define this new world. These subversions lead to challenging tensions that show up in seemingly unrelated policy questions, like those of legality, ethics, and the "ideal" scientific method".

Appendix 4: Raising scientific literacy through participation in citizen science projects

Citizen science projects are organized with the aim to establish cooperation with the general public. This can be to accumulate information or gather extensive data that are necessary in decision making, and that would be hard to obtain with the limited resources of academia. In some of citizen science projects, the expected input cannot be provided without specific skills or knowledge. These projects offer cost-free informal learning accompanied with necessary training to its citizen participants and sometimes even confirm the achieved knowledge level through dedicated certificates.

Participation in citizen science projects does improve scientific literacy of the participants (Price & Lee, 2013) as well as bolster quality of the obtained results. Pandya and Dibner's (2018) wrote, "If it is accepted that citizen science is a valuable tool for expanding and deepening scientific inquiry, then attending to the learning outcomes of participants should be

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

an important consideration for project designers. This, in itself, is one way that advancing learning and advancing science are compatible: More science learning by participants has the potential to improve their contribution to the project and potentially enhance the chance of the discovery and scientific advancement in the project." (p.20).

The Real Astronomy Discovery at home, RAD@home project exemplified this (avialxee, 2013). Founded in 2013 RAD@home project designed its own educational solution, *Any BSc/BE Can Do research* (#ABCDresearch). The project offered several levels that ranged from Discovery Camps over e-classes up to peer learning. Having learnt the basic concepts, analysis tools and techniques and having understood the research interests of the collaborating community, the project's graduates become e-astronomers and continued to learn, discover, and contribute through biweekly Facebook e-classes and e-research sessions conducted by the principal investigator (PI) of the project. RAD@home participants contributed to a number of significant discoveries. A similar approach spanned through different countries including in Europe with European citizens given the opportunity to contribute development of science.

EU project DITO: Doing It Together (DITO, n.d.) organized more than 500 innovative workshops, exhibitions and activities during 2016-2019 in 9 European countries with the aim to encourage active involvement of European citizens in science. With this initiative, universities and research institutions collaborated together to create workshops, informative meetings, exhibitions and activities that promoted scientific literacy and citizen science.

Appendix 5: Social inclusion and employability

Participation of diverse citizen is *per se* an important social inclusion factor, and it also enriches the project's capital, since everyone brings their own expertise of any form. Social inclusion is seen as an enabler for multi-disciplinary and cross-fertilization methods. In cross-fertilization, everyone, even a so-called layman, brings something. For example, a sociologist is a layman in cosmology and vice versa in sociology (Laine 2018). Active participation in a field in which a person would not, at least initially, have expertise, may open possibilities, including employability, in those previously "foreign" knowledge fields.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

The most effective citizen science projects would be those which can reach the widest set of potential participants securing citizen science participation through disseminating **accessibility to opportunities** (Fagan and Holland, 2007). One pressing issue within dissemination is the **digital divide.** The digital divide is the concept of **information poverty** – as Molinari (2011) defines: "the gap between individuals and communities that have access to information technologies and those that don't", or simply "those who have access and those who do not" to the Internet (Hulegaard, n.d.). Estacio et al. (2019) noted in North America and Europe people's "socio-economic and demographic factors, such as age, income, education and health status were predictors of people's likelihood to access and use the internet to seek health information" (p.1668-1669).

The digital divide, which leads to **social and employability exclusion**, is manifested through that part of the population that does not have access to the Internet. Karim (2018) points out that "a good third of the world population … are still outside internet coverage. The bulk of these people living outside the world of internet are in Africa, Asia and Latin America". In the European Union (EU) the digital divide affected under 10 per cent of the twenty-eight member countries as at June 30, 2019 (IWS, 2019). However, Internet penetration varied across the twenty EU countries with Estonia reaching 97.9% of its population, but Bulgaria reaching 66.7% of its population (ibid). In the CSI-COP project the challenge to capture a wider range of participants who might not have Broadband at home will be to use the consortium's networks of networks, including libraries and stakeholder's with initiatives aimed at bridging the digital divide. Free-to-attend informal education CSI-COP workshops and a free online MOOC will be a start to address the digital divide in the CSI-COP project.

Where accessibility has not been an issue, participants in citizen projects moved from peripheral roles to central position in the group, (Jackson, 2015), leadership is one of the motivations to participate (Tipaldo & Allamano, 2017), the participants were able to take active part in decision making processes to achieve justice (Dhillon, 2017). They shared knowledge with each other, they built networks and utilized IT technologies and collaboration with government authorities to promote their missions (Nerbonne & Nelson, 2004).

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

To enhance the employability of its participants, the Phylo citizen science project (phylo.info, n.d.) offered as a service free information on professional opportunities and activities. This included job listings and placement records.

Appendix 6: Best tools for citizen science reporting and interaction with researchers

The working group of the Flemish Knowledge Centre for Citizen Science documented into a guide, '*Communication in Citizen Science',* its expertise in effective communication with the general public (Veeckman et al., 2019). The guide focussed mainly on the tools for recruiting and permanently engaging citizen scientists. They distinguished between generic approaches relying on traditional media (press, flyers, social media, etc.) and specific approaches (collaboration with existing networks and communities) to carefully explain **six tactics** that proved to be useful in appropriate projects:

- Hitch a ride on existing networks
- Offer a fun experience
- Use social media
- Digital storytelling
- Gamification
- Find project ambassadors

To ensure continuing and successful interaction between citizen scientists and project researchers, some of citizen science projects try to **employ creativity**, **imagination** and **intuition** of the involved citizen scientists to solve some challenging real-life problems that are presented in a form of a game or a puzzle. This approach proved to be very attractive e.g. in the projects *Eterna - Invent Medicine* (eternagame, n.d.) dedicated to design of novel molecular medicines. Similarly, in FoldIT (2020) a project that attempted to predict the structure of a protein or to fold the best proteins for specific purpose. To motivate their citizen scientists, project websites take advantage of some psychological effects that are characteristic for game context, namely they stimulate

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

- competitiveness among citizen scientists by informing about recent top achievers (e.g. Top Soloist of this week, Top Soloist of this month, Soloist Hall of Fame)
- a sense of belonging when supporting development of teams or when offering information about the number of participants that are at the same moment working online (e.g. the number of players on 11.3.2020 at 0.52 am was 28).

As a part of the interaction between professional researchers and citizen scientists, it was found that guidelines and procedures should be made clear to everyone. In particular, the constraints and rules concerning the use of digital data should be explained in terms understandable to everyone (Open Knowledge Finland 2017). Of critical importance are **ethical boundary conditions**, which must apply to all involved: professional scientists and citizen scientists (Laine 2018). Moreover, good scientific practices should be elaborated clearly to improve the quality of citizen science (Open Knowledge Finland 2017).

In the context of reporting tools for citizen scientists to convey their findings, various citizen science applications exist. These applications and tools are specifically to communicate findings and upload data realised from citizen science research. Applications can be designed bespoke, so developed for the specific needs of the project. Off-the shelf citizen science reporting tools do exist, they include:

- Anecdata
- iNaturalist
- Sapelli
- Spotteron
- Opendatakit
- ArcGIS's Survey123
- ClimateScan

What embedded trackers are in contained these citizen science reporting tools is outside the scope of this project. The CSI-COP project will co-innovate with its citizen scientists a novel cookie and tracker free, GDPR compliant reporting tool.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Appendix 7: Best platforms for managing citizen scientists' data collection

Similar to citizen science reporting tools, when it comes to selecting a platform for a citizen science project, there are three available options (Citizen science, n.d.):

1. Design a customized one
2. Use one of the existing platforms or
3. Mash-up (use existing platform like Google Form for a CS project)

The decision on which is the best option depends on the specific project. The following steps can help citizen science project designers to decide (Citizen science, n.d.):

- Write down goals and keep in mind the budget, as these two will define your options.
- While using a free platform could be ideal for testing out ideas, in the long run this could prove ineffective, as free platforms can change without much input from users. In the long term, a more stable platform should be considered.
- Be in the market for potential partnerships.
- Outline the characteristics of the participants, decide the number required and lay down the recruitment plan.
  - Join forces with existing citizen science projects
  - Decide if you have appropriately set barriers to entry for users.
- Take into account the following limitations and special needs for the platform features:
  - Language impediments
  - Meta data of the platform is a crucial feature for using the data
  - Find out if there are existing techniques of data gathering. If so, what they are
  - Keeping people engaged at all times, if possible
- Devise plans for the coalescence of geeks and scientists
  - Challenges regarding data and other similar events
  - Corporate social responsibility by asking tech companies to do pro bono work
  - Partner with other organizations for extra cyber infrastructure

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

- Reporting of data should be decided upon the intended outcome of the project. This will determine the level of credibility needed. For example, in order to sway policymaking, data collected and reports to policy makers have to be robust.
- Evaluation metrics for a broad and multi-faceted review of platforms (Azavea and Scistarter, 2014)
    - General
    - Flexibility
    - Display, visualization, and publication
    - Technology of the platform
    - Social, marketing, and incentives
    - Data quality
    - Cost for a new project
- Existing platforms for data collection, management, and sharing (Citizen science, n.d.):
    - iNaturalistCit Sci Platform - http://inaturalist.org
    - OpenStreetMapSpatial Data Repository (only some data is appropriate for OSM) - http://openstreetmap.org
    - HubnetCit Sci Platform - http://HubNet.nationalfield.org
    - eBirdCit Sci Platform - http://ebird.org/content/ebird/
    - SciStarterCit Sci Platform - https://scistarter.com/
    - Instagram/Twitter - use a specific hashtag to filterSocial Media Alternatives
    - FormhubResearch and Data Collection - https://formhub.org/
    - Open Data KitResearch and Data Collection - https://opendatakit.org/
    - Datahub.io Data Repository - http://datahub.io
    - Google Forms / Google Sheets Data Collection and Management
    - Google Fusion Tables Reporting
    - Carto.com*Reporting/ Mapping
    - JotForm.com*Data Collection and Management

Several popular platforms are currently used to announce projects and make citizen scientists aware how to apply to be a part. For example:

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

- SciStarter,
- Zooniverse,
- CitSci.org,
- schweiz-forscht.ch

Comparison of citizen science platforms has been undertaken by Yadav and Darlington (2016). They compared platforms such as Zooniverse, CitizenGrid, World Community Grid, EpiCollect and CrowdCrafting. Most do not provide interaction and do not show comparative performance. However, they are open-source and provide do-it-yourself options. All consider participants' privacy issues. The platforms use social networks for advertisement and participant recruitment, e.g. by using 'followers' feature in social networks.

For this deliverable, the CSI-COP consortium examined the information on citizen science platforms beginning with SciStarter, the foremost citizen science platform. It currently presents information on 1315 projects for citizen science participation across all age ranges, 6-10 years, through graduate students, families and seniors. The project topics are wide-ranging and are alphabetically categorised from agriculture to science policy. The most relevant to CSI-COP are the one hundred and eighty-four projects categorised as 'computing and technology'. These projects include 'Living with machines', a UK British Library citizen science project that seeks "to understand what kinds of accidents affected workers as machines were introduced in the Industrial Revolution". For this project citizen scientists are asked to classify articles in digitised newspapers, "because computers can't match human ability in understanding historical text" (British Library n.d.). Interestingly, the SciStarter information on this British Library projects links to Zooniverse showing synergy between these two citizen science projects' information platforms. As of March 2020, Zooniverse itself stores information on 100 projects in a wide range of topics from Art through climate, physics and others to social sciences.

Another major online platform for citizen science engagement include NASA (n.d). In one citizen science engagement with NASA, citizen scientists were provided with the opportunity to act as amateur astronomers. Citizen scientists assisted NASA's scientists volunteering as a "virtual imaging team". Using their own telescopes citizen scientists were tasked with

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

exploring and submitting their images of the planet Jupiter. Benefits of participating in NASA's Jupiter project was to "contribute to Juno mission decision-making and image analysis. This helped NASA to know what its colour camera JunoCam should see as it passed over Jupiter (NASA, 2016).

The UK's British Broadcasting Corporation (BBC) uses its extensive web-based presence to link interested volunteers with citizen science projects, including links to Zooniverse. The BBC inform on how to get involved in citizen science nature projects such as 'Garden Bird Watch', ‘Big Butterfly count', or create citizen science projects. (2020).

London's Natural History Museum (NHM, n.d.), like the BBC uses its webpages to promote citizen science engagement in a variety of projects. These include opportunities to take part helping researchers to understand how diversity evolved to produce colourful bird plumage: 'Project Plumage'. The 'Big Seaweed' project entails citizen scientists helping marine researchers by exploring the UK coastline. Reporting stranded whales is another NHM citizen science project that engages volunteers in supporting UK marine mammal research. Such is the assortment of NHM's citizen science nature explorations that they too include space science. NHM's 'Star-spotting experiment' provides an opportunity for citizen scientists to collaborate "in a European-wide experiment to map the extent of light pollution affecting the night sky" (NHM, n.d.).

Local libraries could also be providing information on local citizen science engagement activities.

Appendix 8: Existing types of platforms used by citizen scientists and experiences with them

In a manner of speaking, open-source software collaboration is a type of online platform for citizen scientists to work alongside professionals and expert programmers. Hemetsberger and Reinhardt (2006), reported that this sort of platform for collaboration was a "decentralised, self-directed, highly interactive and knowledge-intensive process" (p.188). Open-source

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

communities, such as **GitHub** can provide some valuable insights into the experiences of collaborators. The success of open-source platforms is due to factors including:

- make the project easy to understand
- explain contribution clearly
- build personal relationships
- make contributors feel included
- set-up a code of conduct

Hemetsberger and Reinhardt (2006), cite studies that show open-source platforms as models of "**community-based knowledge creation**" that could be providing a "**strong group culture** with **clear rules** and **norms**" with "patterns of behaviour" that "**enhance commitment** and **foster high-quality team-work**" (p.188). This way of considering "**knowledge as socially constructed"** (Hemetsberger and Reinhardt, 2006, p.189) could help to sustain communities of citizen scientists.

Appendix 9: Challenges in management of collected data

Challenges in the management of collected data include motivating citizen scientists to deliver their gathered data. The amount of data processed by citizen scientists is significant, but it is a small number of contributors who make a large share of the contributions (Sauermann and Franzoni, 2015). This is a pattern that has been shown in other online efforts such as Wikipedia as well as in some Data Collection projects. In fact, the researchers found that most participants contributed only once and with little effort, leaving the top 10% of contributors responsible for almost 80% of total classifications.

As noted in the findings to question 6 (Appendix 6), lack of proper training can also lead to citizen scientists providing less reliable data with errors, or even wrong results to the project (Follett and Strezov, 2015). Previous studies report a great disparity in the quality of citizen science projects' outcomes (Galbraith, 2016; Aceves-Bueno et al., 2017). Volunteer data is more variable than professionally collected data (Harvey et al. 2002, Uychiaoco et al. 2005, Belt and Krausman 2012, Moyer-Horner et al. 2012), specifically, there are problems with

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

citizen science data accuracy (e.g., Hochachka et al. 2012, Vermeiren et al. 2016). The main positive factors of influence on citizen science data quality were: marine or terrestrial environments location, longer participation length, larger group size, prior training and volunteer type (research on volunteer's economic and health situations improves the data accuracy). A longer participation length and holding a training session have a positive effect on the percent agreement, both with around 20% increases. Data quality was good in 73% of the papers' abstracts but comparison to the experts' data showed lower data quality (62% was not significantly different from experts; 55% of the comparisons reporting percent agreement had at least 80% agreement with professional data).

The following challenges need to be taken into account in citizen science projects (Silvertown, 2009):

- data collected by the public must be validated in some way;
- methods of data collection must be well designed and standardized;
- as many assumptions as possible must be made explicit;
- it is desirable to have a hypothesis in mind, even if it is only a question like: 'how is X changing' or 'how is Y distributed?'
- volunteers must receive feedback on their contribution as a reward for participation.

As already mentioned in an earlier appendix, one way to improve the quality of citizen science products, is not only to make the citizen scientists fully cognizant of the scientific processes but allow them to question the processes to understand and be part of the rationale for the decisions.

Appendix 10: Online support- requirements and experiences of citizen scientists

Support is necessary to ensure citizen scientists are clear about their role in the project, to monitor motivations and mitigate drop-out risk. Software tools that are used to support citizen science projects do have some limitations, including for guiding the participants and explaining how the data will be collected. Paper format has been adopted as the most accessible and future-proof publication medium. However, paper use does come with high

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

costs and is not efficient. The advancements of technology have reduced the cost of printing over time and print-on-demand services have become more and more affordable. Silvertown (2009) recommends offering downloadable hand-out e-books. In this way support can be further modified and fine-tuned with customized content to suit the needs of local participants.

With respect to experience of citizen scientists, it has been found that participants like to see that their efforts are appreciated, their contributions are considered meaningful, and fruitful for the growth of the project. Without this confirmation citizen scientists' interest can decrease and can be lost. Establishing an efficient management framework, utilising the best and timely communication channels between the researchers and the citizen scientists, is best to boost the eagerness of volunteers to continue in contributing into the project (Natureindex, 2019).

Leveraging online forums, target groups, organising face-to-face meetings, regular teleconference calls should ensure that the participants' feel connected, part of a research community whose output always matters. This will go some way to achieving a quality project, and importantly, help must be available in case of any queries, such as how to report gathered data for the scientific project.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Abbreviations, Acronyms and Symbols

Acronym	Definition
BBC	British Broadcasting Corporation
BSCS	Biological Sciences Curriculum Study (since 2018, BSCS Science Learning)
CoAct	Co- designing Citizen Social Science for Collective Action
CS	Citizen Science
CSA	Citizen Science Association (USA
CSI-COP	Citizen Scientists Investigating Cookies and App GDPR compliance
D2.1	Deliverable 2.1, this report
DMP	Data Management pPlan
DOAJ	Directory of Open Access Journals
DITO (project)	Doing It Together
EPA	US Environmental Protection Agency
EU	European Union
GDPR	General Data Protection Regulation (EU)
GLOBE (programme)	Global Learning and Observations to Benefit the Environment
H2020	Horizon 2020 (The EU Framework Programme for Research and Innovation)
HDPA	Hellenic Data Protection Authority
HPA	Human Protein Atlas
IB	Immer Besser GmbH (Task 2.1 leader)
iSPEX	(related to) Spectropolarimeter for Planetary EXploration (SPEX
M1, M2, etc	1st month, 2nd month, etc of CSI COP project
MLMP	Monarch Larva Monitoring Project
MOOC	Massive open online course
NASA	The National Aeronautics and Space Administration
NGO	Non- Governmental Organisation
NHM	Natural History Museum (London)
NISS	National Institute of Statistical Sciences
OUH	Odense University Hospital

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

PID	Personal Identifiable Data
R&D	Research and Development
SDU	University of Southern Denmark
SME	Small and medium- sized enterprises
SwafS	Science with and for Society funding (a Horizon 2020 programme)
T2.1	Task 2.1 of CSI- COP
TBN	The Birdhouse Network
UK	United Kingdom
US NSF	United States National Science Foundation
VOiCE	Visioning Outcomes in Community Engagement
WP	Work Package (example: WP1 means Work Package 1)

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

References

1. Aceves-Bueno, E., Adeleye, A.S., Feraud, M., Huang, Y., Tao, M., Yang, Y. & Anderson, S.E. (2017). The Accuracy of Citizen Science Data: A Quantitative Review. The Bulletin of the Ecological Society of America, [online] 98(4), pp.278–290. Available at: https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1336.
2. Alender, B. (2016). Understanding volunteer motivations to participate in citizen science projects: a deeper look at water quality monitoring. Journal of Science Communication, Vol. 15(3), 1-19
3. avialxee (2013). RAD@home - Home. [online] Radathomeindia.org. Available at: https://www.radathomeindia.org/
4. Avoinvirta (2018) Citizen sensors: Cooperative improvement of the environment, Open Knowledge Finland (Kansalaissensorit – yhteistoiminnallista elinympäristön parantamista, Open Knowledge Finland). Available: http://www.avoinvirta.fi/?p=69386. Accessed 28 Jan 2020.
5. Azavea and Scistarter (2014). A Distributed Data Collection Platform for Citizen Science Part 1: Data Collection Platform Evaluation. [online] azavea. Available at: https://www.azavea.com/reports/citizen-science-data-factory-project/ [Accessed 8 Mar. 2020].
6. Ballard, H, & Belsky, J. (2010). Participatory action research and environmental learning: Implications for resilient forests and communities. Environmental Education Research, 16(5), pp. 611–627.
7. BBC (2020). Do Something Great. BBC Citizen science. Accessed March 17, 2020 from here: https://www.bbc.co.uk/programmes/articles/4BZZdHm64S051q2lnZ1Nr7p/citizen-science
8. Belt, J. J., & Krausman, P. R. (2012). Evaluating population estimates of mountain goats based on citizen science. Wildlife Society Bulletin, 36, pp. 264–276.
9. Bonney, R. E. (2001). Observations count. Wild Earth 11(3–4), 18–23

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

10. Bonney, R., Phillips, T.B., Ballard, H.L. and Enck, J.W. (2015). Can citizen science enhance public understanding of science? Public Understanding of Science, 25(1), pp.2–16.
11. Bösch, C., Erb, B., Kargl, F., Kopp, H. and Pfattheicher, S. (2016). Tales from the Dark Side: Privacy Dark Strategies and Privacy Dark Patterns. Proceedings on Privacy Enhancing Technologies, 2016(4), pp.237–254.
12. British Library (n.d.). Living with Machines - citizen science project 'About'. Zooniverse. Accessed March 7, 2020 from here: https://www.zooniverse.org/projects/bldigital/living-with-machines/about/research
13. Brossard, D., Lewenstein, B. and Bonney, R. (2005). Scientific knowledge and attitude change: The impact of a citizen science project. International Journal of Science Education, 27(9), pp.1099–1121.
14. Calabrese Barton, A. (2012). Citizen(s') science. A response to "the future of citizen science." Democracy and Education, 20(2), pp. 12.
15. Cappa, F., Laut, J., Porfiri, M. and Giustiniano, L. (2018). Bring them aboard: Rewarding participation in technology-mediated citizen science projects. Computers in Human Behavior, [online] 89, pp.246–257. Available at: https://www.sciencedirect.com/science/article/pii/S0747563218303923 [Accessed 18 May 2019].
16. Cavalier, D., and Kennedy, E. B., eds. (2016). The Rightful Place of Science: Citizen Science. Tempe, AZ: Consortium for Science, Policy & Outcomes June . ISBN: 0692694838 ISBN-13: 978-0692694831
17. CitizenGrid (2015). Github Source-code. (2015). [online] Available at: https://github.com/ImperialCollegeLondon/citizengrid.
18. Citizen science. (n.d.). Online Platforms for Citizen Science. [online] Available at: https://citizensciencesoutheastasia.weebly.com/online-platforms-for-citizen-science.html [Accessed 8 Mar. 2020].
19. CoACT (2020). Co-designing Citizen Social Science for Collective Action. EU Horizon2020 SwafS project: CORDIS: https://cordis.europa.eu/project/id/873048
20. Community Planning toolkit Community EngagEmEnt. (2014). [online] Available at: https://www.communityplanningtoolkit.org/sites/default/files/Engagement.pdf.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

21. Crall, A, Jordan, R, Holfelder, K, Newman, G, Graham, J, & Waller, D. (2012). The impacts of an invasive species citizen science training program on participant attitudes, behavior, and science literacy. Public Understanding of Science, 22(6), pp. 745–764.
22. Crowdcrafting (2014). Middleware Platform for Citizen Science Projects. (2014). [online] Available at: http://crowdcrafting.org.
23. CSA Webinar: Balancing Citizen Science Data Collection Needs and Privacy Protections. (2020a). YouTube. Available at: https://www.youtube.com/watch?v=HPrMBb1S2VU
24. CSA Webinar: Engaging volunteers for long-term monitoring program success. (2020b). YouTube. Available at: https://www.youtube.com/watch?v=Zgm5gN4NOpk&feature=youtu.be [Accessed 10 Mar. 2020].
25. CSA WEBINAR: Wide Angle Lens of Volunteer Engagement with UMN Extension. (2019). YouTube. Available at: https://www.youtube.com/watch?v=3ZUHfD_1Weg [Accessed 10 Mar. 2020].
26. Curtis, V. (2018). Who Takes Part in Online Citizen Science? Online Citizen Science and the Widening of Academia, pp.45–68. DOI: https://doi.org/10.1007/978-3-319-77664-4_3
27. Darkpatterns.org. (2018). Dark Patterns. [online] Available at: https://www.darkpatterns.org/
28. Dhillon, C. M. (2017). Using citizen science in environmental justice: Participation and decision-making in a Southern California waste facility siting conflict. Local Environment, 22(12), pp. 1,479–1,496.
29. Dialogue Designer (n.d). “Dialogue Designer - Traverse.” Traverse.Ltd, traverse.ltd/dialogue-designer. Accessed 20 Apr. 2020.Duží, B., Osman, R., Lehejček, J., Nováková, E., Taraba, P. and Trojan, J. (2019). Exploring citizen science in post-socialist space: Uncovering its hidden character in the Czech Republic. Moravian Geographical Reports, 27(4), pp.241–253.
30. DITOs (2017) DITOs D3.1. Doing It Together Science. Deliverable of CS EU funded project – grant agreement 709443. Available from:

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

http://www.togetherscience.eu/content/3-about/2-deliverables/5-doing-it-together-science-d3-1-ditos-web/ditos-d3.1-20170130.pdf

31. Duží, B., Osman, R., Lehejček, J., Nováková, E., Taraba, P. and Trojan, J. (2019). Exploring citizen science in post-socialist space: Uncovering its hidden character in the Czech Republic. Moravian Geographical Reports, 27(4), pp.241–253.
32. Edelson, D. C., Kirn, S. L., & Workshop Participants. (2018). Designing citizen science for both science and education: A workshop report. (Technical Report No. 2018-01). Colorado Springs, CO: BSCS Science Learning.
33. Epicollect (2015). A Middleware platform for Citizen Science Data Collection Projects. (2015). [online] Available at: http://www.epicollect.net.
34. Estacio, E.V., Whittle, R. and Protheroe, J. (2019). The Digital Divide: Examining socio-demographic factors associated with health literacy, access and use of internet to seek health information. Journal of Health Psychology, Vol 24(2) 1668-1675.
35. Fagan, Joseph F., and Cynthia R. Holland (2007). “Racial Equality in Intelligence: Predictions from a Theory of Intelligence as Processing.” Intelligence, vol. 35, no. 4, July 2007, pp. 319–334, 10.1016/j.intell.2006.08.009. Accessed 20 Jan. 2020.
36. FINLEX - Etusivu.” Finlex.Fi, finlex.fi/. Accessed 27 Apr. 2020.
37. Fold.it. (2020). Solve Puzzles for Science | Foldit. [online] Available at: https://fold.it/portal/ [Accessed 21 Jan. 2020].
38. Follett, R. & Strezov, V. (2015). An Analysis of Citizen Science Based Research: Usage and Publication Patterns. PLoS ONE PLOS ONE, 10.
39. Frankenstein200.org. (2020). FRANKENSTEIN200: A multi-platform educational experience. [online] Available at: https://frankenstein200.org/.
40. Fogg, BJ. “Persuasive Computers: Perspectives and Research Directions.” Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI ’98, Jan. 1998, pp. 225–232, 10.1145/274644.274677. Accessed 24 Nov. 2019.
41. Gordon, M. (2013). West Oakland Environmental Indicators Project: Citizen Engagement to Measure and Improve Air Quality. https://obamawhitehouse.archives.gov/. Available at: https://obamawhitehouse.archives.gov/blog/2013/06/26/west-oakland-environmental-

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

indicators-project-citizen-engagement-measure-and-improve [Accessed 27 Apr. 2020].

42. Hallmann, C.A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans, W., Müller, A., Sumser, H., Hörren, T., Goulson, D. and de Kroon, H. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLOS ONE, [online] 12(10), p.e0185809. Available at: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0185809.
43. Hano, M.C., Wei, L., Hubbell, B. and Rappold, A.G. (2020). Scaling Up: Citizen Science Engagement and Impacts Beyond the Individual. Citizen Science: Theory and Practice, 5(1), p.1. DOI: http://doi.org/10.5334/cstp.244
44. Harvey, E., D. Fletcher, & M. Shortis. (2002). Estimation of reef fish length by divers and by stereovideo: a first comparison of the accuracy and precision in the field on living fish under operational conditions. Fisheries Research, 57, pp. 255–265.
45. Hecker, S., Muki Haklay, Bowser, A., Zen Mazuch, Johannes Vogel and Aletta Bonn (2018). Citizen science : innovation in open science, society and policy. London: Ucl Press. C.
46. Hemetsberger, A. and Reinhardt, C. (2006). Learning and knowledge-building in open-source communities. Management Learning, Vol. 37(2), 187-214
47. Hochachka, W. M., D. Fink, R. A. Hutchinson, D. Sheldon, W. K. Wong, & S. Kelling. (2012). Dataintensive science applied to broad-scale citizen science. Trends in Ecology & Evolution, 27, pp. 130–137.
48. Hulegaard, D. (n.d). The Digital Divide: What Works and What Doesn't. Academia.edu. Accessed March 2, 2020 from here: https://www.academia.edu/6642754/The_Digital_Divide_Causes_and_Solutions
49. IWS (2019). Internet Usage in the European Union 2019. Internet World Stats. Accessed March 2, 2020 from: https://www.internetworldstats.com/stats9.htm#eu
50. Jackson, C.B., Osterlund, C., Mugar, G., Hassman, K.D. and Crowston, K. (2015). Motivations for Sustained Participation in Crowdsourcing: Case Studies of Citizen Science on the Role of Talk. 2015 48th Hawaii International Conference on System Sciences.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

51. Jennett, C. and A. Cox (2014). 8 guidelines for designing virtual citizen science projects. In Citizen + X Workshop: Volunteer-Based Crowdsourcing in Science, Public Health and Government, HCOMP. AAAI.
52. Jordan, R. C., Ballard, H. L., and Phillips, T. B. (2012). Key issues and new approaches for evaluating citizen-science learning outcomes. Frontiers in Ecology and the Environment, 10(6), pp. 307–309.
53. Jordan, R.C., Gray, S.A., Howe, D.V., Brooks, W.R. and Ehrenfeld, J.G. (2011). Knowledge Gain and Behavioral Change in Citizen-Science Programs. Conservation Biology, 25(6), pp.1148–1154.
54. Karim, H.N. (2018). Challenges in Bridging the Digital Divide. The Daily Star, July 16, 2018. Accessed March 2, 2020 from: https://www.thedailystar.net/opinion/cybernautic-ruminations/challenges-bridging-the-digital-divide-1605844
55. Koke, J, Heimlich, J, Kessler, C, Ong, A, & Ancelet, J. (2007). Project butterfly WINGS: Winning investigative network for great science. Summative Evaluation Report, Institute for Learning Innovation.
56. Krasny, M. and R. Bonney (2004). Environmental education through citizen science and participatory action research. In E. A. Johnson, & M. J. Mappin (Eds.). Environmental education or advocacy: Perspectives of ecology and education in environmental education. New York: Cambridge University Press.
57. Laine, H. (2018) Responsible citizen science (Vastuullinen kansalaistiede). Vastuullinen tiede: tutkimusetiikka ja tiedeviestintä Suomessa. 15 Mar. In Finnish. Available: https://www.vastuullinentiede.fi/fi/tutkimustyö/vastuullinen-kansalaistiede. Accessed 28 Jan 2020.
58. Land-Zandstra, A.M., Devilee, J.L.A., Snik, F., Buurmeijer, F. and van den Broek, J.M. (2016). Citizen science on a smartphone: Participants' motivations and learning. Public understanding of science (Bristol, England), [online] 25(1), pp.45–60. Available at: https://www.ncbi.nlm.nih.gov/pubmed/26346340 [Accessed 9 Jan. 2020].
59. Latham, M. and Ceccaroni, L. (2020). Deliverable 4.1: Guidelines and Recommendations Based on a Range of Best Practices for Achieving Societal and

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Policy-Maker Engagement. [online] Zenodo. Available at: https://zenodo.org/record/3690772#.XqJ1BGgzZRY [Accessed 1 Mar. 2020].

60. Martin, V. Y., Christidis, L., Lloyd, D. J., & Pecl, G. T. (2016a). Understanding drivers, barriers and information sources for public participation in marine citizen science. *Journal of Science Communication*, 15(2), pp. 1–19.
61. Martin, V., Smith, L., Bowling, A., Christidis, L., Lloyd, D., & Pecl, G. (2016b). Citizens as scientists: What influences public contributions to marine research? *Science Communication*, 38(4), pp. 495–522.
62. Molinari, A. (2011). Let's Bridge the Digital Divide, August 2011. TED Talks. Accessed March 2, 2020 from https://www.ted.com/talks/aleph_molinari_let_s_bridge_the_digital_divide?language=en
63. Moyer-Horner, L., M. M. Smith, & J. Belt. (2012). Citizen science and observer variability during American pika surveys. Journal of Wildlife Management, 76, pp. 1472–1479.
64. NASA (n.d.) Get Involved: NASA Solve. Accessed March 17, 2020 from here: https://www.nasa.gov/solve/opportunities/citizenscience
65. NASA (2016). JunoCam Jupiter project. NASA JunoCam. Accessed March 17, from here: https://www.nasa.gov/solve/feature/junocam
66. Natureindex.com. (2019). How to run a successful citizen science project. [online] Available at: https://www.natureindex.com/news-blog/how-to-run-successful-citizen-science-project.
67. NHM (n.d.). Citizen Science. Natural History Museum - Take Part. Accessed March 17, 2020 from here: https://www.nhm.ac.uk/take-part/citizen-science.html
68. Näveri, Hanna (2020) With the help of aurora activists it has been found a new type of aurora borealis – Also foreign media got interested (Revontuliaktiivien avulla on löytynyt uusi, harvinainen revontulityyppi taivaalla – myös kansainvälinen media kiinnostui). Yle Uutiset. 29 Jan. Available: https://yle.fi/uutiset/3-11181408. Accessed 29 Jan 2020.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

69. Nerbonne, J. F., & Nelson, K. C. (2004). Volunteer macroinvertebrate monitoring in the United States: Resource mobilization and comparative state structures. Society and Natural Resources, 17(9), pp. 817–839.
70. NEWSERA (2020). Citizen Science as the new paradigm for Science Communication. EU Horizon2020 SwafS project: CORDIS: https://cordis.europa.eu/project/id/873125
71. Nov, O., Arazy, O. and Anderson, D. (2014). Scientists@Home: What Drives the Quantity and Quality of Online Citizen Science Participation? PLoS ONE, [online] 9(4), p.e90375. Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0090375.
72. Open Knowledge Finland (2017) National recommendations for citizen science (Tiede – Uusi jokamiehenoikeus: Avoin kansalaistiede – Projektin toimenpidesuositukset). Available: https://www.okf.fi/projects/open-citizen-science/. Accessed 28 Jan 2020.
73. Overgaard, A.K. and Kaarsted, T. (2018). A New Trend in Media and Library Collaboration within Citizen Science? The Case of 'A Healthier Funen.' LIBER QUARTERLY, 28, pp.xx–xx. DOI: http://doi.org/10.18352/lq.10248
74. Oy, E.P. (n.d.). FINLEX ® - Ajantasainen lainsäädäntö: Tietosuojalaki 1050/2018. [online] finlex.fi. Available at: http://www.finlex.fi/fi/laki/ajantasa/2018/20181050 [Accessed 26 Apr. 2020].
75. Ouyang, W., Winsnes, C.F., Hjelmare, M., Cesnik, A.J., Åkesson, L., Xu, H., Sullivan, D.P., Dai, S., Lan, J., Jinmo, P., Galib, S.M., Henkel, C., Hwang, K., Poplavskiy, D., Tunguz, B., Wolfinger, R.D., Gu, Y., Li, C., Xie, J., Buslov, D., Fironov, S., Kiselev, A., Panchenko, D., Cao, X., Wei, R., Wu, Y., Zhu, X., Tseng, K.-L., Gao, Z., Ju, C., Yi, X., Zheng, H., Kappel, C. and Lundberg, E. (2019). Analysis of the Human Protein Atlas Image Classification competition. Nature Methods, 16(12), pp.1254–1261.
76. Palmroth, M., Grandin, M., Helin, M., Koski, P., Oksanen, A., Glad, M.A., Valonen, R., Saari, K., Bruus, E., Norberg, J., Viljanen, A., Kauristie, K. and Verronen, P.T. (2020) Citizen scientists discover a new auroral form: Dunes provide insight into the upper atmosphere. AGU Advances. 28 Jan. DOI:10.1029/2019AV000133.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

77. Pandya, R. and Dibner, K.A. eds., (2018). Learning Through Citizen Science. [online] Washington, D.C.: National Academies Press. Available at: https://www.nap.edu/read/25183/chapter/4. People and Participation (n.d.). Online Blog – Peopleandparticipation.Net. www.peopleandparticipation.net. Accessed 20 Apr. 2020.
78. Phillips, T., Porticella, N., Constas, M. and Bonney, R. (2018). A Framework for Articulating and Measuring Individual Learning Outcomes from Participation in Citizen Science. Citizen Science: Theory and Practice, 3(2), p.3.
79. phylo.info. (n.d.). About | Phylo. [online] Available at: http://phylo.info/about [Accessed at 18 Mar. 2020].
80. Prestopnik, N. R., and Crowston K., (2011). Gaming for (Citizen) Science: Exploring Motivation and Data Quality in the Context of Crowdsourced Science through the Design and Evaluation of a Social-Computational System, 2011 IEEE Seventh International Conference on e-Science Workshops, Stockholm, pp. 28-33. doi: 10.1109/eScienceW.2011.14
81. Prestopnik, N., Crowston, K., & Wang, J. (2017). Gamers, citizen scientists, and data: Exploring participant contributions in two games with a purpose. Computers in Human Behavior, 68, pp. 254–268.
82. Price, C.A. and Lee, H.-S. (2013). Changes in participants' scientific attitudes and epistemological beliefs during an astronomical citizen science project. Journal of Research in Science Teaching, 50(7), pp.773–801.
83. Research and Innovation (2020). "Citizen Engagement Workshop: Co-Design Missions with Citizens." Home > News > Citizen Engagement Workshop: Co-Design Missions with Citizens, European Commission, 14 Feb. 2020, ec.europa.eu/info/news/citizen-engagement-workshop-co-design-missions-citizens-2020-feb-14_en. Accessed 19 Apr. 2020.
84. Ridgeway, M. L., & Yerrick, R. K. (2018). Whose banner are we waving? Exploring STEM partnerships for marginalized urban youth. Cultural Studies of Science Education, 13(1), pp. 59–84.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

85. Sauermann, H, & Franzoni, C. (2015). Crowd science user contribution patterns and their implications. Proceedings of the National Academy of Sciences, 112(3), pp. 679–684.
86. SCDC - We believe communities matter. (2019b). VOiCE. [online] Available at: https://www.scdc.org.uk/what/voice/ [Accessed 24 Apr. 2020].
87. Scheliga, K., Friesike, S., Puschmann, C. and Fecher, B. (2016). Setting up crowd science projects. Public Understanding of Science, 27(5), pp.515–534.
88. SciStarter. (2020). SciStarter - SciStarter. [online] Available at: https://scistarter.org/
89. Seaheroquest.org. (2020). [online] Available at: https://seaheroquest.org/ [Accessed 18 Mar. 2020].
90. Serret, H., Deguines, N., Jang, Y., Lois, G. and Julliard, R. (2019). Data Quality and Participant Engagement in Citizen Science: Comparing Two Approaches for Monitoring Pollinators in France and South Korea. *Citizen Science: Theory and Practice*, 4(1), p.22.
91. Shaked, A. Regulations File 5777 No. 7809. 8 May 2017, www.nevo.co.il/Law_word/law06/tak-7809.pdf. Accessed 27 Apr. 2020. p. 1022.
92. Silvertown, J. (2009). A new dawn for citizen science. Trends in Ecology & Evolution, [online] 24(9), pp.467–471. Available at: https://www.sciencedirect.com/science/article/abs/pii/S016953470900175X [Accessed 16 Oct. 2019].
93. Skarlatidou, A., Hamilton, A., Vitos, M. and Haklay, M. (2019). What do volunteers want from citizen science technologies? A systematic literature review and best practice guidelines. Journal of Science Communication, 18(01).
94. Sørensen, J.J.W.H., Pedersen, M.K., Munch, M., Haikka, P., Jensen, J.H., Planke, T., Andreasen, M.G., Gajdacz, M., Mølmer, K., Lieberoth, A. and Sherson, J.F. (2016). Exploring the quantum speed limit with computer games. Nature, [online] 532(7598), pp.210–213. Available at: https://www.nature.com/articles/nature17620.
95. Sullivan, D.P., Winsnes, C.F., Åkesson, L., Hjelmare, M., Wiking, M., Schutten, R., Campbell, L., Leifsson, H., Rhodes, S., Nordgren, A., Smith, K., Revaz, B., Finnbogason, B., Szantner, A. and Lundberg, E. (2018). Deep learning is combined with massive-scale citizen science to improve large-scale image classification. Nature

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Biotechnology, [online] 36(9), pp.820–828. Available at: https://www.nature.com/articles/nbt.4225.

96. The Librarian's Guide to Citizen Science. (2019). [online] Scistarter. Available at: https://s3-us-west-2.amazonaws.com/orrery-media/misc/CitSci_Librarians_Guide_02_22_r1.pdf
97. Thompson, S. (2007). BirdSleuth: Final Evaluation Report. Ithaca, NY: Seavoss Associates.
98. Tipaldo, G., & Allamano, P. (2017). Citizen science and community based rain monitoring initiatives: An interdisciplinary approach across sociology and water science. Wiley Interdisciplinary Reviews: Water, 4(2), e1200 [online]. Available at: doi: 10.1002/wat2.1200.
99. Tweddle, J.C., Savage, J., Robinson, L.D., Roy, H.E. and Pocock, M.J.O. (2017). The diversity and evolution of ecological and environmental citizen science. PLOS ONE, [online] 12(4), p.e0172579. Available at: https://journals.plos.org/ Arazy one/article?id=10.1371/journal.pone.0172579 [Accessed 16 Oct. 2019].
100. Uychiaoco, A. J., H. O. Arceo, S. J. Green, T. Margarita, P. A. Gaite, & P. M. Aliño. (2005). Monitoring and evaluation of reef protected areas by local fishers in the Philippines: tightening the adaptive management cycle. Biodiversity & Conservation, 14, pp. 2775–2794.
101. Veeckman, C., Talboom, S., Gijsel, L., Devoghel, H. and Duerinckx, A. (2019). Communication in Citizen Science A practical guide to communication and engagement in citizen science. [online] Available at: https://www.scivil.be/sites/default/files/paragraph/files/2020-01/Scivil%20Communication%20Guide.pdf [Accessed 25 Apr. 2020].
102. Vermeiren, P., C. Munoz, M. Zimmer, & M. Sheaves. (2016). Hierarchical toolbox: Ensuring scientific accuracy of citizen science for tropical coastal ecosystems. Ecological Indicators, 66, pp. 242–250.
103. Waldman, A.E. (2019). Cognitive biases, dark patterns, and the 'privacy paradox.' Current Opinion in Psychology, 31, pp.105–109.
104. Webster R., Marshall G. (2019). #TalkingClimate Handbook: How to have conversations about climate change - Climate Outreach. [online] Available at:

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

https://climateoutreach.org/resources/how-to-have-a-climate-change-conversation-talking-climate/?gclid=EAIaIQobChMI3Ien3-yK5wIVC0HTCh1coQ_oEAAYASAAEgL0ffD_BwE

105. Wilderman, C. (2005). Portrait of a Watershed: Shermans Creek. Harrisburg, PA: Pennsylvania Department of Environmental Protection.

106. Yadav, P. and Darlington, J. (2016). Design Guidelines for the User-Centred Collaborative Citizen Science Platforms. Human Computation, 3(1).

107. Zooniverse.org. (2019). Zooniverse. [online] Available at: https://www.zooniverse.org/

108. http://www.sapelli.org/ [Accessed 23 Jan. 2020].

109. www.uoou.cz. (n.d.). Act No. 110/2019 Coll.: Legislation: The Office for Personal Data Protection. [online] Available at: https://www.uoou.cz/en/vismo/zobraz_dok.asp?id_org=200156&id_ktg=1420&archiv=0&p1=1105 [Accessed 20 Mar. 2020].

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Bibliography

1. Aanensen, D, Huntley, D, Menegazzo, M, Powell, C, & Spratt, B. (2014). EpiCollect+: linking smartphones to web applications for complex data collection projects. *F1000Res 3* (2014). [online] Available at: DOI:http://dx.doi.org/10.12688/f1000research.4702.1
2. A Changemaker's Eight-Step Guide to Storytelling. (n.d.). [online] Available at: http://www.changemakers.com/sites/default/files/a_changemakers_guide_to_storytelling_12_10_13.pdf
3. Ajani, Z., Cox, A. L., Eveleigh, A., Fuchs, B., Gold, M., Iacovides, I., Jennett, J., Kloetzer, L., Mathieu, K., Schneider, D., Talsi, Y. (2016). Motivations, learning and creativity in online citizen science, Journal of Science Communication, 2016
4. Alabri, A., Hunter, J., van Ingen, C. (2013). Assessing the Quality and Trustwortiness of Cittizen Science Data. Concurrency and Computation: Practice and Experience. Wiley Online Library 2013.
5. Alzheimer's Research UK. (n.d.). *Play Sea Hero Quest and #gameforgood*. [online] Available at: https://www.alzheimersresearchuk.org/our-research/what-we-do/sea-hero-quest/ [Accessed 20 Mar. 2020].
6. Andersen, E., O'Rourke, E., Liu, Y., Snider, R., Lowdermilk, J., Truong, D., Cooper, S. & Popovic, Z. (2012). 'The impact of tutorials on games of varying complexity'. *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems*, 2012 Austin, Texas, USA. 2207687: ACM, 59-68.
7. Anhalt-Depies, C., Stenglein, J.L., Zuckerberg, B., Townsend, P.A. and Rissman, A.R. (2019). Tradeoffs and tools for data quality, privacy, transparency, and trust in citizen science. *Biological Conservation*, [online] 238, p.108195. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0006320719301958?via%3Dihub [Accessed 7 Feb. 2020].
8. Ansine, J., Araya, Y., Dodd, M. and Robinson, D. (2018). iSpot: a citizen science platform for inclusive learning and teaching - Open Research Online. *Open.ac.uk*. [online] Available at: http://oro.open.ac.uk/56342/ [Accessed 6 Feb. 2020].

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

9. Auerbach, J., Barthelmess, E.L., Cavalier, D., Cooper, C.B., Fenyk, H., Haklay, M., Hulbert, J.M., Kyba, C.C.M., Larson, L.R., Lewandowski, E. and Shanley, L. (2019). The problem with delineating narrow criteria for citizen science. Proceedings of the National Academy of Sciences, [online] 116(31), pp.15336–15337. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6681715/ DOI: 10.1073/pnas.1909278116.
10. Ayris, P. and Ignat, T. (2018). Defining the role of libraries in the Open Science landscape: a reflection on current European practice. *Open Information Science*, 2(1), pp.1–22. DOI: http://doi.org/10.1515/opis-2018-0001
11. Ballard, H.L., Dixon, C.G.H. and Harris, E.M. (2017). Youth-focused citizen science: Examining the role of environmental science learning and agency for conservation. Biological Conservation, 208, pp.65–75. DOI: https://doi.org/10.1016/j.biocon.2016.05.024
12. Bang, M. and Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. Science Education, 94(6), pp.1008–1026. DOI: https://doi.org/10.1002/sce.20392
13. Be a Citizen Scientist! http://home.twcny.rr.com/allenz/citizen_scientist.htm, accessed 11 November 2003.
14. BSCS Science Learning. (n.d.). *Designing Citizen Science for Both Science and Education: A Workshop Report*. [online] Available at: https://bscs.org/resources/reports/designing-citizen-science-for-both-science-and-education-a-workshop-report/ [Accessed 20 Mar. 2020].
15. Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., et al. (2009). Public participation in scientific research: Defining the field and assessing its potential for informal science education (pp. 58). Washington DC: *Center for Advancement of Informal Science Education* (CAISE).
16. Bonney, R., Cooper, C., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. & Shirk, J., (2009). Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy. *Bioscience*, 59, pp. 977-984.
17. Boucher, P. The Future of Science Through Citizens' Engagement Participants' booklet. (2017). [online] Available at:

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

http://www.europarl.europa.eu/cmsdata/148986/STOA%20WS%20Citizens%20engagement%20booklet.pdf

18. Brouwer, S. and Hessels, L. K. (2019) 'Increasing research impact with citizen science: The influence of recruitment strategies on sample diversity', Public Understanding of Science, 28(5), pp. 606–621. doi: 10.1177/0963662519840934.
19. Changemakers. (2012). *A Changemaker's Guide to Storytelling: How to Engage Heads, Hearts and Hands to Drive Change*. [online] Available at: https://www.changemakers.com/storytelling
20. Chandler, M., See, L., Copas, K., Bonde, A., Claramunt-Lopez, B., Danielsen, F. & Legind, J. Masinde, S. Miller-Rushing, A. Newman, G. Rosemartin, A. Turak, E. (2016a). Contribution of Citizen Science Towards International Biodiversity Monitoring. *Biological Conservation, 213*, 280-294.
21. Citizen Science Association. (2018). *Citizen Science and Youth Learning - Citizen Science AssociationCitizen Science*. [online] Available at: https://www.citizenscience.org/youth-learning/.
22. Citizen Science Games. (2015). *Claire*. [online] Available at: https://citizensciencegames.com/games/foldit/ [Accessed 29 Jan. 2020].
23. Citizen Science Games. (2015). *Claire*. [online] Available at: https://citizensciencegames.com/games/ [Accessed 6 Feb. 2020].
24. Citizen Science Games. (2015). *Claire*. [online] Available at: https://citizensciencegames.com/games/phylo/ [Accessed 29 Jan. 2020].
25. Citizen Science Games. (2018). *Claire*. [online] Available at: https://citizensciencegames.com/foldit-players-contribute-to-the-casp-experiment/ [Accessed 29 Jan. 2020].
26. Citizen science. (n.d.). *Online Platforms for Citizen Science*. [online] Available at: https://citizensciencesoutheastasia.weebly.com/online-platforms-for-citizen-science.html# [Accessed 27 Jan. 2020].
27. Cohen, K. C. (Ed.). (1997). *Internet links for science education: Student–science partnerships*. New York: Plenum Press.
28. Cohn, J.P. (2008) Citizen science: can volunteers do real research? Bioscience 58, 192–197

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

29. Cooper, S., Khatib, F., Treuille, A., Barbero, J., Lee, J., Beenen, M., Leaver-Fay, A., Baker, D., Popović, Z. and players, F. (2010). Predicting protein structures with a multiplayer online game. *Nature*, 466(7307), pp.756-760. doi:10.1038/nature09304
30. Cooper, S. (2011). *A Framework for Scientific Discovery through Video Games.* Doctor of Philosophy, University of Washington.
31. Cost Action (2019). 'Citizen Science and Gender'. *Citizen Science Cost Action Workshop Report*. Lasi, Romania, March 20, 2019. Available to download from here: https://cs-eu.net/news/workshop-report-wg-4-wg-6-citizen-science-and-gender
32. Cranshaw, J. & Kittur, A. (2011). The Polymath Project: Lessons from a successful online collaboration in mathematics. *CHI* Vancouver.
33. Curtis, V. (2015). Online citizen science projects: an exploration of motivation, contribution and participation - Open Research Online. *Open.ac.uk*. [online] Available at: http://oro.open.ac.uk/42239/ [Accessed 24 Jan. 2020].
34. Data protection law Hungary (2019). évi XXXIV. tv, 2019. Accessible in Hungarian from here: https://mkogy.jogtar.hu/jogszabaly?docid=A1900034.TV
35. Dehnen-Schmutz, K., Foster, G.L., Owen, L. and Persello, S. (2016) 'Exploring the role of smartphone technology for citizen science in agriculture'. *Agronomy for Sustainable Development*, Vol. 36, 25. DOI: https://doi.org/10.1007/s13593-016-0359-9
36. Dem, E.S., Rodríguez-Labajos, B., Wiemers, M., Ott, J., Hirneisen, N., Bustamante, J.V., Bustamante, M. and Settele, J. (2018). Understanding the relationship between volunteers' motivations and learning outcomes of Citizen Science in rice ecosystems in the Northern Philippines. *Paddy and Water Environment*, 16(4), pp.725–735.
37. De Moor, T., Rijpma, A. and Prats López, M. (2019). Dynamics of Engagement in Citizen Science: Results from the "Yes, I do!"-Project. *Citizen Science: Theory and Practice*, 4(1). DOI: http://doi.org/10.5334/cstp.212
38. Dickinson, J.L., Bonney, R. and Fitzpatrick, J.W. (2015). *Citizen science: public participation in environmental research*. Ithaca: Comstock.
39. Diner, D., Nakayama, S., Nov, O., & Porfiri, M. (2018). Social signals as design interventions for enhancing citizen science contributions. *Information, Communication & Society*, 21(4), pp. 594–611.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

40. DPA (2018) Data Protection Act 2018. *Legislation.go.uk.* Accessed from Feb 27, 2019 http://www.legislation.gov.uk/ukpga/2018/12/contents/enacted
41. Durant, J., G. Evans, and G. Thomas, 1989. The public understanding of science. Nature 340:11-14.
42. Eitzel, M.V., Cappadonna, J.L., Santos-Lang, C., Duerr, R.E., Virapongse, A., West, S.E., Kyba, C.C.M., Bowser, A., Cooper, C.B., Sforzi, A., Metcalfe, A.N., Harris, E.S., Thiel, M., Haklay, M., Ponciano, L., Roche, J., Ceccaroni, L., Shilling, F.M., Dörler, D., Heigl, F., Kiessling, T., Davis, B.Y. and Jiang, Q. (2017). Citizen Science Terminology Matters: Exploring Key Terms. Citizen Science: Theory and Practice, [online] 2(1), p.1. Available at: https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.96/
43. Eleta, I, et al. 2019. The Promise of Participation and Decision-Making Power in Citizen Science. Citizen Science: Theory and Practice, 4(1): 8, pp. 1–9. DOI: https://doi.org/10.5334/cstp.171
44. Engaging Queenslanders- An introduction to community engagement Naaee.org. (2020). [online] Available at: https://naaee.org/sites/default/files/intro_ce.pdf https://naaee.org/sites/default/files/intro_ce.pdf
45. Engel, S.R., and J.R. Voshell. 2002. Volunteer biological monitoring: Can it accurately assess the ecological condition of streams? American Entomologist 48:164-177.
46. EU (2018). Exploring and Supporting Citizen Science: SwafS15-2019. *EU Commission Funding and Tender Opportunities*. Accessed from: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/swafs-15-2018-2019
47. Ferguson, Rebecca; Jones, Ann and Scanlon, Eileen (2019). *Educational visions: The lessons from 40 years of innovation*. London: Ubiquity Press. https://core.ac.uk/reader/275553120
48. Figueiredo Nascimento, S., Cuccillato, E., Schade, S., Guimarães Pereira, A. (2016) Citizen Engagement in Science and Policy-Making: JRC Science for Policy Report. doi: 10.2788/40563

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

49. Finch, E., Cornwell, P., Ward, E.C. and McPhail, S.M. (2013). Factors influencing research engagement: research interest, confidence and experience in an Australian speech-language pathology workforce. BMC Health Services Research, 13(1). DOI:10.1186/1472-6963-13-144
50. Fiske, A., Prainsack, B. and Buyx, A. (2019) 'Meeting the needs of underserved populations: setting the agenda for more inclusive citizen science of medicine'. *Journal of Medical Ethics*, Vol. 45, 617-622
51. Fredricks, J.A., Blumenfeld, P.C. and Paris, A.H. (2004). School Engagement: Potential of the Concept, State of the Evidence. Review of Educational Research, 74(1), pp.59–109. [online] Available at: https://www.isbe.net/documents/engagement-concept.pdf
52. Friedman, N. (2019). *Fighting Alzheimer's Disease During the Megathon - SciStarter Blog*. [online] SciStarter Blog. Available at: https://blog.scistarter.com/2019/03/fighting-alzheimers-disease-during-the-megathon-spotlight-on-three-citizen-scientists/.
53. Fresa, A., Justrel, B., Bachi, V. and Forbes, N. (2015) 'Civic Epistemoliogies – Development of a Roadmap for Citizen Researchers in the Age of Digital Culture'. Chapter in Birgit Schmidt and Milena Dobreva (Eds). *New Avenues for Electronic Publishing in the Age of Infinite Collections and Citizen Science*: *Scale, Openness and Trust* (pp: 8-14). Amsterdam, Netherlands: IOS Press. DOI: 10.3233/978-1-61499-562-3-8
54. Füchslin, T. and Schäfer, M.S. (2019) 'Who wants to be a citizen scientist? Identifying the potential of citizen science and target segments in Switzerland'. *Public Understanding of Science*, Vol 28(6), 652-668
55. Genet, K.S., and L.G. Sargent. 2003. Evaluation of methods and data quality from a volunteer-based amphibian call survey. Wildlife Society Bulletin 31:703-714.
56. globe-czech.cz. (n.d.). *O programu | GLOBE*. [online] Available at: https://globe-czech.cz/cz/o-programu [Accessed 20 Mar. 2020].
57. Golumbic, Y.N., Orr, D., Baram-Tsabari, A. and Fishbain, B. (2017). Between Vision and Reality: A Case Study of Scientists' Views on Citizen Science. *Citizen Science:*

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Theory and Practice, [online] 2(1), p.6. Available at: https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.53/ .

58. Gonsamo, A. and D'Odorico, P. (2014) 'Citizen Science: best practices to remove observer bias in trend analysis'. *International Journal of Biometeorol*, Vol. 58, 2159-2163. DOI 10.1007/s00484-014-0806-8
59. Göbel, C., Nold, C., Berditchevskaia, A. and Haklay, M. (2019). How Does Citizen Science "Do" Governance? Reflections from the DITOs Project. *Citizen Science: Theory and Practice*, 4(1). DOI: http://doi.org/10.5334/cstp.204
60. Grainger, A. (2017). Citizen observatories and the new earth observation science. *Remote Sensing*, 9(2), pp. 1–30. https://vedavyzkum.cz/ze-zahranici/ze-zahranici/obcanska-veda-vsem-prospesna.
61. Grand, A., Bultitude, K., Wilkinson, C. & Winfield, A. (2010). 'Muddy the waters or clearing the stream? Open science as a communication medium'. *11th International Conference on Public Communication of Science and Technology*, December 6 - 10, 2010 New Delhi.
62. Greenhill, A, Holmes, K, Woodcock, J, Lintott, C, Simmons, B, Graham, G, Cox, J, Oh, E & Masters, K 2016, 'Playing With Science: Exploring How Game Activity Motivates Users Participation on an Online Citizen Science Platform', *Aslib Journal of Information Management*. https://doi.org/10.1108/AJIM-11-2015-0182
63. Hajibayova, L. (2019). (Un)theorizing citizen science: Investigation of theories applied to citizen science studies. *Journal of the Association of Information Science and & Technology*. [online]. Available at: https://doi.org/10.1002/asi.24308. [Accessed 8 March 2020].
64. Haklay, M. (2013). Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation, in: Sui, D., Elwood, S.Goodchild, M. (Eds.), Crowdsourcing Geographic Knowledge, pp.105=122, Springer Netherlands, http://doi.org/10.1007/078-94-007-4587-2
65. Hamari, J., Koivisto, J., and Sarsa, H. (2014). *Does Gamification Work? - A Literature Review of Empirical Studies on Gamification*. In Procedings of the 47th Havaii International Conference on System Sciences. pp 3025.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

66. Harris E., Ballard H. (2018) A Framework for Teachers to Design and Facilitate Citizen Science Activities, https://education.ucdavis.edu/post/new-paper-framework-teachers-design-and-facilitate-citizen-science-activities-0
67. HDPA (2019). *Legal Framework*. [online] Hellenic Data Protection Authority (HDPA). Available at: https://www.dpa.gr/portal/page?_pageid=33,43560&_dad=portal&_schema=PORTAL
68. [Accessed 22 Mar. 2020].
69. Herodotou Ch., Aristeidou M., Sharples M. and Scanlon E. (2018) Designing citizen science tools for learning: lessons learnt from the iterative development of nQuire, *Research and Practice in Technology Enhanced Learning* (2018) 13:4 https://core.ac.uk/reader/157841371 [Accessed 9 Feb. 2020].
70. Hirshon, B. (2019). *Top 19 Citizen Science Projects of 2019 - SciStarter Blog*. [online] SciStarter Blog. Available at: https://blog.scistarter.com/2019/12/top-19-citizen-science-projects-of-2019/.
71. Holliman, R. (2010). 'From analogue to digital scholarship: implications for science communication researchers'. *Journal of Science Communication*, 9, pp 1 - 6.
72. Hota, A., Croston, J.H., Ohyama, Y. at al. (2014). New results on the exotic galaxy `Speca' and discovering many more Specas with RAD@home network. *ASInC*, [online] 13, pp.141–145. Available at: https://ui.adsabs.harvard.edu/abs/2014ASInC..13..141H/abstract
73. Hota, A., Konar, C., Stalin, C.S., Vaddi, S., Mohanty, P.K., Dabhade, P., Dharmik Bhoga, S.A., Rajoria, M. and Sethi, S. (2016). Tracking Galaxy Evolution Through Low-Frequency Radio Continuum Observations using SKA and Citizen-Science Research using Multi-Wavelength Data. *Journal of Astrophysics and Astronomy*, 37(4).
74. Howe, J. 2008. Crowd sourcing: Why the power of the crowd is driving the future of business. New York: Crown.
75. Hutton, K.D. (2017). Assessing the Effectiveness of Citizen Science: A Case Study of Publications Produced by Earthwatch Projects. *Harvard.edu*. [online] Available at: https://dash.harvard.edu/handle/1/37736751 [Accessed 9 Feb. 2020].

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

76. Ignat, T., Ayris, P., Labastida I Juan, I., Reilly, S., Dorch, B., Kaarsted, T. and Overgaard, A.K. (2018). Merry work: libraries and citizen science. *Insights the UKSG journal*, 31. DOI: http://doi.org/10.1629/uksg.431
77. Ignat, T., Cavalier, D. and Nickerson, C. (2019). Citizen Science and Libraries: Waltzing towards a collaboration. *Mitteilungen der Vereinigung Österreichischer Bibliothekarinnen und Bibliothekare*, 72(2), pp.328–336. DOI: https://doi.org/10.31263/voebm.v72i2.3047.
78. iNaturalist.org. (2011). *About · iNaturalist.org*. [online] Available at: https://www.inaturalist.org/pages/about
79. invgame.azurewebsites.net. (n.d.). *PatNum: an Invariant Generation Game*. [online] Available at: https://invgame.azurewebsites.net/game/app/start.html?noifs.
80. Ispotnature.org. (2020). *Home | iSpot Nature*. [online] Available at: https://www.ispotnature.org/ [Accessed 11 Feb. 2020].
81. Katapally TR, Bhawra J, Leatherdale ST, et al. (2018) The SMART Study, a Mobile Health and Citizen Science Methodological Platform for Active Living Surveillance, Integrated Knowledge Translation, and Policy Interventions: Longitudinal Study. *JMIR Public Health Surveill*. 2018;4(1):e31. Published 2018 Mar 27. doi:10.2196/publichealth.8953
82. Katapally TR. (2019). The SMART Framework: Integration of citizen science, community-based participatory research, and systems science for Population Health Science in the digital age. *JMIR mHealth and uHealth*. https://preprints.jmir.org/preprint/14056
83. Keasar, C., McGuffin, L.J., Wallner, B., Chopra, G., Adhikari, B., Bhattacharya, D., Blake, L., Bortot, L.O., Cao, R., Dhanasekaran, B.K., Dimas, I., Faccioli, R.A., Faraggi, E., Ganzynkowicz, R., Ghosh, S., Ghosh, S., Giełdoń, A., Golon, L., He, Y., Heo, L., Hou, J., Khan, M., Khatib, F., Khoury, G.A., Kieslich, C., Kim, D.E., Krupa, P., Lee, G.R., Li, H., Li, J., Lipska, A., Liwo, A., Maghrabi, A.H.A., Mirdita, M., Mirzaei, S., Mozolewska, M.A., Onel, M., Ovchinnikov, S., Shah, A., Shah, U., Sidi, T., Sieradzan, A.K., Ślusarz, M., Ślusarz, R., Smadbeck, J., Tamamis, P., Trieber, N., Wirecki, T., Yin, Y., Zhang, Y., Bacardit, J., Baranowski, M., Chapman, N., Cooper, S., Defelicibus, A., Flatten, J., Koepnick, B., Popović, Z., Zaborowski, B., Baker, D.,

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Cheng, J., Czaplewski, C., Delbem, A.C.B., Floudas, C., Kloczkowski, A., Ołdziej, S., Levitt, M., Scheraga, H., Seok, C., Söding, J., Vishveshwara, S., Xu, D. and Crivelli, S.N. (2018). An analysis and evaluation of the WeFold collaborative for protein structure prediction and its pipelines in CASP11 and CASP12. *Scientific Reports*, [online] 8(1). Available at: https://www.nature.com/articles/s41598-018-26812-8 [Accessed 30 Jan. 2020].

84. Keel, W.C., Chojnowski, S.D., Bennert, V.N., Schawinski, K., Lintott, C.J., Lynn, S., Pancoast, A., Harris, C., Nierenberg, A.M., Sonnenfeld, A. and Proctor, R. (2011). The Galaxy Zoo survey for giant AGN-ionized clouds: past and present black hole accretion events. *Monthly Notices of the Royal Astronomical Society*, [online] 420(1), pp.878–900. Available at: https://ui.adsabs.harvard.edu/abs/2012MNRAS.420..878K/abstract.
85. Keel, W.C., Lintott, C.J., Schawinski, K., Bennert, V.N., Thomas, D., Manning, A., Chojnowski, S.D., van Arkel, H. and Lynn, S. (2012). THE HISTORY AND ENVIRONMENT OF A FADED QUASAR:HUBBLE SPACE TELESCOPEOBSERVATIONS OF HANNY'S VOORWERP AND IC 2497. *The Astronomical Journal*, [online] 144(2), p.66. Available at:https://ui.adsabs.harvard.edu/abs/2012AJ....144...66K/abstract [Accessed 23 Jan. 2020].
86. Kelemen-Finan, J., Scheuch, M. and Winter, S. (2018). Contributions from citizen science to science education: an examination of a biodiversity citizen science project with schools in Central Europe. *International Journal of Science Education*, 40(17), pp.2078–2098.
87. Kock and Sherson, J. (2015). Play or science?: a study of learning and framing in crowdscience games. [online] arXiv.org. Available at: https://arxiv.org/abs/1510.06841 [Accessed 3 Feb. 2020].
88. Kock Pedersen, M., Rasmussen, N., Sherson, J. and Vaid Basaiawmoit, R. (2017). *Leaderboard Effects on Player Performance in a Citizen Science Game*. [online] Available at: https://arxiv.org/pdf/1707.03704.pdf [Accessed 2 Feb. 2020].
89. Kosmala, M., A. Wiggins, A. Swanson, & B. Simmons. (2016). Assessing data quality in citizen science. *Frontiers in Ecology and the Environment,* 14, pp. 551–560.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

90. Landström, C. (2019). Public Participation in Environmental Science. Environmental Participation, [online] pp.23–43. Available at: https://link.springer.com/chapter/10.1007%2F978-3-030-33043-9_2 DOI: 10.1007/978-3-030-33043-9_4, In book: Environmental Participation, Practices engaging the public with science and governance, Catharina Landström
91. languagearc.org. (n.d.). *LDC UA | Home*. [online] Available at: https://languagearc.org.
92. LEARN Citizen Science (2017). Available at https://education.ucdavis.edu/learn-citizen-science
93. Lewandowski, E., Caldwell, W., Elmquist, D. and Oberhauser, K. (2017). Public Perceptions of Citizen Science. *Citizen Science: Theory and Practice*, 2(1). DOI: http://doi.org/10.5334/cstp.77
94. Lieberoth, A., Pedersen, Mads Kock and Sherson, J. (2014). Getting humans to do quantum optimization, *Human Computation 1*, 219.
95. Lieberoth, A., Pedersen, Mads Kock and Sherson, J. (2015). *Play or science?: a study of learning and framing in crowdscience games*. [online] arXiv.org. Available at: https://arxiv.org/abs/1510.06841 [Accessed 3 Feb. 2020].
96. Lintott, C.J., Schawinski, K., Keel, W., van Arkel, H., Bennert, N., Edmondson, E., Thomas, D., Smith, D.J.B., Herbert, P.D., Jarvis, M.J., Virani, S., Andreescu, D., Bamford, S.P., Land, K., Murray, P., Nichol, R.C., Raddick, M.J., Slosar, A., Szalay, A. and Vandenberg, J. (2009). Galaxy Zoo: 'Hanny's Voorwerp', a quasar light echo? *Monthly Notices of the Royal Astronomical Society*, [online] 399(1), pp.129–140. Available at: https://arxiv.org/abs/0906.5304 [Accessed 23 Jan. 2020].
97. Liu, Hai-Ying & Grossberndt, Sonja & Kobernus, Mike. (2017). Citizen science and citizens' observatories: Trends, roles, challenges and development needs for science and environmental governance. Citizen science and citizens' observatories: Trends, roles, challenges and development needs for science and environmental governance. 10.5334/bbf.
98. Lukyanenko, R., Parsons, J., & Wiersma, Y. F. (2014). The IQ of the crowd: Understanding and improving information quality in structured user-generated content. *Information Systems Research*, 25(4), pp. 669–689.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

99. Luther, K., Counts, S., Stecher, K. B., Hoff, A. & Johns, P. (2009). 'Pathfinder: an online collaboration environment for citizen scientists'. In *Proceedings of the 27th international conference on Human factors in computing systems — CHI 09* (Boston, MA, U.S.A. 4th–9th April 2009).[online] Available at: https://doi.org/10.1145/1518701.1518741.

100. Mehlenbacher, A. (2019). *Science Communication Online: A New Book Exploring How We Do and Share Science On the Internet - SciStarter Blog*. [online] SciStarter Blog. Available at: https://blog.scistarter.com/2019/05/science-communication-online-a-new-book-exploring-how-we-do-and-share-science-on-the-internet/

101. Miller, J. 2006. Civic Scientific literacy of Europe and the United States. Montreal: World Association for Public Opinion Research.

102. Mspnet.org. (2018). *Designing Citizen Science Projects*. [online] Available at: http://hub.mspnet.org/index.cfm/33674 [Accessed 24 Jan. 2020].

103. Mturk.com. (2018). Amazon Mechanical Turk. [online] Available at: https://www.mturk.com/ .

104. Ng, C., Bartlett, B. and Elliott, S.N. (2018). *Empowering Engagement : Creating Learning Opportunities for Students from Challenging Backgrounds*. Cham Springer International Publishing Springer Nature.

105. Nickerson, C. (2019). *Join Megathon from Anywhere in the World - SciStarter Blog*. [online] SciStarter Blog. Available at: https://blog.scistarter.com/2019/04/how-to-join-the-megathon-from-anywhere-in-the-world-on-citsciday2019/.

106. Nickerson, C. (2019). *Webinar Recording: Become a Citizen Scientist to Protect the Planet - SciStarter Blog*. [online] SciStarter Blog. Available at: https://blog.scistarter.com/2019/12/webinar-recording-become-a-citizen-scientist-to-protect-the-planet/

107. Nielsen, M. (2012). *Reinventing Discovery. The New Era of Networked Science*, Princeton University Press.

108. O'Brien, H. L. & Toms, E. G. (2010). 'The development and evaluation of a survey to measure user engagement'. *Journal of the American Society for Information Science and Technology*, 61, pp 50-69.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

109. OSGeo. (2018). *Please share GeoForAll teaching and research resources with your colleagues and students - OSGeo*. [online] Available at: https://www.osgeo.org/foundation-news/please-share-geoforall-teaching-research-resources-colleagues-students/

110. Parsons, J., & Wand, Y. (2013). Extending classification principles from information modeling to other disciplines. *Journal of the Association for Information Systems*, 14(5), pp. 245–273.

111. Parthenos-project.eu. (2019). *What's in it for the Citizen Scientists? – Parthenos training*. [online] Available at: https://training.parthenos-project.eu/sample-page/citizen-science-in-the-digital-arts-and-humanities/creating-a-citizen-science-project/72490-2/.

112. Pathfinder Science, http://pathfinderscience.net/, accessed 17 February 2020.

113. Pedersen, M.K., Skyum, B., Heck, R., Müller, R., Bason, M., Lieberoth, A. and Sherson, J.F. (2016). Virtual Learning Environment for Interactive Engagement with Advanced Quantum Mechanics. *Physical Review Physics Education Research*, [online] 12(1). Available at: https://arxiv.org/abs/1511.01714 [Accessed 3 Feb. 2020].

114. Pe'er, G., Dicks, L.V., Visconti, P., Arlettaz, R., Báldi, A., Benton, T.G., Collins, S., Dieterich, M., Gregory, R.D., Hartig, F., Henle, K., Hobson, P.R., Kleijn, D., Neumann, R.K., Robijns, T., Schmidt, J., Shwartz, A., Sutherland, W.J., Turbé, A., Wulf, F. and Scott, A.V. (2014). Agriculture policy. EU agricultural reform fails on biodiversity. *Science (New York, N.Y.)*, [online] 344(6188), pp.1090–2. Available at: https://www.ncbi.nlm.nih.gov/pubmed/24904142 [Accessed 23 Jan. 2020].

115. Perovich, L. J., Wylie, S., & Bongiovanni, R. (2018). Pokémon Go, pH, and projectors: Applying transformation design and participatory action research to an environmental justice collaboration in Chelsea, MA. *Cogent Arts & Humanities*, 5(1), 1483874.

116. Petty, R. E., & Cacioppo, J. T. (1981). *Attitudes and persuasion: Classical and contemporary approaches*. Dubuque, IA: Wm. C. Brown.

117. Petty, R.E. and Cacioppo, J.T. (1986). *The Elaboration Likelihood Model of Persuasion*. [online] ScienceDirect. Available at:

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

https://www.sciencedirect.com/science/article/pii/S0065260108602142 [Accessed 17 Feb. 2020].

118. Ponti, M. (n.d.). *Citizen-generated data for public policy A brief review of European citizen- generated data projects*. [online] Available at: https://marisaponti.files.wordpress.com/2020/03/ponti_jrc-report-final.pdf

119. Proteinatlas.org. (2020). News: Mapping of cells and proteins improved with combination of multiplayer crowdsourcing and AI - The Human Protein Atlas. [online] Available at: https://www.proteinatlas.org/news/2018-08-20/mapping-of-cells-and-proteins-improved-with-combination-of-multiplayer-crowdsourcing-and-ai https://www.proteinatlas.org/news/2018-08-20/mapping-of-cells-and-proteins-improved-with-combination-of-multiplayer-crowdsourcing-and-ai

120. Rambonnet, L., Vink, S.C., Land-Zandstra, A.M., and Bosker, T. (2019) ‘Making citizen science count: best practices and challenges of citizen science projects on plastics in aquatic environments’. *Marine Pollution Bulletin*, 145, 2710277

121. Raoking F., Cohoon J. M., Cooke, Taufer M. and Estrada T. (2014), "Gender and volunteer computing: A survey study," *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, Madrid, 2014, pp. 1-5.

122. Reed, J., Raddick, J., Lardner, A., & Carney, K. (2013, 7-11 January 2013). *An exploratory factor analysis of motivations for participating in Zooniverse, a collection of virtual citizen*

123. Saunders, M.E., Roger, E., Geary, W.L., Meredith, F., Welbourne, D.J., Bako, A., Canavan, E., Herro, F., Herron, C., Hung, O., Kunstler, M., Lin, J., Ludlow, N., Paton, M., Salt, S., Simpson, T., Wang, A., Zimmerman, N., Drews, K.B., Dawson, H.F., Martin, L.W.J., Sutton, J.B., Webber, C.C., Ritchie, A.L., Berns, L.D., Winch, B.A., Reeves, H.R., McLennan, E.C., Gardner, J.M., Butler, C.G., Sutton, E.I., Couttie, M.M., Hildebrand, J.B., Blackney, I.A., Forsyth, J.A., Keating, D.M. and Moles, A.T. (2018). Citizen science in schools: Engaging students in research on urban habitat for pollinators. Austral Ecology, [online] 43(6), pp.635–642. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/aec.12608 [Accessed 11 Nov. 2019].

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

124. Schmeller, D.S., P.-Y. Henry, R. Julliard, B. Gruber, J. Clobert, F. Dziock, S. Lengyel, P. Nowicki, E. Déri, E. Budrys, et al. 2009. Advantages of volunteer- based biodiversity monitoring in Europe. Conservation Biology 23:307-316. Doi: 10.1111/j.1523-1739.2008.01125.x

125. Schlozman, K.L., Burns, N., Verba, S. and Donahue, J. (1995) 'Gender and Citizen Participation: Is There a Difference Voice?' *American Journal of Political Science*, Vol. 39 (2), 267-293

126. Schrögel, P., Kolleck, A. (2019). The Many Faces of Participation in Science: Literature Review and Proposal for a Three-Dimensional Framework. Science and Technology Studies 32(2). 77-99 October 2018, Available at: https://www.researchgate.net/publication/333107804_The_Many_Faces_of_Participation_in_Science [Accessed 29 Jan. 2020].

127. *science projects.* Paper presented at the Proceedings of the 46th Annual Hawaii International Conference on Systems Sciences, Maui, HI.

128. ScienceAtHome : Citizen Science Games (2020). *ScienceAtHome | Citizen science games*. [online] ScienceAtHome.org. Available at: https://www.scienceathome.org/ [Accessed 2 Feb. 2020].

129. ScienceAtHome : Citizen Science Games (2020). *ScienceAtHome | Games | Quantum Moves*. [online] ScienceAtHome.org. Available at: https://www.scienceathome.org/games/quantum-moves/ [Accessed 2 Feb. 2020].

130. ScienceDaily. (n.d.). *Citizens Asked To Monitor Impact Of Invasive Bird Species*. [online] Available at: https://www.sciencedaily.com/releases/2004/04/040422224617.htm [Accessed 19 Feb. 2020].

131. Scientific Foresight (STOA (2017). *The role of citizens in the future of science*. [online] European Parliamentary Research Service Blog. Available at: https://epthinktank.eu/2017/05/19/the-role-of-citizens-in-the-future-of-science/

132. SciStarter (2014). Citizen Science Applications Web Portal and Catalogue. (2014). [online] Available at: http://scistarter.com.

133. Semuels, A. (2018). The Online Hell of Amazon's Mechanical Turk. [online] The Atlantic. Available at:

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement N°873169

https://www.theatlantic.com/business/archive/2018/01/amazon-mechanical-turk/551192/ [Accessed 22 Jan. 2020].

134. Shah, H. (2014). Eugene Goostman machine convinced 33.33% of a new set of Judges at The Royal Society 6-7 June 2014, following its 29.17% performance at Bletchley Park in 2012. *Turing tests in 2014 Blog*, post 10 June 2014. Accessed from http://turingtestsin2014.blogspot.com/2014/06/eugene-goostman-machine-convinced-3333.html

135. Shanley, L.A., Parker, A., Schade, S. and Bonn, A. (2019). Policy Perspectives on Citizen Science and Crowdsourcing. Citizen Science: Theory and Practice, 4(1).

136. Shell, L. (2019). *"How To" Become a Citizen Scientist in Minutes - SciStarter Blog*. [online] SciStarter Blog. Available at: https://blog.scistarter.com/featured-projects/2019/09/how-to-citizen-science-videos-on-youtube/.

137. Shell, L. (2019). *Citizen Science Association & SciStarter Education - SciStarter Blog*. [online] SciStarter Blog. Available at: https://blog.scistarter.com/2019/06/citizen-science-association-scistarter-webinar-edtech/.

138. Sheridan, S.M. and Elizabeth Moorman Kim (2015). *Processes and Pathways of Family-School Partnerships Across Development*. Cham: Springer International Publishing.

139. Shirk, J.L., Ballard, H.L., Wilderman, C.C., Phillips, T., Wiggins, A., Jordan, R., McCallie, E., Minarchek, M., Lewenstein, B.V., Krasny, M.E. and Bonney, R. (2012). Public Participation in Scientific Research: a Framework for Deliberate Design. *Ecology and Society*, [online] 17(2). Available at: https://www.ecologyandsociety.org/vol17/iss2/art29/.

140. SLU.SE. (2017). Species Observations | ArtDatabanken. [online] Available at: https://www.artdatabanken.se/en/species-observations/ [Accessed 11 Feb. 2020]. 18010202.

141. SMART Framework, https://www.smartstudysask.com/blank

142. SMART Study: A Mobile Health and Citizen Science Platform. https://www.smartstudysask.com/about

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

143. static.birds.cornell.edu. (n.d.). *The Birdhouse Network- a message from the staff*. [online] Available at: http://static.birds.cornell.edu/Publications/Birdscope/Spring2001/birdhouse.html [Accessed 17 Feb. 2020].

144. STEM4YOUTH. (2020). CITIZEN SCIENCE | STEMFORYOUTH. [online] Available at: http://www.stem4youth.eu/citizen-science/

145. Stem.org.uk. (2010). Evolution MegaLab | STEM. [online] Available at: https://www.stem.org.uk/resources/collection/4114/evolution-megalab [Accessed 11 Feb. 2020].

146. Stevenson, R.D. et al. (2003) Electronic field guides and user communities in the eco-informatics revolution. *Conserv. Ecol.* 7, 3, available at.http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7044369&isnumber=7043978

147. Sturm, U., Schade, S., Ceccaroni, L., Gold, M., Kyba, C., Claramunt, B., Haklay, M., Kasperowski, D., Albert, A., Piera, J., Brier, J., Kullenberg, C. and Luna, S. (2018). ‘Defining principles for mobile apps and platforms development in citizen science’. *Research Ideas and Outcomes* 4, e23394. https://doi.org/10.3897/rio.4.e23394 [Accessed 8 Feb. 2020].

148. Tarun Reddy K. (2019). The SMART Framework: Integration of Citizen Science, Community-Based Participative Research, and Systems Science for population Health Science in the Digital Age. JMIR Mhealth and Uhealth 2019.

149. The Experience of the Citizen Scientist. (n.d.). [online] Available at: https://training.parthenos-project.eu/wp-content/uploads/2019/05/Amy-Clotworthy-Interview-on-the-Citizen-Scientist-experience-April-2019.pdf.

150. Theobold, E., Ettinger, A., Burgess, H. & Debey, L. (2014). Global Change and Local Solutions: Tapping the Unrealized Potential of Citizen Science for Biodiversity Research. *Biological Conservation, 181*, 236-244.

151. Timmer, J. (2015) Most participants in “citizen science” projects give up almost immediately, Ars Technica https://arstechnica.com/science/2015/01/most-participants-in-citizen-science-projects-give-up-almost-immediately/

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

152. Trouille, L., Lintott, C.J. and Fortson, L.F. (2019). Citizen science frontiers: Efficiency, engagement, and serendipitous discovery with human–machine systems. *Proceedings of the National Academy of Sciences*, 116(6), pp.1902–1909. DOI: https://doi.org/10.1073/pnas.1807190116

153. Turrini, T., Dörler, D., Richter, A., Heigl, F. and Bonn, A. (2018). The threefold potential of environmental citizen science - Generating knowledge, creating learning opportunities and enabling civic participation. *Biological Conservation*, 225, pp.176–186.

154. UCL Department of Geography. (2019). *Extreme Citizen Science (ExCiteS)*. [online] Available at: https://www.geog.ucl.ac.uk/research/research-centres/excites [Accessed 23 Jan. 2020].

155. University, H. (2014). Citizen Science Search platform. (2014). [online] Available at: http://koenigstuhl.geog.uni-heidelberg.de/citizenscience/.

156. Van Vugt, M., M. Snyder, T. Tyler, and A. Biel, eds. 2000. *Cooperation in Modern Society: Promoting the Welfare of Communities, States and Organizations*. London: Routledge.

157. Wang, C., Khoo, A., Liu, W., & Divaharan, S. (2008). Passion and intrinsic motivation in digital gaming. *CyberPsychology & Behavior*, 11(1), 39–45.

158. Weitenberg C., Kuhr S., Mølmer K, and Sherson J., 2011. Quantum computation architecture using optical tweezers, *Physical Review A* 84, 032322.

159. Werbach, K., and Hunter, D. (2012). *For the Win: How Game Thinking Can Revolutionize Your Business*. Wharton Digital Pres8

160. West, S. and Pateman, R. (2016). Recruiting and Retaining Participants in Citizen Science: What Can Be Learned from the Volunteering Literature? Citizen Science: Theory and Practice, [online] 1(2). Available at: https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.8/ [Accessed 11 Nov. 2019].

161. Wiggins, A. and Crowston, K. (2011). *From Conservation to Crowdsourcing: A Typology of Citizen Science*. [online] IEEE Xplore. Available at: https://ieeexplore.ieee.org/document/5718708 [Accessed 17 Feb. 2020].

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

162. World Community Grid (2015). (2015). [online] Available at: http://www.worldcommunitygrid.org/.

163. Wotton, S.R., Eaton, M.A., Sheehan, D., Munyekenye, F.B., Burfield, I.J., Butchart, S.H.M., Moleofi, K., Nalwanga-Wabwire, D., Ndang'ang'a, P.K., Pomeroy, D., Senyatso, K.J. and Gregory, R.D. (2017). Developing biodiversity indicators for African birds. *Oryx*, [online] 54(1), pp.62–73. Available at: https://www.cambridge.org/core/services/aop-cambridge-core/content/view/700264316D92C2BF3F8B4D79326AD556/S0030605317001181a.pdf/developing_biodiversity_indicators_for_african_birds.pdf [Accessed 23 Jan. 2020].

164. www.europarl.europa.eu. (2019). *Research for CULT Committee – Science and Scientific Literacy as an Educational Challenge - Think Tank*. [online] Available at: http://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL_STU%282019%29629188 [Accessed 17 Feb. 2020].

165. www.facetopo.com. (n.d.). *JOIN - Facetopo*. [online] Available at: http://www.facetopo.com/.

166. www.globe.gov. (n.d.). *About & Contacts - GLOBE.gov*. [online] Available at: https://www.globe.gov/web/czech-republic/home/contact-info.

167. www.togetherscience.eu. (n.d.). *Doing It Together Science*. [online] Available at: http://www.togetherscience.eu/ [Accessed 20 Mar. 2020].

168. Wyler D. (2016). Citizen science at universities: Trends, guidelines and recommendations, *LERU* Advice Paper. Available at: https://www.leru.org/files/Citizen-Science-at-Universities-Trends-Guidelines-and-Recommendations-Full-paper.pdf Saved G.drive.

169. Zooniverse (2015). The human-computation based Citizen Science project hosting platform. (2015). [online] Available at: https://www.zooniverse.org.

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

Index of Figures and Tables

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169

This communication is part of a project that has received funding from the
European Union's Horizon 2020 research and innovation programme under grant agreement Nº873169