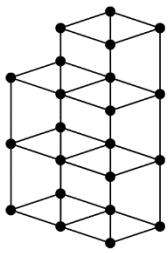

doing it together science

Grant agreement no. 709443

DITOs

Doing It Together science

Coordination & Support Action

D4.2 Policy Briefs 2

Work Package: 4

Due date of deliverable: Month 24

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Lead beneficiary for this deliverable: European Citizen Science Association (ECSA)

Contributors: University College London, Université Paris Descartes, ECSA, Institut Royal des Sciences Naturelles de Belgique

Reviewer: Carole Paleco, Justine Jacquemin (RBINS), Matt Postles, Aleksandra Berditchevskaia (TK), Mira Kekarainen (FEI), Sarah West (SEI), members of the ECSA Open Science working group

Project co-funded by the European Commission within the H2020 Programme (2014-2020)		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)	
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)	
EU-SEC	EU-SEC Classified Information: SECRET UE (Commission Decision 2005/444/EC)	

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Other contributors	Members of the ECSA BioBlitz Working group on BioBlitzes: Simone Cutajar, Matt Postles, Cristina Villaverde, Vito Maria Cambria, Jaume Piera, Rita Mendes, Lila Higgins, Lucy Robinson, Francisco Hortas Members of the ECSA working group on Citizen Science and Open Science, especially Kyle Copas, Daniel Mietchen, Eveline-Wandl Vogt, Qijun Jiang, Thomas Mboa, Christine Marizzi, Daniel Dörler, Oscar Corcho, Anne Bowser, Sven Schade, Heiner Benking, Milena Dobreva Members of the ECSA working group on Citizen Science and Education and COST Action working group on Education and Learning in Citizen Science: Laure Kloetzer, John Harlin, Juhani Kettunen, Mira Kekarainen

	ECSA: Katrin Vohland, Claudia Göbel, Gaia Agnello, Gina Maskell, Marisa Ponti, Inian Moorthy, Barbara Kieslinger, Michael Sogaard Jorgensen, Martin Brocklehurst, Fermin Serrano RBINS: Carole Paleco, Justine Jacquemin Stockholm Environment Institute: Sarah West Tekiu: Ted Fjallman, Aleksandra Berditchevskaia UCL: Muki Haklay, Christian Nold, Judy Barrett UNIGE: Bruno Strasser UPD: Imane Baïz, Gaëlle Guérin, Karim Sandid Waag Society: Wieke Betten Eutema: Erich Prem, Georg Melzer
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Abstract	Second series of policy briefs: evaluation of public engagement with biological recording activities; potentials of Biodesign for education; RRI indicators that reflect the practice of public engagement organisations; synergies between Citizen Science and Open Science.
Keywords	Citizen Science, biodiversity, biological recording, BioBlitz, biodiversity, DIY science, Biodesign, Open Science, Open Data, Education, Sustainable Development Goals (SDGs), RRI, evaluation, public engagement, gender equality, science learning, social inclusion
Sent to peer reviewer	23/05/18
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1 Version log

Version	Date	Released by	Nature of Change
Brief 1: DRAFT 1	27/03/2018	Gaia Agnello (ECSA)	Suggestion of outline
Brief 2: DRAFT 2	21/05/2018	Gaia Agnello (ECSA)	Draft compiled content
Brief 3: DRAFT 3	24/05/2018	Gaia Agnello (ECSA)	External Review
Brief 4: DRAFT 4	25/05/2018	Gaia Agnello (ECSA)	Consortium Review
Brief 2: DRAFT 1	15/05/2018	Imane Baïz (UPD), Gina Maskell (ECSA)	First draft
Brief 2: DRAFT 2	18/05/2018	Aleksandra Berditchevskaia (TK)	Internal Review
Brief 2: DRAFT 3	23/05/2018	Mira Kekarainen (FEI)	External Review
Brief 2: DRAFT 4	24/05/2018	Imane Baïz (UPD)	Consortium Review
Brief 3: DRAFT 1	18/05/2018	Cindy Regalado (UCL)	First draft
Brief 3: DRAFT 2	18/05/2018	Ted Fjallman (TK)	Internal Review
Brief 3: DRAFT 3	21/05/2018	Carole Paleco (RBINS)	Internal Review
Brief 3: DRAFT 4	22/05/2018	Sarah West (SEI)	External Review
Brief 3: FINAL DRAFT	23/05/2018	Cindy Regalado (UCL)	Release of final draft
Brief 4: DRAFT 1	25/04/2017	Claudia Göbel (ECSA)	First draft
Brief 4: DRAFT 2	04/07/2017	Claudia Göbel (ECSA)	Workshop for gathering input, Dagstuhl seminar
Brief 4: DRAFT 3	09-10/07/2017	Claudia Göbel (ECSA), Erich Prem (eutema), Kyle Copas (GBIF)	Policy brief writing workshop, Copenhagen
Brief 4: DRAFT 4	15/08/2017	ECSA working group	External review
Brief 4: DRAFT 5	15/09/2017	DITOs consortium	Internal review
Brief 4: DRAFT 6	05/10/2017	Erich Prem (eutema)	Presentation at Policy Round Table, Brussels
Brief 4: DRAFT 7	23/10/2017	ECSA working group	Final external review

Brief 4: FINAL DRAFT	22/12/2017	DITOs consortium	Final internal review
Brief 4: design changes	08/02/2017	Claudia Göbel (ECSA)	Publication of brief
Brief 4: printed	01/03/2017	Claudia Göbel (ECSA), Kyle Copas (GBIF)	Launch at workshop in Brussels

1 Definitions and acronyms

Acronyms	Definitions
BNHC	Bristol Natural History Consortium
CNC	City Nature Challenge
CSA	Coordination and Support Action
DITOs	Doing It Together science
DIY	Do It Yourself
DIYBio	Do It Yourself Biotechnology
ECSA	European Citizen Science Association / Verein der Europäischen Bürgerwissenschaften
Eutema	EUTEMA GMBH
GA	Grant Agreement
H2020	Horizon 2020 Programme
KI	Kersnikova Institute
M	Month
Meritum	Centrum Szkolen I Rozwoju Osobistego Meritum
PEBR	Public Engagement with Biological Recording
RBINS	Institut Royal des Sciences Naturelles de Belgique
RI	Research Insight
RRI	Responsible Research and Innovation
SDGs	Sustainable Development Goals
SEI	Stockholm Environment Institute
Tekiu	Tekiu Limited
TK	Tekiu Limited
UCL	University College London
UNIGE	Université de Genève
UPD	Université Paris Descartes
WG	Working Group
WP	Work Package
WS	Waag Society

2 Management summary

The second batch of DITOs policy briefs focuses on four themes:

Brief 1 - Environmental sustainability: This brief follows up the policy brief #1 on BioBlitzes and focuses on the pilot study conducted to develop a common evaluation framework for the City Nature Challenge (CNC) 2018 in Europe.

Brief 2 - Biodesign: This brief follows up the policy brief #1 on Do It Yourself Biotechnology (DIYBio). It assesses the potential and challenges of biodesign citizen science for education and how it can contribute to achieving the Sustainable Development Goals (SDGs).

Brief 3 - RRI indicators that reflect the practices of public engagement organisations: This third brief on the overarching topic of RRI is focussed on enriching the conversation and applications of RRI frameworks, in particular how they can move from being used as tools for assessment by funders and evaluators to being useful guidelines for personal and organisational learning and development. The brief presents results from in-depth conversations with facilitators and insights from reviewing RRI indicators in a way that reflects their practices.

Brief 4 - RRI - linking Citizen Science and Open Science: This second policy brief on the topic of RRI is focussed on relations between Citizen Science and Open Science. It draws on initiatives implemented in Europe to identify synergies and future areas of work.

In response to request from the mid-term project review for more evidence on inclusion impacts of the project, we have decided to diversify the types of policy briefs we will produce. In addition to 'classic' policy briefs aimed at giving an introduction and overview of a given topic (Brief 2 and 4) we now also offer 'Research Insights' that are based on gathering more thorough evidence from within the project and providing it to decision-makers (Brief 1 and 3).

Like the first batch of briefs, a community-oriented approach was chosen for defining the specific topics of each brief and elaborating the content. Brief 1 has been developed by the ECSA working group on BioBlitzes, Brief 2 in cooperation with the in ECSA working group on Citizen Science for Learning and Education. Brief 3 draws on collaborative evaluation work within the DITOs consortium. Brief 4 was created together with the ECSA working group on Citizen Science and Open Science.

The timeline of each policy brief has been adapted to be responsive to schedules of contributors, political dynamics and external demands. Brief 4 was already launched in February 2018. Brief 3 is finished and will be designed and published in the next weeks. Brief 1 and 2 are presented as an advanced draft version. Their final review will be conducted in workshops with the respective working groups and external experts at the International ECSA Conference in Geneva next week.

This deliverable concludes the successful second stage of WP4 facilitating policy engagement for RRI. The final batch of policy briefs (M36) will further expand this work on biodesign, environmental sustainability and additional aspects of RRI.

DITOs 'Policy Briefs 2' is Deliverable 4.2 (D4.2) from the coordination and support action (CSA) Doing It Together science (DITOs), grant agreement 709443.

3 Introduction

DITOs' Work Package 4 (WP4) concerns policy engagement for Responsible Research and Innovation (RRI) within DITOs' two defined themes, namely biodesign and environmental sustainability. From the consortium Grant Agreement (GA), the objectives of WP4 are:

To develop clear guidelines, mechanisms and institutions to extend the development of policy engagement in citizen science and DIY science across Europe, fostering Responsible Research and Innovation (RRI), linking the pan-European citizen science and DIY science community to decision-makers at various levels and supporting innovation by:

- Elaborating, sharing and providing policy support on good practices of RRI activities with a focus on DITOs;
- Mainstreaming gender equality, ethics and quality evaluation as RRI standards for DITOs activities in Europe;
- Channelling societal inputs regarding responsible R&I policies to policy makers at different levels, especially in the fields of Biodesign and Environmental Sustainability.

WP4 is designed to strengthen the two-way link between the DITOs network and policy makers to promote sustainable and resilient RRI governance. It will guide a learning process among DITOs practitioners, elaborate and mainstream RRI standards, and engage policy and decision-makers at local, regional, national, EU and international levels.

Activities in WP4 include structured knowledge creation and exchange, development of guidelines (policy briefs), mechanisms for engagement (stakeholder roundtables and pan-European policy forum) and sustainable institutions (namely the European Citizen Science Association - ECSA) for policy engagement.

ECSA leads WP4 which runs from Month 1 to month 36 of the project. During this time, three sets of policy briefs will be produced (M12, M24 and M36). This deliverable covers the production of the second set of briefs (M24), namely:

- Cross-border research and cooperation for **environmental sustainability**;
- **Biodesign** regulations and adaptation potentials;
- **RRI**: Gender equality and inclusion of disadvantaged groups;
- **RRI**: Open access, open data, and open science.

This deliverable outlines the process followed to produce the briefs and the sources of information as well as the content of the briefs themselves.

4 Activities carried out and results

4.1 Diversifying Policy Brief Formats, creating Research Insights

After creating, publishing and disseminating the first set of policy briefs, we decided to diversify the format of DITOs policy briefs and thus enrich the kind of information we're making available for decision-makers. In the first phase of the project, our policy briefs had the character of providing general introductions to novel activity types that are becoming popular in CS (e.g. BioBlitz) and sub-fields of practice (e.g. DIY

biotechnology) as well as relating CS to other fields of research practice and policy (e.g. Open Science). The information provided in these briefs was of a rather general nature, with the aim of giving decision-makers an overview and pointing out examples for the practice and giving further resources. For the second period of the project, we will continue having this 'classic' type of policy brief and introduce new formats to satisfy additional information demands. One request from the mid-term evaluation was for more evidence-based accounts of citizen science activities, such as ethnographically-informed reports of engagement events. As a result, we will offer a new type of policy brief focused on 'research insights'. A first prototype of this new format will be created bundling insights from WP5 ethnographic evaluation of the DITOs science bus participatory exhibition.

4.2 Sources of information and methods of working

The information presented in all the policy briefs draws on the initial fact finding and review exercise (WP4T1), which included materials from other EU reference projects, such as CAPS, PLACES, Citizens Observatories, Everyaware, Geo-Wiki, RRI Toolkit, Socientize, Synenergene, as well as other projects and institutions, such as the Joint Research Center and the Hackteria network. In addition, scientific and popular science literature has been consulted as well as grey literature by practitioners from the respective fields.

Since both citizen science and DIY science are emerging fields - along with the public engagement related to them, the goal of creating of these policy briefs is to make more information about these practices available. For this reason, a community-oriented approach has been used for determining the specific topics of each brief within the framework of the broader topics stipulated by DITOs. To facilitate such a community-oriented approach, knowledge and experience from practitioners, within the DITOs consortium and beyond, has been collected through various processes described below.

The Research Insight on **environmental sustainability** is a follow up version of the policy brief 1 on BioBlitzes. It has been developed with contributions from members of the ECSA BioBlitz WG, particularly the organisers of the CNC in Europe and other stakeholders involved in this initiative. Since the establishment of the WG in January 2017, activities and events involving the BioBlitz WG and promoted and supported through DITOs within WP2 (e.g. the capacity building workshop for BioBlitz organisers held in Rome in November 2017; the facilitation and coordination provided to organisers of the CNC 2018 held in European cities) have attracted the interest of an increasing number of ECSA member and non-members. The CNC started in 2016 as a BioBlitz-style competition between Los Angeles and San Francisco, encouraging residents and visitors in documenting nature to better understand the urban biodiversity. In 2017, the City Nature Challenge went national, with 16 cities around the US joining in the competition. The CNC became international in 2018 with almost 70 cities across the globe, with 11 cities from 6 European countries participating. ECSA supported the CNC by promoting the initiative to European partners, facilitating coordination and developing a common evaluation framework. Ultimately, the CNC was a useful exercise for strengthening the network. With the introduction of the CNC in Europe, ECSA and BNHC (respectively chairing and co-chairing the BioBlitz WG), were interested to coordinate a basic evaluation of CNC events across Europe factoring for the diversity of approaches adopted for PEBR. In fact, since different European countries employed different event formats, it was important to describe the

different methodologies and provide some case examples. This study was possible thanks to a collaboration with the COST Action 151212 Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe. ECSA and BNHC have hosted Simone Cutajar (Greenhouse Malta) for a Short-Term Scientific Mission (STSM) in order to conduct the study, linking to the work conducted on BioBlitzes by ECSA and the DITOs project and making a valuable contribution towards achieving the aims and objectives of the ECSA BioBlitz WG. The objective of the STSM was to develop an evaluation tool to be used for the events organised during the CNC across Europe. The evaluation tool was developed with a participatory approach involving members of the BioBlitz WG; it was subsequently translated in 9 languages and uploaded online (on Google Form) for evaluating participants' experience after they attended CNC events. Online meetings were held regularly to allow everyone to participate in the development of the questionnaire and outline of the RI. The timeline for the development of the document was defined during the meeting, and members who expressed interest in contributing to the document accepted the proposed deadlines and specified the section of the outline they would contribute to. A working document with the outline of the policy brief was created on an online collaboration platform. In order to bring evidence of the diversity of approaches and event formats adopted during the CNC, case examples were provided by the organisers. Contributions were merged into a first draft by the WG coordinator, and the draft was sent around for different rounds of feedback. The draft was reviewed by the members of the group, by an external and internal reviewer, then shared with DITOs consortium PIs.

Members/institutions of ECSA WG who have been involved in CNC 2018 and in the study for the development of the evaluation framework and the RI are: Bristol Natural History Consortium (UK); Natural History Museum London (UK); Natural History Museum of Barcelona (Spain); CREAF (Spain); Marine Biological Association (UK); Department of Environmental Biology of Sapienza University of Rome (Italy); Laboratório da Paisagem - Landscape Laboratory (Portugal); Institute of Marine Sciences - ICM-CSIC (Spain); GBIF.ES - Royal Botanic Garden Madrid (Spain); Department of Land, Environment, Agriculture and Forestry of the University of Padua (Italy); University of Trieste (Italy); Natural History Museum Prague (Czech Republic); Museum für Naturkunde (Germany); California Academy of Science (US); Natural History Museum of Los Angeles (US).

The **Biodesign policy brief** has been developed based on an initial planning at the end of 2017. This planning was shared with the consortium members and adjusted when needed in online conference calls.

The plan included multiple strategies towards gathering information about synergies between biodesign, citizen science, education and the SDGs. Contributions were collected via a series of online and physical interviews with citizen science practitioners and educators throughout Europe, but also through the constitution of a working group with experts from and outside of the Center for Research and Interdisciplinarity. Additional input was collected during the COST Action / ECSA workshop on Citizen Science & Education that took place in Leysin in March 2018. The workshop aimed to provide inspiration and critical discussion between participants from different communities: educational researchers, scientists, science educators, and teachers. During this process, several WP1 Biodesign activities took place that offered additional opportunities to gather information and opinions. In particular, UPD's and KI's educational workshops have been included as case studies in the policy brief.

In addition to the literature review, tasks were divided to write the policy brief itself between members of the DITOs consortium, especially between UPD and ECSA. Using an online collaborative platform, a working document was created, which outlined the main sections and boxes for case studies. A summary of this initial policy brief will be transformed into a public presentation, which will be held at the ECSA Conference in Geneva in the presence of citizen science practitioners and teachers from all over Europe and the world. The discussions at this event will serve as external review of the policy brief and feed into the final version. This is going to be designed and distributed to stakeholders.

Initial research for the Research Insight on **RRI indicators that reflect the practice of public engagement organisations** began looking at 'The User's Guide for Evaluating Citizen Science Learning Outcomes' (Phillips et al., 2014), the results from the EU FP7 project Citizen Cyberlab, the 'White Paper on Citizen Science' by the project Socientize (Serrano Sanz et al., 2014), the PLACES toolkit (Semir, et al., 2011), and the EC report on RRI criteria and indicators (Strand et al., 2015). To understand RRI in practice we carried out one-on-one interviews with event facilitators and coordinators of DITOs partner organisations. In a conversational manner, we discussed the pros and cons of employing each indicator with the purpose of producing a set of RRI indicator descriptions that reflected the actual practices of partner organisations. That is, we produce indicators with depth that were meaningful and relevant. It must be noted that the interviews also functioned as spaces for reflection and sharing of ideas, approaches, and questions with the facilitators; these spaces and opportunities had not been created before. It must also be noted that these interviews were not done exclusively for the creation of this research insight; they were part of the formative evaluation of DITOs and hightls extracted for the creation of this research insight. The research insight was reviewed by two internal DITOs readers and one external reviewer, member of our RRI advisory board.

Policy Brief 4 on **Open Science** was developed with contributions from a mixed group of experts from both fields - Citizen Science and Open Science - who came together in the dedicated ECSA working group. We organised a series of workshops to develop this policy brief, including regular online working group meetings, a face-to-face policy brief drafting workshop in Copenhagen (June 2017) and a review at the DITOs European stakeholder round table 'Towards a Citizen Science Roadmap' (October 2017). The policy brief draws on case studies of practices linking aspects of both Citizen Science and Open Science. Short versions of these case studies are presented within the brief and an extended version with longer and more case studies accompany the brief online - it is planned to be extended: https://ecsa.citizen-science.net/blog/citizen-science-open-science-policy-brief-out

Members of the ECSA Open Science working group who have been involved are: Kyle Copas, Erich Prem, Georg Melzer, Daniel Mietchen, Eveline-Wandl Vogt, Qijun Jiang, Thomas Mboa, Christine Marizzi, Daniel Dörler, Oscar Corcho, Anne Bowser, Sven Schade, Heiner Benking, Milena Dobreva, Muki Haklay, Christian Nold, Aleksandra Berditchevskaia, Katrin Vohland, Gina Maskell, Marisa Ponti, Inian Moorthy, Barbara Kieslinger, Michael Sogaard Jorgensen, Martin Brocklehurst, Fermin Serrano.

4.3 Environmental sustainability policy brief considerations

Title: Developing a common evaluation framework for the City Nature Challenge 2018 in Europe factoring for the diversity of approaches for public engagement with biological recording

Outline:

1. Executive summary
2. What is the City Nature Challenge
3. The need for a common evaluation framework
4. A challenge for the European BioBlitz Network
5. Setting out distinction between different event formats
6. Case examples of different event formats during the CNC in Europe
   6.1 24-hour BioBlitz in London
   6.2 Mini-BioBlitz in Guimarães, Portugal
   6.3 Recording marine species in Barcelona, Spain
   6.4 Recording nocturnal species in Berlin, Germany
   6.5.Guided nature walks ´ScopriNatura´ in Padova, Italy
   6.6 Natusfera platform training for the CNC in Madrid, Spain
   6.7 Biomaratón and Natusfera training for participants in Cádiz, Spain
   6.8 Biomaratón and ID Party 'Identificatona' in Madrid, Spain
   6.9 Survey Teams in Bristol & Bath
7. Methodology used for developing a common evaluation framework
   7.1 Outcomes and indicators used in the common evaluation
8. Results
   8.1 Self identified knowledge gained and intention for behaviour change
   8.2 Organiser's survey
   8.2 Box 1 Results from the ethnographic observations in London
9. Conclusions
10. Recommendations

The full content of the *'*Developing a common evaluation framework for the City Nature Challenge 2018 in Europe factoring for the diversity of approaches for public engagement with biological recording*'* research insight can be found in Appendix 1.

Status: An advanced draft of the policy brief is presented in the appendix. It has been reviewed by internal and external reviewers. The draft will be discussed at a dedicated workshop at the International ECSA conference next week, then finalised and reviewed by the DITOs consortium and published.

4.4 Biodesign policy brief considerations

Title: Unleashing the potential of biodesign citizen science for Education towards the Sustainable Development Goals (SDGs). For a meaningful, challenge-based and action-oriented learning and teaching.

Outline:

1. Executive Summary
2. Understanding the potential of biodesign educational programmes
3. Action-oriented citizen science for students
4. How can biodesign citizen science contribute to education towards the SDGs?
   a. Contribution to SDG 4 Quality Education
   b. Contribution to SDG 3 Good Health and Well-being
   c. Contribution to SDG 6 Clean Water and Sanitation
   d. Contribution to SDG 11 Sustainable Cities and Communities
5. Recommendations

Target audience: policy and decision-makers from the European Commission who coordinate education and training policy, national Ministries of Education, UNESCO, educational researchers, scientists, science educators and teachers.

Purpose: informing stakeholders about the potential of DIYBio.

The full content of this brief can be found in Appendix 2 – Biodesign Policy Brief.

Status: An advanced draft of the policy brief is presented in the appendix. The draft will be discussed at a dedicated workshop at the International ECSA conference next week, then finalised and reviewed by the DITOs consortium and published.

4.5 RRI indicators policy brief considerations

Title: Research insight on RRI indicators that reflect the practice of public engagement organisations

Outline:

1. Introduction
2. Key findings
3. The challenges of RRI indicators for public engagement organisations
4. Revised RRI indicators that reflect the practice of public engagement organisations
    a. Public engagement
    b. Gender equality
    c. Science learning
    d. Social inclusion
5. Recommendations

Target audience: Public engagement practitioners who have to follow or are interested in applying RRI frameworks to assess their work; funding bodies and policy/decision-makers to apply RRI indicators to assess suitability and outcomes of public engagement initiatives.

Purpose: Presenting revised RRI indicators to public engagement practitioners and funding organisations to consider and use when planning or assessing public engagement initiatives.

The full content of the '*Research insight on RRI indicators that reflect the practice of public engagement organisations*' is in Appendix 3.

Status: A final draft of the policy brief is presented in the appendix. It has been reviewed by an internal and external reviewer and will be published soon.

4.6 RRI open science policy brief considerations

Title: Citizen Science & Open Science: Synergies & Future Areas of Work

Outline:

1. Executive Summary
2. Transformations of Research
3. Links between Citizen Science & Open Science
    a. How Open Science facilitates Participation
    b. How Citizen Science enables Openness
    c. Joint Benefits
4. Current Status & Future Challenges
    a. Openness

   b. Inclusion & Empowerment
   c. Education & training
   d. Funding
   e. Infrastructure & Reward Systems
   f. Further Research & Critical Discussion
5. Conclusion
6. Recommendations

Target audience: decision-makers who have already adopted either Citizen Science or Open Science.

Purpose: informing decision-makers on the synergies between these approaches and the benefits of considering them together.

The full content of the policy brief 'Citizen Science & Open Science: Synergies & Future Areas of Work' brief can be found in Appendix 4.

Status: The policy brief was published and disseminated in February 2018.

4.7 Design and presentation of policy briefs

The design and presentation of policy briefs has been well received. We're updating iteratively as to improve presentation of contents and workflow, but no major changes are foreseen.

4.8 Dissemination of policy briefs

Policy briefs will be distributed online (through the DITOs and partners websites and mailing lists, via online discussion lists and social media, accompanying blog posts, etc.), in print (as handouts to decision-makers), and via events and presentations. Policy briefs will also be presented, handed out and discussed at future DITOs and partners' events to attract additional attention, such as stakeholder round tables and conferences. Finally, the community-oriented process of writing the policy briefs will also be used for their distribution.

5 Conclusions

This deliverable concludes the successful second stage of WP4 and the timely deliverable of four policy briefs evidences a firm foundation and network on which to extend the consortium's activities on policy engagement for RRI. The key achievements in this phase have been:

- **Guidelines:** Publishing the second batch of policy briefs focusing on good practices of RRI activities regarding public engagement in research for environmental sustainability, DIYBio, RRI indicators and Open Science. This material can now be leveraged for supporting policy and further developing policy engagement in citizen science and DIY science;
- **Mechanisms:** Establishing and deepening collaborative, open networks around the topics of BioBlitz, Biodesign and education, Open Science and evaluation dimensions between DITOs partners, external practitioners of

citizen science and DIY science, their organisations, policy makers and other stakeholders that support learning and can stimulate innovation;

- **Mechanisms:** Carrying out four open, community-oriented processes for determining the specific themes and contents of the policy briefs and thereby piloting participatory processes along with accompanying communication strategies to be built on for future deliverables;
- **Institutions:** Extending ECSA's and DITOs' capacities as de facto sources of information for policy makers throughout Europe;
- **Institutions:** Building and extending institutional structures – creation of ECSA WG on BioBlitz in Europe and on Citizen Science and Open Science – to build capacities for sustainable networking and policy engagement for citizen science and DIY science communities;
- **Internal:** Successfully integrating WP4 (Policy Engagement) activities with WP1 (Environmental Sustainability), WP2 (Biodesign) and WP5 (Evaluation) activities through identification of relevant and actionable topics of concern, thereby providing tangible examples of processes and outputs of the implementation of the matrix structure behind the DITOs project;
- **Internal:** Linking the work on policy briefs to other WP4 activities, especially stakeholder round tables, carried out by various partners thus improving coordination between partners;

Future briefs (M36) will further expand the themes of biodesign and environmental sustainability and will address other key principles of RRI (gender equality and the inclusion of disadvantaged groups, open access, data and science, ethics and quality evaluation and the involvement of SMEs and industry). The sources of information will be continually expanded and updated. In addition, future policy briefs will pilot further ways of mobilising input by linking to other WP4 activities, especially Discovery Trips, as well as WP1 and 2 activities, especially feedback on exhibits, activities and outputs of deliberation. Next to the policy briefs, also mechanisms and institutions for policy engagement of citizen science and DIY science communities across Europe will be developed further. Altogether, this work aims at contributing to work towards maximising the innovation potential of Europe, building trust in R&I activities and closing the research and innovation capabilities gap. Within the RRI framework, data ownership and IPR will receive special attention, in consultation with legal experts.

6 Bibliography / References

References given here were used in the deliverable text; references used in the policy briefs are given below in each brief.

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Strand, R. et al., 2015. Indicators for promoting and monitoring Responsible Research and Innovation Report from the Expert Group on Policy Indicators, Brussels.

7 APPENDICES

7.1 Appendix 1 – Environmental Sustainability Policy Brief

Research Insight on the *development of a common evaluation framework for the City Nature Challenge 2018 in Europe factoring for the diversity of approaches for public engagement with biological recording*

Executive summary

The City Nature Challenge[1] (CNC) is an international initiative that helps people to find and document plants and wildlife in cities across the world. It is based on a competitive model where cities compete to collect the most observations in a geographic area over a set time-frame. Although competition motivates some, CNC organisers found in 2016 and 2017 that the collective effort, to document biodiversity in all cities participating, was a motivator for others. As part of the challenge, cities around the world have hosted a large diversity of local events**,** including BioBlitzes, mini-BioBlitzes, species surveys, guided nature walks, ID parties and other adaptations of these formats. Although the scope of all these events is based on the notion of collecting biodiversity data and engaging the public with nature, the methodologies of these events are intrinsically different. For this unique occasion, the European BioBlitz network collaborated to develop a common evaluation framework to assess outcomes of the events from a social perspective. The standardised questionnaire was piloted during the CNC 2018 and for the purpose of this paper we analysed the indicators used to measure participants' self reported behaviour change and knowledge outcomes. This pilot study highlights the importance of factoring for differences between event formats for public engagement with biological recording when designing and implementing an evaluation framework. Therefore, this research insight sets out distinctions between different event formats adopted for public engagement with biological recording (PEBR) bringing case examples of events held during the CNC 2018 in Europe. Such a synthesis of event formats and an attempt at evaluating them with one common evaluation tool has not, thus far, been carried out and so we employ a cross-cutting approach to objectively assess these different formats and pilot a standard survey. From this we outline key recommendations and suggestions for developing a common evaluation framework for CNC initiatives. This study has been conducted with contribution from members of the European BioBlitz network and the COST Action 151212 'Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe' within the framework of the Horizon 2020 'Doing It Together Science' (DITOs) project.

[1] City Nature Challenge (nd). Available at: http://citynaturechallenge.org

What is the City Nature Challenge

Derived from a traditional BioBlitz model – CNC is an intercity competition setup by the Natural History Museum of Los Angeles County and the California Academy of Sciences. The multi-day challenge encourages participants to submit observations of organisms via a mobile phone app and/or website. Many cities also host a number of events (including BioBlitzes) as sub-formats. The CNC was launched in 2016 as a competition between Los Angeles and San Francisco and lasted 7 days. In 2017, the CNC went national, with 16 cities in the US joining in the competition and was reduced to a 5-day challenge. The CNC became international in 2018 with 68 cities across the globe, with 11 cities from 6 European countries submitting observations from 27th to 30th April 2018.

Country	**City**
UK	London, Bristol & Bath City Region, Plymouth
Italy	Rome, Padua
Spain	Barcelona, Madrid, Cadiz
Portugal	Guimarães
Czech Republic	Prague
Germany	Berlin

Table 1. European countries and cities participating in the CNC 2018.

The need for a common evaluation framework

The multifaceted nature of the CNC initiative means that a holistic approach to evaluation is highly challenging. As recommended by Postles and Bartlett[2] (2018), to more accurately evaluate BioBlitz style events, there is a need for a centralised flexible evaluation tool to assess and collate the outcomes of individual events against an agreed set of collective aims and objectives.

A challenge for the European BioBlitz network

The European BioBlitz Network is a community of practice interested in the BioBlitz approach and its implications for public engagement, scientific, environmental management and policy outcomes[3]. Approaches to engaging the public in biological recordings vary across the globe. At the European scale, variability is amplified due to differences in language, technologies used, and tradition in running citizen science activities. This variability adds complexity to the coordination of PEBR efforts in the European landscape. The CNC has the advantage of bringing together a great diversity of event formats *at the same time in multiple cities*. This was an opportunity to conduct a coordinated standardised evaluation of the distributed events and compile a collection of different event formats. A collaboration was established among organisers in Europe and coordinators of the CNC to conduct an evaluation of events during the CNC 2018 across Europe factoring for the diversity of event formats. Ultimately, the CNC was a useful exercise contributing to strengthening the European network.

Setting out distinctions between different event formats

In recent years, the term 'BioBlitz' has become widely used as a catch-all term for many different event-based platforms for PEBR. However, when exploring the relative merits of different programmes and methodologies, it is important to set out distinctions between the diversity of formats and approaches.

[2] Matthew Postles & Madeleine Bartlett (2018): The rise of BioBlitz: Evaluating a popular event format for public engagement and wildlife recording in the United Kingdom, Applied Environmental Education & Communication, DOI: 10.1080/1533015X.2018.1427010

[3] DITOs Consortium (2017). BioBlitz: Promoting cross border Research and collaborative practices for Biodiversity Conservation. UCL (University College of London): London, UK.

Figure 1. Common event formats for public engagement with biological recording. These formats may exist independently or as subformats within larger umbrella events such as a large scale BioBlitz or City Nature Challenge. Credit: Matt Postles, Bristol Natural History Consortium.

Case examples of event formats during the CNC in Europe

24-hour BioBlitz in London

The London City Nature Challenge was led by the Natural History Museum in partnership with the Royal Parks and University College London and supported by a range of partner organisations across the capital. The focus of the activity was a 'classic' BioBlitz format of a 24-hour event bringing professional scientists, volunteer naturalists and the public together to conduct an intensive biodiversity survey within a fixed geographical area. This central large-scale event provided a news 'hook' to engage participation across the city. Hosted in Hyde Park in central London, the event centred around a basecamp hub in the LookOut education centre. The basecamp contained a welcome desk, iNaturalist app support area, identification station and indoor displays and activities. From this hub, guided surveys and self-led activities set out across the park. A broad range of taxa were covered through the guided surveys including bats, moths, lichens, trees and other plants, spiders, earthworms, beetles and other insects. The event attracted over 130 participants (lower numbers than expected due to poor weather) but nevertheless 110 people submitted 2629 observations of 737 species using the iNaturalist app. These observations were identified and/or verified by 149 people. The event attracted a number of expert naturalists who identified some interesting lichen species previously unrecorded from this area and a non-native gallwasp which will be included in a forthcoming publication. Media interest was attracted, and the event was covered by TV company London Live. Evaluation forms (consistent with those used across Europe) were available during the event and informal interviews conducted with participants. Ethnographic research observations of young participants (aged 5-19 years) were also conducted through the international LEARN CitSci research programme funded by Wellcome, the UK Economic and Social

Research Council and the National Science Foundation, which seeks to understand learning and the development of agency in young people who participate in different formats of citizen science.

Mini-BioBlitz in Guimarães, Portugal

The CNC in Guimarães was coordinated by the Landscape Laboratory, in collaboration with universities, associations for science divulgation, an environmental non-governmental association, a local volunteer group and local scouts group. The main objectives of the CNC in Guimarães was to increase the knowledge of the community on the local wildlife, as well as commitment to the protection of Guimarães' biodiversity. The CNC included 8 events, which mobilised more than 100 people. A total of 238 observations from 112 different species were recorded using the BiodiversityGO! mobile App. The CNC was structured around the mini-BioBlitz format, with a total of 5 events. This format allowed covering a larger geographical area to a normal BioBlitz with several biodiversity routes for observation and identification of species across different green areas, including Penha Mountain (120ha), Monte Latito Park (10ha), Meadow of Creixomil (300ha) and Guimarães' City Park (30ha). The organisation of these events was carried out by a primary school, the local scouts group, and the associations for science divulgation, with the assistance of species experts from Landscape Laboratory and universities. Each mini-BioBlitz lasted 2 hours and was led by 2 experts who assisted the 15 participants (per group) in the observation and identification of species. In addition, a major BioBlitz was organised in Guimarães's city park by the Landscape Laboratory, in collaboration with the partners mentioned above and with support of 12 experts in the field of zoology and botany. Activities for seniors were organised to raise awareness in wildlife protection, using games and videos.

Figure 2. Participants conducting observations during the CNC in Portugal. Credits: Rita Mendes, Laboratório da Paisagem.

Recording marine species in Barcelona, Spain

The CNC 2018 was coordinated in Barcelona Metropolitan Area, including 35 municipalities and 10 districts in the city. The objective of the event was to bring together a network of local groups involved in the CNC within the metropolitan area of Barcelona. There were no specific target species, however, one of the main organisers, the Institute of Marine Sciences, promoted activities for the recording of marine species. Previous efforts were made in preparation to the competition, in order to introduce the CNC and the platform used, Natusfera, to the many local groups in the metropolitan area. The CNC in Barcelona included a diversity of event formats, allowing local groups to design and conduct their own event within the municipality or district. A subproject was created in the platform Natusfera for each municipality and district. The total number of participants registered was 158 and between 20-40 volunteers/experts were also involved, although it is difficult to pinpoint the exact number.

Recording nocturnal species in Berlin, Germany

The CNC 2018 in Berlin included 13 events aimed at engaging people with species recording using the mobile App Naturblick. The CNC was organised by the Museum für Naturkunde Berlin (MfN) and supported by partners from local NGOs, municipality and research institutes. Following an open call, partners chose the format for their event based on their interest and capabilities with the only limiting factors being their time and space (within Berlin's boundaries). Almost half of the events were guided nature walks with a focus on birds or amphibians. Other formats included a guided walk, lecture, discussion as well as species surveys. A nocturnal species survey for insects gave participants an insight into scientific methods by using a light trap. Additionally, a local radio station mobilised their audience with a day-long reporting. Overall 334 participants made observations with Naturblick. The exact number of participants were probably slightly higher because some of the participants at events experienced problems with the app due to technical difficulties with older mobile phone models.

Figure 3. Nocturnal species survey at environmental centre Kienberg, one of the event organised as part of CNC in Berlin. Credits: Susan Karlebowski

Guided nature walks ´ScopriNatura´ in Padova, Italy

The CNC in Padua was organised by the Department of Land, Environment, Agriculture and Forestry of the University of Padua, in cooperation with the Municipality. During the 4-day event, about 150 people have collected 737 observations of more than 200 species using iNaturalist and within the administrative boundaries of the city (93 km2). Six guided nature walks - so called ´ScopriNatura´ - have been organised by local associations and public body with the assistance of 11 experts in botany, zoology and forestry. The main objective was to increase local community awareness of woodlands of Padua. One nature walk, focused on the urban nature of Padua, was led by two botany experts through a wild urban woodland to conduct observations of the local flora and explain the benefits of increasing such areas in the city. During this 2-hours event, 144 observations of 71 different taxa were submitted by 20 people. This nature walk was a suitable event format to conduct informal training of participants on the use of the iNaturalist App. A second nature walk had stops along the way where PhD students presented their research on urban ecology and city planning in a mini-lecture format. A total of 55 observations of 34 different taxa were collected by 25 people. Another 2-hours nature walk was attended by 15 residents and contributed 72 observations of 40 taxa. The sighting of a grey squirrel - a rare invasive alien species (IAS) in North Italy, was an opportunity for group leaders to raise awareness on the importance of monitoring IAS. An additional event was held on a boat, sailing one of the most important rivers of the city. Six 'urban sailors' collected about 40 observations on riverine flora and fauna. The most interesting species observed was a water snake, *Natrix natrix*, an animal quite rare to find in urban rivers. The last two 'Scoprinatura' carried out in Padua engaged about 30-35 people contributing about 280 observations to the challenge.

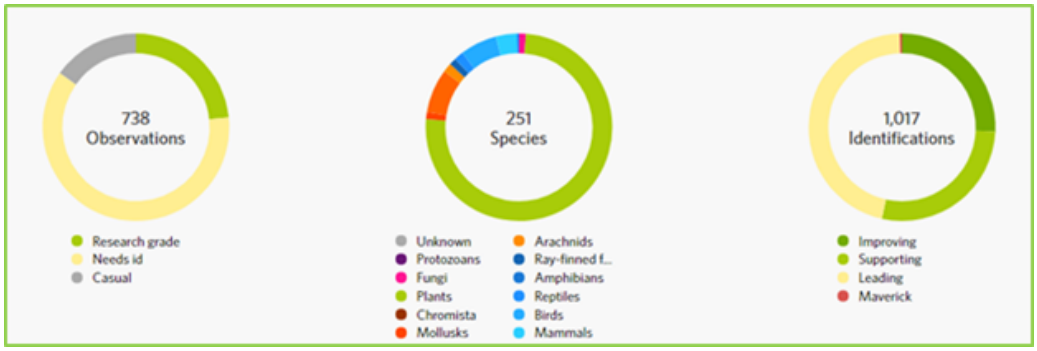


Figure 4. Detail of CNC Padova: number of observations, species and identifications gathered.

Figure 5. Nature walks in Padua. Credits: Giulia Corradini

Natusfera platform training for the CNC in Madrid, Spain

The workshop 'Recording and Managing Observations From Nature Using Natusfera' was organised by GBIF Spain in April 5-6, 2018 in the computing facility of the Royal Botanic Garden (CSIC) of Madrid. This workshop was aimed mainly at managers of nature groups to prepare their participation in the City Nature Challenge (called Biomaratón Madrid, in Spanish). It was a free 9-hours workshop that involved 26 participants who were technicians and educators from different Environmental Education Centers in Madrid, teachers of primary and secondary education and members of nature associations. The trainers were from the Natusfera Coordination team. During the first day of the workshop, teachers introduced the basic concepts of citizen science and its relationship with the GBIF network as well as the functionality of Natusfera. In addition, information on the CNC was presented to enable participants to organise their own activities during the days of the competition. On the second day of the workshop, we held a mini-BioBlitz to explore the urban biodiversity in the Quinta de Torre Arias Park, and observations were registered in a specific project created in Natusfera. Participants evaluated the course in an online survey and the rating were very positive. The participants appreciated the preparation and support of the teaching staff, the general experience and the location of the activity. Natusfera was valued very positively, especially its functionality of creating projects, the institutional support and the wide diversity of users.

Figure 6. Workshop on the use of Natusfera organised by GBIF.ES. Credits: GBIF.ES

Biomaratón and Natusfera training for participants in Cádiz, Spain

The Cádiz Natural History Society (SGHN) coordinated and organised the CNC 2018 (Biomaratón in Spanish) in the metropolitan area of Cádiz Bay (890 km2 and including 6 municipalities). To increase participation two practical workshops on the use of Natusfera (the platform used in Spain) and overview of the objectives of the CNC were organised. During one of the days of fieldwork, experts in the use of the Natusfera application and various different taxonomic groups stayed at two points in the sampling area. There was an intense media campaign on the website of the SGHN, as well as social media networks. The results were better than expected with a total of 2,154 observations and 712 species. Cadiz has been the city with a very high percentage of observations that have reached the research grade (70,5%), that is, observations with photo or audio, geolocation, date and time, identified by the community. Two new species for the Iberian Peninsula were recorded, notably the diptera *Dasineura gentianae* on flowers of *Blackstonia perfoliata* and the mite *Aceria tenuis* on the herbaceous plant *Hyparrhenia sinaica*.

Figure 7. Practical workshops in Jerez Zoo (Cádiz, Spain). Photo: Francisco Hortas (SGHN).

Biomaratón and ID Party 'Identificatona' in Madrid, Spain

The Spanish GBIF Node (GBIF.ES), hosted by the Royal Botanic Garden (RJB-CSIC), organised and coordinated the CNC 2018 - so called Biomaratón in Spanish - in the metropolitan area of Madrid, (1,743 km² and including 28 municipalities). An intense outreach and training campaign was carried out to encourage the citizens of Madrid to participate in the CNC and included a workshop on the use of Natusfera; several presentations to inform stakeholders about the CNC and the methodology implemented in Madrid; a field activity to record urban nature observations in La Casa de Campo; and an ID Party with experts in different taxonomic groups to identify species within the Madrid project. The aim of these events was to make the most observations of any species; promoting citizen participation; discovering the biodiversity of the urban nature of Madrid; increasing the co-responsibility of citizens in decision-making; and becoming aware of the importance of urban biodiversity for the detection of environmental and human health problems. The informative meetings were directed towards naturalist associations, social groups and public administrations related with the environment and education. As a result, 19 activities were organised by 12 partners. This network contributed to disseminating and expanding the scope of the CNC in Madrid. The campaign had the support of the Press Department of the RJB, and the CNC was disseminated through different media, press releases, radio and television interviews. In addition, there has been a close coordination with the other Spanish cities, Barcelona and Cádiz, to standardise criteria and exchange strategies during the organisation of the event. The ID Party**,** 'Identificatona', was organised as the final activity of the Biomaratón Madrid on 3rd May 2018 from 16:00 to 19:30 in the auditorium of Medialab Prado (a citizens' laboratory managed by the Madrid City Council that works as a meeting place for producing open cultural projects). The attendees worked together and exchanged their experience about taxonomy. More than 20 Natusfera users and taxonomic experts from research centers, universities and NGOs, attended the activity and contributed to the identification and validation of some of the nearly 7,000 observations of almost 800 different species registered in the metropolitan area of Madrid during the contest. Ángel Fernández Cancio (INIA) was one of the ´top observer´ during the Biomaratón Madrid, with roughly 1,400 observations and 400 species recorded. Comments on this activity were very positive and participants highlighted the usefulness, originality, and enjoyment of the 'Identificatona'. Finally, 1,231 observations reached research grade classification, corresponding to the 20% of the total observations registered in the metropolitan area of Madrid.

Figure 8. ID Party 'Identificatona' at MediaLab Prado organised by GBIF.ES. Credits: GBIF.ES

Survey Teams in Bristol & Bath

Bristol & Bath City Region used CNC to bring together a large number of partner organisations to host small activity formats on their own sites and public open space (including mini-BioBlitz events, species surveys and guided walks). This, alongside promotion of self guided recording using the iNaturalist app, provided a broad programme for engaging a public audience - primarily families and interested adults. This was supplemented with a programme dedicated to supporting young naturalists to take on leadership roles as part of our CNC Wildlife Survey Teams. Seven teams themed by taxonomic group (e.g. Team Bird, Team Invertebrates, etc.) came together led by specially trained volunteers (2 leaders per group). The groups were set a mission: "*To seek out rare and interesting species, explore local wildlife hotspots, fill gaps in the dataset through expedition 'mini-missions', all the while meeting and sharing knowledge with like-minded nature buffs!*". With some guidance from the experienced BioBlitz team at Bristol Natural History Consortium, the survey teams developed their own programme of species ID training workshops, social wildlife walks and mini-BioBlitz events. A social, informal emphasis was put on this programme and setting that tone, whilst tapping into local conservation and academic networks, created amazing opportunities for peer-to-peer learning as well as linking up with local experts and supporting the parallel public engagement events programme. The group came back together at the end for an ID party / DataHack and were rewarded with free pizza and beer! The groups became a driving force for marketing and online engagement by generating exciting and creative social media content.

Figure 9. Survey teams at the Bristol & Bath CNC. Credits: Matt Postles

Methodology used for developing a common evaluation framework

We employ a cross-cutting approach to objectively assess these different formats and pilot a standard survey, including:

1. Consultation with event organisers on event formats in order to understand the varieties of formats

2. Collation of detailed case studies on a selection of event formats carried out during the CNC 2018.
3. Surveys with organisers of these events in order to fully understand their motivations for evaluations, what would encourage them to evaluate and what they are interested in evaluating.
4. Brief overview of core indicators chosen in a collaborative effort to include in a common evaluation framework.
5. Brief overview on the effect of these different event formats on the knowledge gained and behaviour change outcomes as self-reported by event participants based on the piloting of the common evaluation framework in CNC 2018.

Preliminary stakeholder consultation meetings with organisers and coordinators of the CNC were necessary to develop the evaluation framework. For simplicity's sake, the event formats were classified as either 'self-led' or 'expert-led'. This distinction reflected the openness of CNC in allowing the public to submit observations from within the defined geographical area during the 4-days challenge even if not attending a particular event run by experts. Indicators were first identified through an open participatory process to assess organisers´ motivations to evaluate events. Furthermore, the literature review provided existing tools which were taken into account when designing the questionnaire. In order to keep the questionnaire concise, a core evaluation of 16 questions, (short enough to fit a double-sided A4 page) was agreed based on the common outcomes all organisers were interested to measure. Based on these outcomes, a selection of indicators was presented to the organisers and adapted according to need. The organisers were free to add their own questions to the survey to evaluate more targeted actions (for example, uptake of their new app etc). The survey was piloted with a group of people who had just participated in a mini-BioBlitz event. The survey was adapted based on the piloting and the final version of the questionnaire was translated in 7 languages (English, Italian, Portuguese, Spanish, Catalan, Czech and German). CNC event organisers from within the BioBlitz Network were invited to collect data from visitors attending their events using the standardised evaluation survey. Organisers were asked to share the survey either online after the event or as paper based during events *(Questionnaire in Appendix 1)*. A second questionnaire was designed to gather feedback from organisers and understand how best to support organisers in evaluating future CNC. Ethnographic observations over the 4 days of the CNC were also conducted during the Bristol & Bath and London CNC initiatives (see Box 1 for the results of the ethnographic observations in London).

Outcomes and indicators used in the common evaluation

For the purpose of this report, *outcomes* are being defined as changes or benefits results from participating in activities. *Indicators* provide evidence that a certain

condition exists or certain outcomes have or have not been achieved[4]. The outcomes chosen to be assessed in this evaluation and their corresponding indicators are:

1) *Knowledge outcomes*, assessed by the following indicators – the biodiversity of the participants' local area, the threats of this biodiversity, the organisations/projects working to monitor and protect biodiversity in the participants' local area and different ways that the participants can contribute to protect the local environment. (Question 12)

2) *Changes in behaviour outcomes*, assessed by the participants' intention to – take part in similar future events, join a wildlife group/charity/biodiversity project, promote similar initiatives and encourage others to participate, encourage wildlife in their garden/surrounding areas, spend more time outdoors and learn more about local wildlife. (Question 11)

3) *Increased mobile application uptake outcomes*, assessed by the following indicator – new usage of biodiversity collection mobile application. (Question 8)

4) *Increased public engagement outcomes*, assessed by the following indicator - participation in events of people who had never been involved in a similar event. (Question 4)

Results

Self identified knowledge gained and intention for behaviour change

The survey was conducted in 11 cities around Europe, with a total 158 participants filling in the evaluation. We were interested in evaluating behaviour change and knowledge outcomes for participants of CNC events in Europe. Factoring in the diversity of approaches in the CNC, the evaluation results were split up in two groups – those who only participated in 'self led' events and those who only participated in 'expert led' events. To avoid confusion, we discarded the responses of the people who participated in more than one type of event format. People who responded that they only volunteered for a CNC (as part of the administration/organisation/species specialist) or who responded that they participated in both 'self led' and 'expert led' event were not included to avoid confounding factors. Those who responded that they joined a school group and where helping a particular group were also not included since the definition of 'school groups' did not fall under neither 'self led' nor 'expert led'. After the removal of these responses we ended up with 137 responses, 67 for

[4] Preskill, H., Parkhurst, M. and Splansky Juster, J., 2014. Guide to evaluating collective impact: Learning and evaluation in the collective impact context. *Boston, MA: FSG Social Impact Consultants*.

self-led events and 45 for expert-led events. Respondents were asked to indicate the likelihood of the below statements:

11.a : Take part in similar future events

11.b : Join a wildlife group/charity/biodiversity project

11.c : Promote such initiatives & encourage others to participate

11.d : Encourage wildlife in your garden/your surrounding areas

11.e : Spend more time outdoors

11.f : Learn more about local wildlife

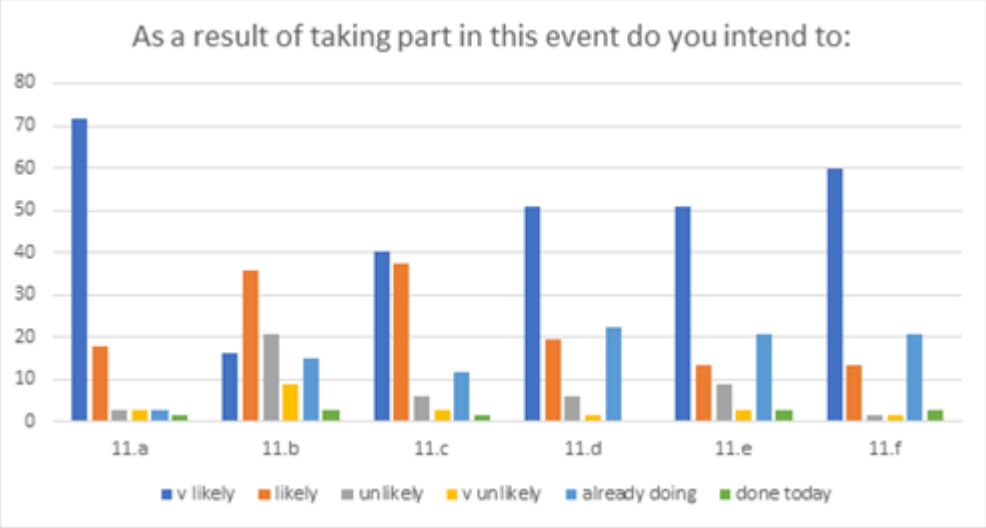


Figure 10.a Results for the participant group who only participated in an expert-led event.

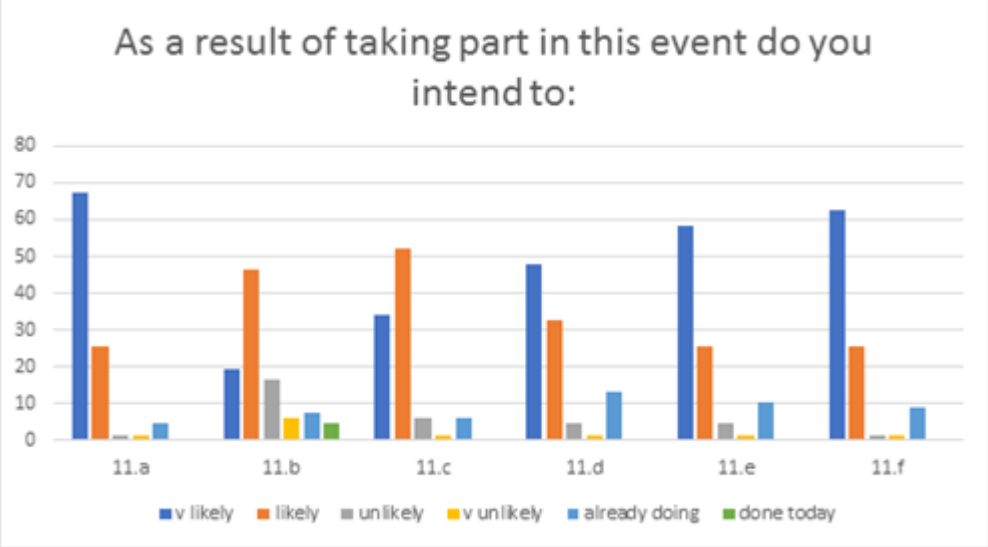


Figure 10.b Results for the participant group who only participated in a self-led event.

The above graph assessed participants' self-reported intention to change their behaviour in some way or form as a result of their participation in CNC. Both groups

showed a high indication of willingness to join a similar event in the future; promote such an initiative; join a wildlife group/charity/biodiversity project; encourage wildlife in their garden (or surrounding area); spend more time outdoors and learn more about local wildlife. More people who attended 'expert-led' events were already involved in a wildlife group/charity/project; promoting such events; encouraging wildlife in their gardens; spending time outdoors and learning more about local wildlife. The most positive self-reported response, for both groups, were for 'Take part in similar future events'. The least positive self-reported response, for both groups was 'Join a wildlife group/charity/biodiversity project'. Respondents were asked to indicate their level of agreement of the below statements:

12.a: I have learnt something new about the animals and plants in my local area

12.b: I have learnt something new about the threats to animals and plants in my area

12.c: I have learnt about the organisations/projects working to monitor and protect animals and plants in my area

12.d: I have learnt about different ways I can contribute to protect the local environment

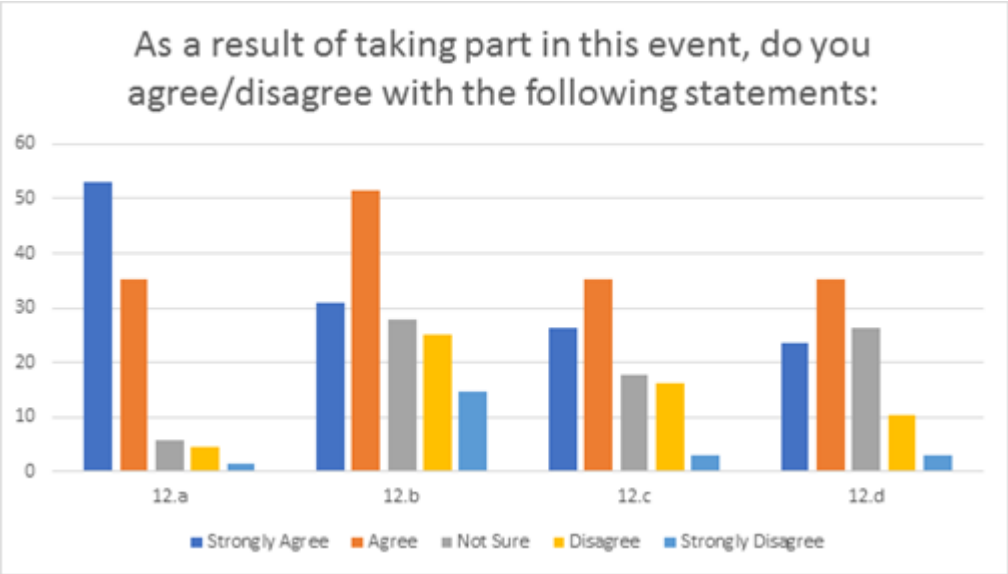


Figure 11.a Results for the participant group who only participated in an expert-led event.

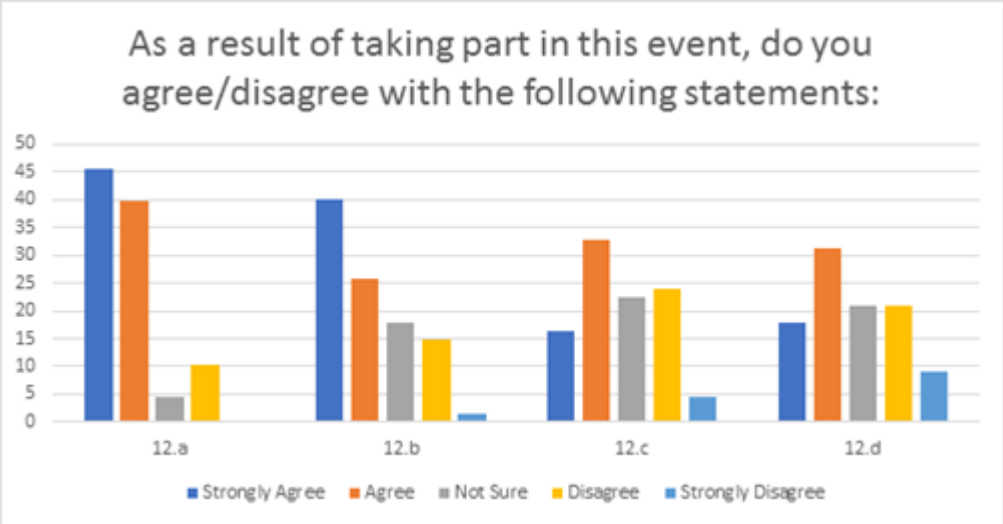


Figure 11.b Results for the participant group who only participated in a self-led event.

Both groups showed a self-reported high uptake of new knowledge about animals and plants in their local area and about the threats they face. Both felt they had learnt about organisations/projects to monitor and protect animals and plants in their areas, and there was also a similar uptake of information about the ways they can contribute to protect the local environment in both groups. Overall, for both groups, the 'knowledge indicators' which registered the highest positive replies were 'I have learnt something new about the animals and plants in my local area' and 'I have learnt something new about the threats to animals and plants in my area'.

Results from the organiser's survey

The survey was completed by 7 organisers. Below we report some key points:

- In order to promote ID parties the period for validating observations should be extended to the weekend after the CNC (it is difficult to achieve massive participation during working days).
- Participation in CNC 2018 has been a useful exercise for learning how to engage more effectively in 2019.
- It will be important to adapt evaluation surveys to different countries, realities and cultures, in other similar activities.
- It would be useful to gather feedback on the App used, (e.g. problems or bugs) in order to improve the App.
- It is important to keep the survey short enough to fit on two sides of A4 to not discourage respondents.

Box 1 - Results from the ethnographic observations
This case study on ethnography of the London component of the CNC identifies four topics:

1 *It was difficult to identify who was taking part in the CNC.* In London the majority of people using the iNaturalist app seemed to have been CNC organisers or their friends and relatives. The top identifiers in London also seem to have a Natural History Museum affiliation. On the contrary, many people who took part in identification activities that did not involve the app. For example, a young family picked up identification sheets from the information point and went off on their own to carry out identifications. Other people took part in group identification of spiders that did not involve any app use. This raises question about relying on the statistics from iNaturalist to determine participant numbers. This suggests the need for excluding event organisers from the statistics and trying to include headcounts of peripherally involved participants.

2 *The framing of the CNC as a competition may not be engaging the public.* When communicating the CNC some of the organisers focused on the competition between cities while hardly mentioning broader goals such as biodiversity monitoring. In contrast, the participants didn't seem to be motivated by this competition. This raises some questions about whether the general public as well as the organisers are motivated by the competition framing of the CNC.

3 *There appeared to be selectivity in terms of what plants and animals were recorded.* In the park the most common plants - grasses were hardly recorded. One of the respondents described this phenomenon as 'plant blindness'. Participants appeared to be trying to record 'authentic' native plants while cultivated plants, people and pet dogs were not tagged. This suggests that the resulting CNC observation data has a strong cultural component.

4 *There are questions about how well the survey captures critical opinions.* One respondent suggested the location of the CNC event in affluent West London was exclusionary for people from

diverse backgrounds and they were sceptical about the way inclusion was framed in the survey. They suggested the need for local events within disadvantaged areas. They did not want to fill in the survey form and did not want to be audio recorded. This suggests the need for combining evaluation methods and highlights some critical voices might not be being captured within the survey.

Conclusions

The multifaceted nature of CNC events means that a holistic approach to evaluation is highly challenging. The variety of audiences, their level of participation (e.g. some participated in more than one type of event, others were involved both as event participants and volunteers to help run the events) and volume of data per person required to recognise the diversity of perspectives set out challenges to gathering, processing and analysing reliable data. The challenge is to be able to clearly set out these distinctions of event formats and level of participation in the survey while also keeping it at an acceptable length. Analyses were run using the two categories ´self led´ and ´expert led´ as variables, however, these are not comprehensive of all the different event formats. Therefore, this tool does not evaluate the different approaches used for PEBR and can, for now, only be used to collect data on PEBR as a collective and which will not necessarily reflect the outcomes of any individual event format. Another challenge was to encourage participants to fill in the evaluation, the fact that not all organisers collected email addresses from the participants made it harder to follow up with a post-event evaluation. For the purpose of this pilot study, we decided to focus on the impacts of CNC at the EU level by measuring indicators of behaviour change and knowledge gain outcomes. Further analysis could have measured the other indicators included in the evaluation framework. Preliminary results show that there was no real difference in 'behaviour change' and 'knowledge uptake' outcomes between event formats self-led and ´expert-led´, however the survey resulted in a small sample size, plus participants might not have been clear about which type of event they participated in.

Recommendations

- The survey was piloted during CNC 2018 in different languages, further work needs to be conducted to internally validate the translated questionnaires.

- This evaluation tool does not assess the different motivations for participation because the construction of such questionnaire would have needed to be context-specific. Future work should gather baseline data of the motivations for participating in PEBR events in different countries and cultures. By including such component, useful information can be provided to event organisers for improving strategies for public engagement in their events.

- The design of a common evaluation survey tool needs to be linked with a strong offer of support to event organisers to achieve sufficient buy-in and should be well resourced to provide support, training, and incentives.

- The survey needs more clear distinction between the different event formats used for PEBR and respondents need to be guided to understand which event format they have attended.

- This study offers descriptive statistical analysis only. Action should be taken to reduce the margins of error before deeper statistical analysis can be carried out with any accuracy.

7.2 Appendix 2 – Biodesign Policy Brief

Unleashing the potential of biodesign citizen science for Education towards the Sustainable Development Goals (SDGs)

For a meaningful, challenge-based and action-oriented learning and teaching

Executive Summary

This policy brief assesses the potential and challenges of biodesign citizen science for education and how it can contribute to achieving the Sustainable Development Goals (SDGs). While biodesign educational programmes can address specific challenges across almost all of the 17 SDGs, this policy brief will focus on 4 specific goals that are the most relevant regarding this topic:

1. Quality Education (Goal 4)
2. Good Health & Well-being (Goal 3)
3. Clean Water and Sanitation (Goal 6)
4. Sustainable Cities and Communities (Goal 11)

By highlighting the role biodesign and citizen science educational practices can have in these policy-relevant areas through a selection of inspiring initiatives taking place throughout Europe, this brief aims to support the European Commission and national Ministries of Education in integrating these non-traditional educational practices into existing funding schemes, education policy and curricula towards a more meaningful, challenge-based and action-oriented learning and teaching.

Drawing on other discussions in the field of how biodesign citizen science can contribute to the SDGs, this brief highlights two of the three contributions suggested by the SEI Discussion Brief[5] on how generally citizen science can support the SDGs: (1) defining national and subnational targets; (2) monitoring progress; (3) implementing action.

What is biodesign?

Biodesign is often described as "the use of living things such as bacteria or plants in designing products or as art." Within DITOs, the title 'biodesign' is used to describe a wide range of activities including bioart, DIYBio and synthetic biology. Biodesign citizen science activities aim to engage citizens, scientists and policy makers in shaping and conducting research in biodesign and technology, addressing personal health and global issues. [6]

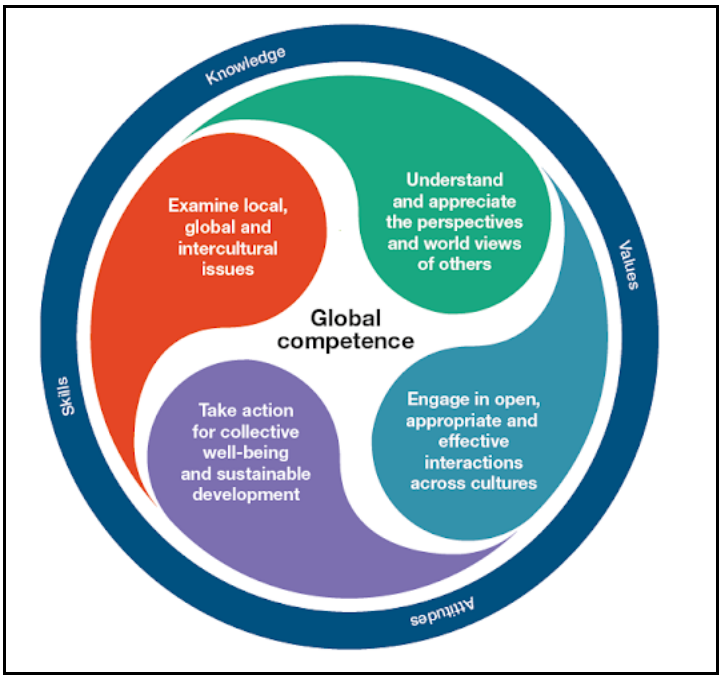
Box 1: What is biodesign?

Understanding the potential of biodesign educational programmes

[5] West, S. & Pateman, R. (2017). How could citizen science support the Sustainable Development Goals?. Discussion brief. Available at: https:// www.sei-international.org/publications?pid=3255

[6] DITOs Consortium, (2016). Doing It Together science: Outreach Plan for Biodesign, UCL, London. Deliverable. Accessible at: at:http://togetherscience.eu/content/4-about/3-deliverables/3-doing-it-together-science-d1-1-outreach-plan-for-biodesign/ditos-d1.1-20161130.pdf

As mentioned in the previous DITOs policy brief on the potential of DIYBio[7], biodesign educational programmes offer explicit room for improvisation, experimentation, and creative tangents from predetermined instructions and endpoints. This type of learning-through-doing, often called project- or challenge-based learning promotes many of the attitudes and skills indispensable to fostering "sustainability change-makers."[8] Some of these skills are mentioned in target 4.7 (box 3) and have been laid out in many OECD reports in terms of global competence, defined also as "multi-dimensional, lifelong learning for sustainability"[9] (box 2) .



Box 2: Dimensions of Global Competence, from the PISA Handbook on Global Competence, 2018[10]

Action-oriented citizen science for students

Actions spurred by a citizen science investigation can take a multitude of forms and scales. Examples include (1) using citizen science data as evidence for an awareness raising campaign or influencing policy (such as the air quality measurements being taken by community members and *Mapping for Change*[11] on North London school bus stops); (2) using personal and scientific lessons learned to write to local or national policy makers or create a media buzz; (3) taking local actions such as planting trees, litter clean-ups, or creation of microhabitats in an urban setting.

[7] DITOs consortium, (2017). 'Do It Yourself Biotechnology' (DIYBio) for open, inclusive, responsible Biotechnology. DITOs policy brief 2. https://waag.org/sites/waag/files/ditos-policybrief2-20171004-diybio.pdf

[8] UNESCO, (2017). Education for Sustainable Development Goals - Learning Objectives. Publication. P. 7. Avaible at: http://unesdoc.unesco.org/images/0024/002474/247444e.pdf

[9] OECD, (2018). Preparing our youth for an inclusive and sustainable world - The OECD PISA global competence framework. Available at: http://www.oecd.org/pisa/Handbook-PISA-2018-Global-Competence.pdf

[10] OECD, (2018). Preparing our youth for an inclusive and sustainable world - The OECD PISA global competence framework. Available at: http://www.oecd.org/pisa/Handbook-PISA-2018-Global-Competence.pdf

[11] University College of London, (2014). Clean Up London Air. available at: http://mappingforchange.org.uk/2014/10/clean-air-citizen-science/

These actions can be localised, in a classroom or school space, where a citizen science investigation or inquiry occurring in or around a classroom leads to a classroom cultural change (e.g. turning off the lights when the students leave the room) or implementation of a new classroom model (e.g. a new worm bin for composting organic lunch waste). These actions can also be 'scaled-up' to a community level, not just physically, but by involving a multitude of community members, from parents and grandparents to store owners and local nature conservation offices. Engagement at the community level can take form as collaborations at many steps through an action-oriented approach. It could be a partnership in defining a local concern or question or through sharing resources, teaching skills or methodology, not only for a scientific inquiry and observation but also for outreach and campaigning.

A key element for fostering a pathway to action through citizen science is beginning with a question that is relevant for students. This can be a local issue suggested by community members, a teacher (in a more structured inquiry), or by a student observation. Usually relevant questions have a local impact or actualisation, yet many of these relevant inquiries also have a national or global relevance (e.g. climate change). Starting with localised or community-based actions can potentially encourage students to 'think bigger' by allowing students to see that they can in fact have an impact.

In some cases, actions or causes can even grow to a regional, national or even international level, influencing policy or administrative rules. This can occur through cross-regional school-to-school exchange (fostering many ground-up actions in various regions) and/or 'snowball' support, building gradually from one school or classroom and onboarding other community groups in the neighborhood, town, neighboring towns, regions, and so on. Actions at a larger scale often involve media and policy change campaigns and focus less on 'doing' actions and more on communicating actions.

This points to another key element in enabling students to 'take action' during and/or after a citizen science inquiry: drawing on multiple learning methods. This could include internet and library research, scientific observation, recording qualitative-style interviews, data analysis and visualisation, persuasive writing and presentation, and hands-on activities. Not only does this allow for inclusivity of multiple learning styles and for students' particular strengths to thrive, it also gives students practice in carrying out meaningful and applicable science and communication.

How can biodesign citizen science contribute to education towards the SDGs?

While biodesign educational programmes can address specific challenges across almost all of the 17 SDGs, this policy brief will focus on 4 specific goals that are the most relevant for biodesign. Here we present case studies of concrete initiatives how this takes shape.

1. **Contribution to SDG 4** Quality Education

Goal 4: Ensure inclusive and quality education for all and promote lifelong learning

Case Study 1 - Potential for curricular integration

Far Out, Finland
http://www.syke.fi/en-US

Far Out, a Finnish two-year basic education programme, aims to bring together project-based and multidisciplinary learning, citizen science skills, mobile technology literacy, and other 21st century competences to basic education in Finland. The programme introduces these skills through two environmental themes, (i) carbon neutrality and (ii) researching and improving the state of waterways. In a transdisciplinary partnership between schools and environmental scientists at the Finnish Environmental Institute, pupils collect water samples, analyse the findings and feed the information to a nation-wide, open-source environmental databases. The Far Out programme encourages learning in the authentic environments, by the lakes, rivers or sea, as well as via simulation through a mobile game. The gamification of the environmental knowledge allows for another entry-point to exploring water quality. However Far Out programming does not stop at just hands-on and interactive learning, but also contextualises students' learning to their home and schools by investigating energy use in terms of carbon neutrality, of the places where they spend most of their time.

Mira Kekarainen on behalf of the Finnish Environment Institute

Case Study 2 - Potential for teacher trainings and capacity building

CRI Leadership Programme, France
http://togetherscience.eu/events/leadership-programme-phase-2_gtrqc

The **'Leadership Programme'** is a Teaching Through Research programme addressing young teachers and researchers in life sciences and biotechnology. It aims to support these young professionals in developing and implementing innovative educational projects in their schools. During the programme - of which the High School biodesign Workshops are an indispensable part -, the participants explored the use of biodesign as a creative educational tool that ensures full complementarity between teaching and research. After having completed a few High School biodesign Workshops, we had already collaborated with the majority of the teachers involved in the workshops and the Leadership Programme. As such, during our final meeting on the 13th of March, we had the chance to exchange experience, knowledge, feedback and future visions regarding innovative educational science projects in schools with the inspector and teachers from the Académie de Versailles, representatives from Les Savanturiers project and from the association Open Science School, but also researchers we have been collaborating with for the organisation of our previous Colab biodesign Workshops. The researchers exchanged with the teachers the latest research on their fields, their vision of collaborating further with teachers and students and answered to the teachers' questions. On the other hand, the targeted questions made by the teachers, highlighted the points to be ameliorated. One of the most important conclusions that rose at the end of the Leadership Programme was that teachers will always be the nodal point when it comes to introducing innovation in classrooms, and therefore they should always play an indispensable part of the co-creation procedure.

Imane Baïz, Université Paris Descartes/Center for Research and Interdisciplinarity, 'Leadership Programme'

Case Study 3 - Potential for innovative student assessments

Multimedia Storytelling for Biodiversity Monitoring Citizen Science Projects, Europe
https://narrativeatlas.ushahidi.io/views/map

Within the framework of the Doing it Together Science project (DITOs), the European Citizen Science Association (ECSA), in partnership with MapWorks Learning, is organising three interactive online student challenges. The overall aim is to promote young people's engagement with citizen science and to encourage inquiry and exploration around aspects of environmental and biodiversity monitoring. Teams, comprised of a group of secondary students and a mentor (i.e. a teacher or informal educator), document and creatively share their experiences, their processes and results, of undertaking a citizen science project in their community. Their projects should specifically be in the field of environmental and biodiversity monitoring, involving student-developed research question or student-collected and -analysed data on this topic (for example, a schoolyard BioBlitz). The data (or results) can be in any form: quantitative, qualitative, photos, through mapping, as a contribution to an already existing citizen science Project. The story, the multimedia piece submitted, should be a reflection on the student-led project. This can include creatively sharing observational information collected, through using a snapchat or instagram social media 'story' from the day of data collection, a blog-style piece including photos, or a gallery of scientific drawings from students. The submitted stories will be housed on an the Narrative Atlas online 'exhibition space' and shared via ECSA and DITOs social media platforms, as a way to share student citizen science stories outside of the physical school space, and hopefully across regions and borders. A focus will be placed on visual stories as a means to make cross-language communication. The competition will take place in 3 rounds. The first round, to be launched in March 2018, will function as a pilot. The following two rounds, to be launched in Spring 2019 and Fall 2019 will build off of the lessons learned in the pilot round.

Gina Maskell, ECSA, 'Student Citizen Science Challenge'

Case Study 4 - Addressing inclusivity in implementing SDG 4

GLOBE Program, international
https://www.globe.gov/about/overview

"The Global Learning and Observations to Benefit the Environment (GLOBE) Program is an international science and education program that provides students and the public worldwide with the opportunity to participate in data collection and the scientific process, and contribute meaningfully to our understanding of the Earth system and global environment." Teachers can opt into the program and then have access to the multitude of data collection, analysis, and visualisation tools for environmental data such as cloud monitoring and local waterway monitoring. GLOBE "ambassadors organise both regional and international conferences for not only GLOBE teachers to meet and share experiences but for students to celebrate their accomplishments."

Mira Kekarainen on behalf of the Finnish Environment Institute

2. **Contribution to SDG 3** Good Health & Well-being

Goal 3: Ensure healthy lives and promote well-being for all at all ages

Education, while often having the reputation of only occurring within sanctioned schools and designated educational spaces, of course occurs in many other arenas. As defined by the World Health Organisation, health education "is any combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes." Health education implies to monitor population behavior and issues in order to implement accurate solutions, but also to focus on the education around health topics such as reproductive health and addictions[12]. Finally there is also the ethical and philosophical dimension of the definition of well being which have to be taken into account [13]

Case Study 5

CRI Labs Summer School, France
https://cri-paris.org/cri-labs-summer-school-2018/

The CRI Labs Summer School is a 8-week challenge-based programme, hosted by the CRI GameLab and MakerLab. The Summer School hosts 50 international participants, from a variety of fields, who join forces to learn and collaborate through masterclasses, workshops, hackathons, and group projects tackling the UN's Sustainable Development Goals – specifically **Health & Education & Environment.** Summer school participants create games and devices that benefit from digital fabrication (3D printing, rapid prototyping, and more). Experts in game making, medicine, environmental science, digital fabrication, and frugal innovation mentor groups of students as they hack their way to a better world. In the Maker Lab, a CRI student is developing an open source smartwatch that will allow users to fully customise the information and interactions it will deliver (movement, heart rate, respiration rate and more). Using participatory design, workshops will be organised with adults and children to facilitate a mutual learning process based on designing experiences about their health. People with medical conditions (such as diabetes, asthma, etc.) will design experiences to help them better manage their chronic disease and improve their quality of life (also known as patient education).
This project will replace citizens in the heart and empower them about their health and health research.

Imane Baïz, Université Paris Descartes/Center for Research and Interdisciplinarity, *'CRI Labs Summer School'*
Karim Sandid, CRI student and General practitioner, *'Open Source Smartwatch'*

Case Study 6

'Bio Friday Academy', Slovenia
http://togetherscience.eu/events/bio-friday-academy-phase-2_tjgdp

Bio Friday Academy, an educational programme led by Kersnikova Institute, consists of individual and thematically grouped workshops run on Doing-It-Together principles,

[12] West, S. & Pateman, R. (2017). How could citizen science support the Sustainable Development Goals?. Discussion brief. Available at: https:// www.sei-international.org/publications?pid=3255
[13] UNESCO, (2017). Education for Sustainable Development Goals - Learning Objectives. Publication. P. 7. Avaible at: http://unesdoc.unesco.org/images/0024/002474/247444e.pdf

bringing the youngest of our population in touch with the newest scientific discoveries and processes. The activity sensitises youngsters to science and helps them to better understand the rapidly changing world around them. An entire chapter of Friday Academy has been dedicated to genetics, DNA, and biotechnology. In a series of workshops, children were able to design, test, and experiment with DIY laboratory equipment, and discovered the processes of extracting and multiplying their DNA. The workshops were designed as a complementary segment of the art programme taking place at Kersnikova, where participants were introduced to contemporary art practices that employ the scientific processes that they used in the DIYBio workshops.

Simon Gmajner, Kersnikova Institute, 'Bio Friday Academy'

3. **Contribution to SDG 6** Clean Water and Sanitation

Goal 6: Ensure access to water and sanitation for all

Preserve water sources and contain pollution is a major issue for this century and a future challenge for the next generation. It is important to work towards a most responsible consumption. A first step is to collect data on water quality and to identify the species that are potentially endangered by the degradation of the water quality. [14] Workshops, conferences and other hands-on activities can be held in or outside of a school setting to bring awareness around the differents tools and methods to clean water from the different substances that are potentially impacting on its quality.[15]

Case Study 7

'Co-Lab Workshop - Bioremediation', Paris
https://issuu.com/shneel9/docs/co-lab_book

The 'Co-Lab workshops' are a series of interdisciplinary co-creation workshops around various topics related to biodesign. The 3-day Co-Lab Bioremediation Workshop was held at University College London and the Institute of Making from November 26-28th, 2016. Bioremediation refers to the use of plants and microorganisms to remove or sequester pollutants. This event gathered participants from different specialisations ranging from biology, engineering and chemistry, to neuroscience, architecture, design and social scientists, with the aim to collaborate, co-design and prototype solutions that tackle environmental pollution. The remarkable aspect of this workshop was that its topic was linked to a real pollution case-study, introduced by the Blacksmith Institute NGO based in India. As such, the workshop started with introduction to the case study and a stakeholder empathy map activity, during which participants tried to understand the viewpoints and interests of policy makers, industries, local organisations and populations involved in the case study. During the three days of the workshop, scientists had the opportunity to learn about design thinking and ethnographic methodology as applied in science, while designers gained exposure to lab environment and techniques. By the end

[14] West, S. & Pateman, R. (2017). How could citizen science support the Sustainable Development Goals?. Discussion brief. Available at: https:// www.sei-international.org/publications?pid=3255

[15] UNESCO, (2017). Education for Sustainable Development Goals - Learning Objectives. Publication. P. 7. Avaible at: http://unesdoc.unesco.org/images/0024/002474/247444e.pdf

of the workshop, the five following projects were produced by participant teams and presented to the public: Self irrigate/Lowtech bioreactor, Bio-Bucket Chromium Bioremediation, CHROMACTION! Replacing Chemical ETPs with Biological ETPs, Citizen lead (Pb) detection and Fungi Edu Kit.

Imane Baïz, Université Paris Descartes/Center for Research and Interdisciplinarity in collaboration with Open Science School, 'Co-lab Biodesign Workshops'

Case Study 8

'High School Biodesign Workshops', Paris
http://togetherscience.eu/events/high-school-biodesign-workshops-phase-2_pxhck

The 'High School biodesign Workshops' constitute a series of workshops led by UPD addressing the field of biodesign for students aged 15 to 17 years old through a variety of experimentation activities. These activities were categorised in 3 main topics: I) Introduction to microalgae and its mapping in water samples from different areas, II) Applications of microalgae and alginate and the process of bioremediation and III) Experimentation with kombucha and its different uses. The final aim was for the students to explore the principles of biodesign by experimenting on case studies and participating in classroom activities. Our collaborating schools and teachers, from the network of the Académie de Versailles and the Open Science School association, developed the scientific kits used in classroom. During these workshops, students seemed enthusiastic to have external people introducing interactive and interdisciplinary applications of biology. These student and teacher teams worked during a series of sessions on the above mentioned workshop topics and published their results in the Biotech News Journal.

Imane Baïz, Université Paris Descartes/Center for Research and Interdisciplinarity in collaboration with Les Savanturiers and Open Science School, 'High School Biodesign Workshops'

4. **Contribution to SDG 11** Sustainable Cities and Communities

Goal 11: Make cities inclusive, safe, resilient and sustainable

Cities keep expanding, and they have to be monitored in order to do so in a sustainable, inclusive way, while preserving their traditional setting, and resources on which some population rely for their work. Short term solutions of management can be a problem for the future populations, and the environment in which it's setted. It is again important to monitor the impact of public installation on our environment, such as air quality, and waste management facilities[16]. From there school and research can tackles problems that has been pointed out, whether it is about the agriculture facilities, our how to make the building more sustainable and respectful of the environment and wildlife setting in which they are installed. This could be done by gather communities around cities project and promoting the need to move toward more sustainable installations[17].

[16] West, S. & Pateman, R. (2017). How could citizen science support the Sustainable Development Goals?. Discussion brief. Available at: https:// www.sei-international.org/publications?pid=3255

[17] UNESCO, (2017). Education for Sustainable Development Goals - Learning Objectives. Publication. P. 7. Avaible at: http://unesdoc.unesco.org/images/0024/002474/247444e.pdf

Case Study 9

'Harvard Summer School', Paris
https://www.summer.harvard.edu/study-abroad/paris-france-biology

This programme is organised by Harvard University in partnership with the Center of Research and Interdisciplinarity (CRI) in Paris, the Sciences Po School of Public Affairs, and the Paris Mayor's office. Students are invited to use the SDG framework to create new urban development models that enhance not just the physical infrastructure of a city, but also the intellectual and social capital of its residents. The participatory elements of these models seek to foster the collective intelligence of the population in a manner that is broadly inclusive and oriented towards innovative problem-solving. The course is an interdisciplinary exploration of how biological principles derived from how organisms thrive and evolve can be applied to the ever-growing challenges facing large cities in the twenty-first century. The city of Paris with its remarkable history and diversity provides an especially rich context for students to learn about and tackle these challenges. Students explore how living systems work at the cellular level and how natural selection and adaptation drives evolution at the level of individuals and populations, while exploring parallels with historical models of urban planning and sustainable development. Student teams use this theoretical foundation to develop specific project designs to improve the quality of life in Paris through effective engagement of its citizens. Projects are as wildly creative and diverse as the imaginations of the student teams, running the gamut from new software that uses crowd-sourced information as the basis for urban design to novel ways to generate electricity in the city center to new community programmes that leverage the creativity of school children. Each project also uses media such as video and animation to communicate the fundamental concepts of the design as well as its implementation. The project designs are open source and shared with the world through an online media blog thebiopolis.com. Projects have gone on to international presentations in Geneva and Shenzhen, and have continued through other programmes.

Robert Lue, Harvard, 'Harvard Summer School'

Recommendations

Based on the points discussed above, the following recommendations are made:

- **Curricula integration**: promote the integration of challenge-based, transdisciplinary, and cross-curricular, biodesign and citizen science into curricula (from primary school level to university level) in order to foster critical thinking, empathy, and other competencies necessary for sustainable-minded citizens
- **Partnerships:** call for mentors, graduate students, and actors outside the academic field, interested in facilitating challenging cross-disciplinary projects with students or other learners in order to bridge learning gaps and provide the tools and methods for citizens of all ages to be autonomous changemakers.
- **Digital tools:** create digital tools for documenting and recognising formal and informal knowledge acquisition and sharing, in order to track progress and allow for reproducibility of both science methodology and action by schools, teachers, and other life learners.

7.3 Appendix 3 – RRI Indicators Policy Brief

Research insight on RRI indicators that reflect the practice of public engagement organisations

KEY FINDINGS

- Existing RRI indicators currently do not match the practices of public engagement practitioners
- RRI for monitoring and evaluation is mainly used to satisfy requirements from funding organisations and therefore becomes a burden for public engagement organisations
- RRI can function as a useful framework for organisational development when paired with reflective conversations and documentation of key lessons learnt

Large-scale initiatives such as the UN's Citizen Science Global Partnership and the World Economic Forum's focus on citizen science to meet Sustainability Development Goals demonstrate a heightened policy interest in engaging society. At the European Commission (EC) this interest is exemplified by the strategic orientations of the Science with and for Society (SwafS) work programme 2018-2020, which include 'Exploring and supporting citizen science'. Citizen science denotes the many ways that the public is engaged in science: from crowdsourcing, obtaining data from a large number of people via the Internet, to truly collaborative science, in which people are involved in problem definition, data collection and analysis in a project. At the heart of this policy interest is a strong focus on Responsible Research and Innovation (RRI), which the EC defines as a process that allows "all societal actors (researchers, citizens, policy makers, business, third sector organisations etc.) to work together during the whole research and innovation process to better align both the process and its outcomes with the values, needs and expectations of European society" (EC, 2016). In line with this, the EC envisions citizen science as a public engagement (PE) activity to promote RRI. Yet, limited attention is given to the individuals and organisations that promote and make PE happen – in particular, those who are not part of research institutes, at which RRI is aimed.

The challenges of RRI indicators for public engagement organisations

One of the aims of our EU-funded project 'Doing It Together science' (DITOs) is to promote wider and deeper public participation in science. We do this by organising events along an 'escalator model' that allows people to enter at a level of engagement that matches their needs, interests, and abilities, while also encouraging them to move beyond. We also aim to guide funding agencies to set up schemes that acknowledge different levels of engagement and the impact that they have. As part of this we have developed an evaluation framework based on the PLACES and RRI toolkits, and the EC report on RRI criteria and indicators (Strand et al., 2015). During the design process we identified four salient challenges: 1) Current RRI frameworks and their PE indicators have been mostly targeted at institutions that carry out or promote research and technology development; 2) There are numerous organisations (that are not part of research institutes) developing and carrying out PE initiatives but, as the RRI toolkit notes, these Civil Society Organisations (CSOs) are underrepresented in R&I

committees. This is problematic because the contexts within which they operate, their perspectives, and their roles are overlooked, leading to designs of RRI frameworks that do not reflect the needs and practices of CSOs; 3) RRI frameworks are used by funders and evaluators to assess compliance with RRI. This becomes problematic when Key Performance Indicators become target numbers for evaluators seeking to quantify and report on impact and institutional change actions rather than guidelines that support organisational learning and management. Hence, monitoring and evaluation becomes a burden for CSOs, especially if the data is collected merely to satisfy funders' requirements and has little value for the management of the organisation; and 4) Evaluation and RRI frameworks have limited focus on organisational capacity (which enables and supports PE) and almost no focus on the personal development and contributions of individual facilitators of PE (who are the front line of practice and experience in PE).

Revised RRI indicators that reflect the practice of public engagement organisations

Why revise existing RRI indicators? As noted by Rask et al., (2016) "defining what success is, and how it can be measured, are completely separate tasks from explaining what leads to success or limits its achievement". The formative evaluation in DITOs focuses on the latter. As part of this evaluation task we conducted ten thorough one-on-one conversational interviews with event facilitators and project coordinators to discuss the pros and cons of employing each RRI indicator. The result was a set of revised RRI indicator descriptions with depth that are meaningful and relevant and that reflect the actual practices of partner organisations. The interviews also functioned as spaces for reflection and sharing of ideas, approaches, and questions. The full summary of amended indicators and the salient insights from applying and discussing indicators can be found in the DITOs deliverable D5.2 Phase 2 project evaluation. Below we share a small sample of the insights from these reflections and revisions. We aim to show that an RRI framework can support organisational learning through the creation of dedicated spaces for conversation and systematic documentation, analysis, and use of empirically supported lessons learned.

> "Commitment by facilitators – their efforts, focus, and the impact that they have – should not be taken for granted"

Public engagement

The subdimensions of this criterion (see table below for guidance) acknowledge processes and outcomes at the organisational, activities, practice/capacity building levels. Discussing the indicator ***commitments by institutions & organisations to PE*** reveals the constraints that these commitments have on organisations' practice (e.g. how funds are used, what topics are given priority, how responsibility is framed, etc.) and the ways these are shaped by local political environments and social contexts, which in turn means that "*having commitments at the policy level has limited weight if there is little societal support or value for it*". Exploration of ***number, type, & purpose of initiatives*** reveals the need to recognise that 'purpose' is about being honest and open about facilitator/organisational stance and intention and how these

link to audiences' expectations e.g. PE tackling taboo subjects rather than popular topics that may attract more audiences. It also highlights the importance of providing multiple avenues for engagement and the role of collaborations to build capacity outwards (how collaborations complement and expand an organisations' work). ***Number of facilitators*** helps to explore the role of facilitators as part of the core organisational infrastructure (including who/what is missing, what their needs are including training and support, and self-care). It also explores considerations for resources available for capacity development and taking stock of 'behind the scenes' and taken-for-granted tasks. Exploring this indicator revealed that organisational capacity requires organisational will and finding balance in organisational management between enabling emergence and working together toward a focused (and agreed upon) goal. It also highlighted that there is great need for reflective spaces to share practice and talk about issues during regular hours as part of organisational culture. It is well known that focusing on numbers and pushing for 'increased PE' pushes organisational capacity and creates loss of focus (or connection to bigger picture). It can also lead to burnout. The purpose for tracking exact numbers needs to be linked to organisational use (not merely fulfilling reporting requirements). Hence, the indicator ***number of visitors / participants at activities*** needs depth of information so that facilitators can benefit from the collected data e.g. help with understanding who is and isn't present, what are their motivations, who returns and why? Exploring this indicator also reveals a tacit/attuned skill that facilitators use to 'capture' the complex interactions, depth of engagement, and expectations of visitors rather than merely tracking numbers. This is linked to ***number and types of skills developed by participants & facilitators*** (which include soft and hard skills as well as tacit knowledge gained from practice). Discussing this indicator reveals the great need for the creation of spaces for facilitators to share and discuss issues, ideas, and concerns with the rest of the team during working hours. Partners note that sharing and discussing 'practice' needs to be integrated into the organisation's culture through, for example, frequent dedicated and minuted in-person update meetings. Documentation supports follow-up and organisational development. ***Costs of increased organisational capacity*** opened up conversations about sustainability; it was revealed that this indicator requires considerations for external factors such as government funding and public valuing (e.g. underfunding of sector); internal factors such as retaining talent, return on investment, the need to build value of the activities and the skills provided (e.g. rewards, certification, etc.); and general considerations for exclusion because of financial limitations.

Gender equality

This criterion has two subdimensions: promoting the equal participation of men and women in R&I and inclusion of gender perspectives in science & technology content. Strand et al., (2015) recommend that the focus for this criterion should be on processes of institutional change to see whether general ambitions for equality and inclusion are translated into concrete forms of action. As DITOs evaluators and partners we recommend that indicators should include looking at external relations and collaborations as these influence practice, approaches, and strategies to address gender equality. For example, collaborators might have different attitudes toward/awareness about gender equality (e.g. mismatch in values, invisibility of gender discrimination in practices). Looking at relationships with collaborators also sheds light on how organisations shape (enrich or adapt) their practices and strategies. Conversations with partners revealed that gender equality issues and the strategies to address them also need to be looked at in terms of social and historical contexts of the organisations' region/country. For example, there might be political will (e.g. through regulations and policies) but these are not necessarily adhered to by everyone. It is compulsory but importance given to it at the societal level is still lagging. Partners also commented on the issues that arise from treating 'gender equality' as separate from other criteria; "*they are not independent from each other*" and singling out gender (or any other difference) can exacerbate it. Another issue raised was "*is there compromise in pushing forth gender balance over merit?*" That is, by trying to abide by percentage of women dictated by frameworks, are other issues/opportunities being pushed to the side? ***Number and type of events discussing gender*** as an indicator includes events specifically designed to have a dedicated space to discuss gender issues/opportunities in science or that promote the discussion of the role of gender in science and technology. The indicator includes considerations for how to introduce or open up sensitive subjects with tact but impact. For example, partners who promote action-based approaches find that there is more impact when something practical/material is produced during the activity. For example, in Medialab Prado "*we have activities promoting women in science, Wikitons, getting together to add or edit women scientists' biographies; it is direct action rather than just having discussions. Sometimes just discussing doesn't get you very far. It should be about doing something - research and edit or make – to contribute directly to change*". Reflections on this criterion, as with PE above, highlighted that the skills of facilitators in knowing their audiences should not be taken for granted. It also highlights the necessary but often taken-for-granted support that they require to design and deliver special events. For example, it requires assessing organisational capacity including the need for extra help, materials, special settings or safe spaces, creation of spaces for sharing practice, etc.) and match with mission statement. Counting ***number of women*** says little about gender equality as a partner notes "*just because you are there as a woman – and you are a tracked percentage – it doesn't reflect the depth of your engagement*". Quantitative data needs to be complemented by qualitative data (over time if possible) that sheds light on depth of women's experiences. Through this indicator recognition can be given to the various strategies created by organisations to address gender inequality, for example, approaches that focus on confidence building to empower women rather than highlighting differences in gender thereby exacerbating divides.

Science learning

The dimensions of this criterion are organisational scientific capacity and scientific capacity of the public. Although there is an overlap between science learning and capacity building in PE (above), the latter is focused on planning and delivery of events, whereas the former is focused on providing participants, facilitators, and organisations with the capacity to engage in science and technology. The indicator ***skills gained*** focuses on participants and their expected and unexpected learning outcomes, but to be useful it requires disambiguation. For example, the indicator's multiple dimensions and manifestations include a) know-how of scientific process ("*including critical analysis and ability to question*"); b) knowledge and understanding of relevance of science and scientific process in other aspects of life, c) appreciation of the value of science and the scientific processes in connection with the contemporary world (e.g. "*there is a wider appreciation of science - even if you are not able to do certain experiments you can still gain an appreciation for how science works*"), d) appreciation and respect for what a scientist is and what their work entails (e.g. "*an understanding by putting yourselves in the scientist's shoes – i.e. skills gained include an empathetic understanding on both sides*", e) curiosity about and respect for the environment, and f) physical representations of skills e.g. "*the proof of skill gained is embedded in the prototypes people develop*". For partners the indicator ***level of ownership over science learning*** seeks to understand if participants/facilitators feel they have gained skills and if they feel that these skills are relevant / transferable / replicable. It also seeks to understand if in the long run they feel they have gained (local) expertise that they are able to engage with scientific experts, participate in the decisions about their local environment, etc. Partners note that there is a need to look at what promotes ownership and at what level this ownership is manifested. This requires looking at the 'depth' of ownership and some aspects highlighted by partners include ownership as mutual learning, ownership as personal development (e.g. "*enrichment of practice from both volunteer experts and in-house experts and ability to share their expertise*"), ownership as humility and understanding gained (e.g. "*on both sides – taking care to not patronise but rather focus on learning from each other. Ownership is not about seeking truth or owning knowledge but being curious and being able to be wrong*"), ownership as governance (e.g. "*ownership over decision about environment or research into it*", ownership as commitment, ownership as community (e.g. building a community of practice), and ownership as meaning and relevance, including "*joy for what you do and meaningfulness of work*".

> "The passion and enthusiasm of facilitators is as important as their skills and scientific competency"

> "Issues arise from treating 'gender equality' as separate from other criteria; they are not independent from each other and singling out gender (or any other difference) can exacerbate it"

Social inclusion

> “Social inclusion should be at the centre of event design because it helps to define the purpose of the activity and then you can draw from existing organisations or frameworks as a starting point”

Problems arise when the focus is on achieving target number on 'inclusion' (e.g. the percentage of participants attending events from disadvantaged groups) but activities have already been pre-designed. Practitioners are aware of conditions that promote accessibility and the importance of taking activities to external locations to increase reach. For them, it is not only about how many activities were made accessible but what and who make them accessible, organisationally (funds, communication, PR strategy, commitments, collaborations, etc.) and methodologically (setting, sensitivity, physical and cognitive accessibility, creating, connection and relevance, etc) so that a strategy for inclusion that builds organisational memory can begin to take shape. Reflections on this criterion's various indicators reveals that they are not useful as static measures. For example, the indicator ***percentage of activities purposefully modified to address issues of social justice and inclusion*** does not make sense because over time, as an organisation gains experience and a strategy, less modifications need to be made. Also, to facilitate exchange of good practices and techniques, social justice and social inclusion need to be discussed and defined collectively by project partners on a continuous basis. A collective understanding of what the shared consortium values are and where the project is going. For example, “*social justice is equal opportunity to take part, but we need considerations for difference between equality and equity*”. A common understanding also helps to guide the expectations from the facilitators. ***Percentage of activities that may have unintended negative effects on social justice*** as indicator needs depth and a definition of ‘negative effects’. For example, in some cases, to build safe spaces and create inclusivity, some exclusions are created. That is, “*some events are tailored for specific audiences [e.g. people affected by cancer]; they’re closed events, and therefore exclusive*”. An issue with this indicator is that negative effects cannot be known until after the fact. In addition, organisations need to experiment and try out different approaches, that is, learn from consequences and transitions, which initially might have negative impacts. Examples of strategies for social inclusion developed by partners are numerous and include: Mobile events e.g. through traveling exhibitions such as the Royal Belgian Institute of Natural Science’s Xperilab truck; having issues of social inclusion as an event theme, which enables “*talking in terms of social issues, trends, or taken-for-granted practices*”; and the creation of reflective spaces to explore hidden instances of exclusion done e.g. through discussions during or at the end of an event.

Criteria	Dimensions of criteria	Performance indicators		Perception indicators
		Process indicators	Outcome indicators	
Public engage-ment	**Policies, regulations & frameworks**	Commitments by institutions & organisations to PE	Changes in agendas / organisational practices as a result from PE	Public interest on impact of science & technology Public expectations of engagement in decision-making processes
	Science initiatives & events	Number, type, & purpose of Initiatives	Number of visitors / participants at activities Types of visitors / participants Social media coverage	Perceived 'level' of participation/contribution Attitude toward facilitator & organisation
	Capacity building	Number of facilitators / science communicators Current experience & training opportunities for facilitators	Number of collaborations & types Number & type of participant-initiated/led activities Number & types of skills developed by participants & facilitators Costs of (increased) organisational capacity	Understanding of science & technology Attitude towards science & technology Participants' attitude towards their own abilities
Gender equality	**Equal participation of males and females**	Gender equality commitments / frameworks	Percentage of women attending events Percentage of women in Advisory Boards Percentage of women facilitators & collaborators	General perception of gender equality issues in science & technology Perception of opportunities for women in science Perception/awareness of gender equality efforts / initiatives in science & technology Perception/awareness of gender equality issues in science & technology relevant to their own lives
	Inclusion of gender perspectives in science & technology content	Number & type of events discussing gender dimension in science & technology	Percentage of women initiating/leading citizen initiatives Percentage of women sharing feedback	
Science learning	**Organisational scientific capacity**	Capacity building initiatives at the organisational level	Methods for science learning at the organisation level	Level of ownership over science learning Level of creativity in science activities
	Scientific capacity of the public	Strategies for science-learning outcomes at events	Skills gained	

Social inclusion	**N/A**	Considerations/strategies for: a) addressing access issues from disadvantaged social groups; b) ethical issues and values in the design, development and implementation of activities; c) benefits from activities; d) design of communication and outreach strategies Number of stakeholders who actively review/show interest in research results that have an impact on social justice	Percentage of activities: a) delivered in accessible locations; b) modified to address issues of social justice and inclusion; c) that may have unintended negative effects on social justice The percentage of participants attending events from disadvantaged groups	Level of importance given to social justice/inclusion Level of organisational importance & commitment given to development of methodology & implementation of social justice/inclusion strategies Public belief on the positive & negative impact of activities

RECOMMENDATIONS

- An RRI framework that supports organisational development and reflective practice to strengthen organisational learning and management of CSOs
- Evaluation frameworks for organisational capacity building developed through iterative exploration of needs and practices
- Creation of dedicated spaces for conversation and systematic documentation for the identification, analysis, and use of high quality (empirically supported and triangulated) lessons learned

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7.4 Appendix 4 – RRI Policy Brief on Open Science

See next page.

Amsterdam Smart Citizen Lab #1. Credit: Waag Society CC BY-NC-SA 2.0

Citizen Science & Open Science: Synergies & Future Areas of Work

Executive Summary

Citizen Science (CS) and Open Science (OS) are among the most discussed topics in current research and innovation policy, and are becoming increasingly related. This policy brief was developed with contributions from a mixed group of experts from both fields. It aims at informing decision makers who have adopted Citizen Science or Open Science on the synergies between these approaches and the benefits of considering them together. By showcasing initiatives implemented in Europe, this document highlights how Citizen Science and Open Science together can address grand challenges, respond to diminishing societal trust in science, contribute to the creation of common goods and shared resources, and facilitate knowledge transfer between science and society to stimulate innovation. The issues of openness, inclusion and empowerment, education and training, funding, infrastructures and reward systems are discussed regarding critical challenges for both approaches. The document concludes by recommending to consider Citizen Science and Open Science jointly, to strengthen synergies by building on existing initiatives, launching targeted actions regarding education and training, and infrastructures. This policy brief was developed within the framework of the Horizon 2020 project 'Doing It Together Science' (DITOs) to establish a collaborative network with external organisations and decision makers throughout Europe.

Transformations of Research

The ongoing digital revolution has prompted rapid changes in scientific practices and governance. Computer-supported data, tools and technologies are enabling greater potential for both broader access and wider non-expert participation in scientific research and innovation. In this context, Open Science and Citizen Science represent two influential and steadily evolving concepts in research policy and practice that are used differently by various stakeholder groups.

Open Science (OS) is an "umbrella term encompassing a multitude of assumptions about the future of knowledge creation and dissemination", widely applied to e.g. technological infrastructure, accessibility of knowledge creation, access to knowledge, measurement of impact and collaborative research.[1] At the core of OS is the idea of sharing of and throughout the research process. Facets of OS include: Open Access, Open Data, Open Source, Open Hardware, Open Educational Resources, Open Methodology and Open Evaluation.[2] Policy support for OS is increasingly widespread throughout the world.

Citizen Science (CS) refers to the "inclusion of members of the public in some aspect of scientific research", such as co-creating research questions, data collection and analysis or volunteer computing.[3] The field is very diverse and includes multiple forms, depths and aims of collaboration between academic and citizen scientists as well as virtually all scientific disciplines. The European Citizen Science Association (ECSA) puts forward 10 principles of what constitutes good Citizen Science.[4] While interest in CS is booming around the world, the creation of formal support structures remains uneven.

It is critical to note that research projects may have different degrees of both openness and citizen involvement. Thus, policy makers are advised to view them across a spectrum, rather than as binary 'yes or no' conditions[5] :

Links between Citizen Science & Open Science

OS and CS can share concerns, values and outcomes despite their distinct agendas. Recognising such commonalities (see for instance Fig. 1) provides a foundation for designing policies that can simultaneously support both movements.

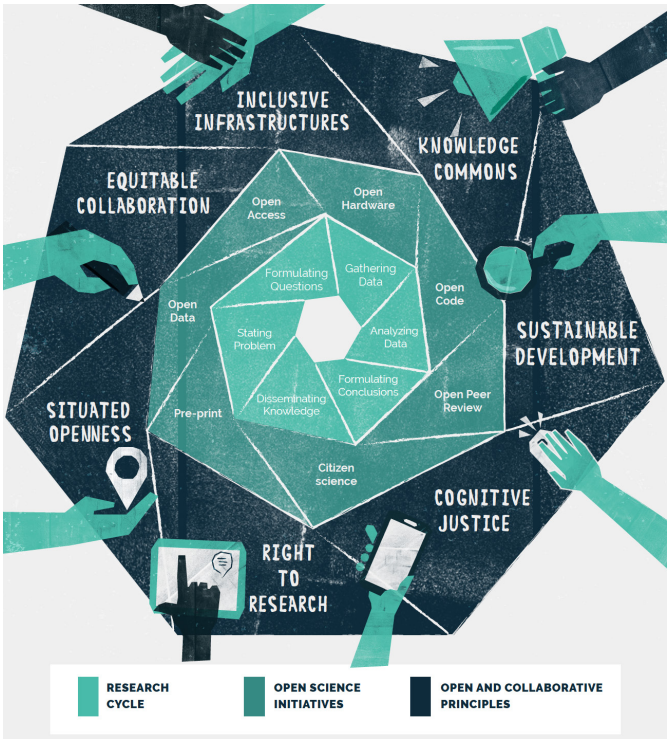

Fig. 1: Principles of Open Collaborative Science from OCSDNet, 2017.[6]

1) How Open Science facilitates Participation

Citizen involvement in research requires at least a basic degree of openness. In projects driven by academia, researchers must communicate with potential participants about the research objectives and expected results of the project in order to motivate engagement.[7] In addition to encouraging participation in projects, increased openness and easy access to researchers, e.g. through social media, *enables a wider public to suggest research topics* that they would like to see scientists address, or joint projects to tackle.

OS furthermore enables CS by giving access to *existing research data and scholarly literature,* which otherwise is likely to be too expensive for citizen scientists when publications are behind a paywall. *Use of open-source hardware and software tools* can also serve to reinforce the accessible nature of educational and data resources generated by CS projects.

2) How Citizen Science enables Openness

Many CS projects make the data they generate accessible to some degree or contribute to the development of *freely (re) usable research tools and methods.* CS projects with *open data sharing and licensing policies* enable citizens to set clearer guidelines on data access corresponding with their motivations (Case study 1).[8]

What is more, CS can generate new perspectives on research subjects. Participatory research projects allow asking questions about the *philosophical and conceptual foundations of the research context*. Instead of accepting the existing ways in which science is articulated, researchers can work with affected groups to design research projects that are suitable for all stakeholders involved (Case study 2).[9]

3) Joint Benefits

Doing Citizen Science and Open Science holds potential benefits for scientific processes as well as society (Fig. 2).

CS and OS both have potential to *address many of the grand challenges of our time* such as social justice, epidemics, emergency response and resilience, environmental monitoring, climate change and sustainable development (Case study 3).[10] Such contributions from CS and OS reinforce the dimensions, agendas and results of Responsible Research and Innovation (RRI). To ensure positive feedback, the practices of CS and OS must themselves become more responsible and innovative, i.e. 'science with and for society'.[11]

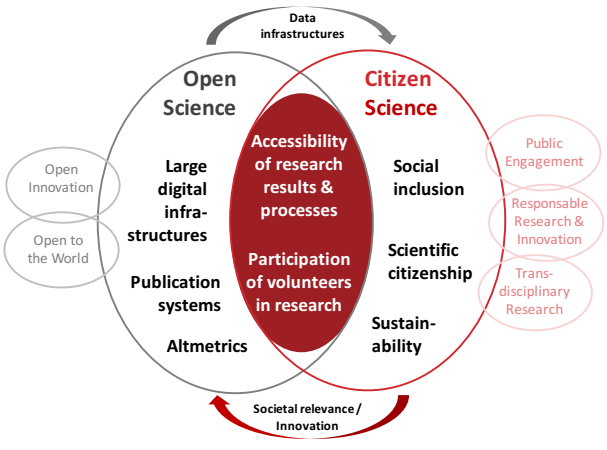

Fig. 2: OS and CS Core Concepts and Areas of Synergy from Vohland & Göbel, 2017.[12]

Case study 1: ExploreAT! - Humanities, natural science and FAIR data

https://exploreat.usal.es/

ExploreAT! is a multidisciplinary open science project that relies on social tools for cultural discovery and preservation of the German language. Using games and novel visual analytics, the project brings together citizens, researchers, heritage institutions, and designers to reveal the rich texture of Bavarian regional dialects.

CS aspect: The project works with dialect natives and global citizens as well as school children and adults, who perform problem crowdsourcing, define the research design and discover new forms of knowledge exchange.

OS aspect: ExploreAT! publishes linked open data that connects lexical, temporal, geographical and historical linguistic features with the global and European knowledge web.

ExploreAT! illustrates an example of a research infrastructure that helps humanities scholars to open up to work with researchers from other disciplines and civil society, generating new research opportunities.

Case study 2: Prototyping a new Heathrow Airport

http://www.softhook.com/heathrow

This initiative involved working with residents living near Heathrow airport to design noise-sensing hardware. Devices installed in their homes and gardens gathered independent evidence of the impact of noise on people and wildlife. The project registered complaints about off-hour flights while gathering a long-term dataset. The data shared with local authorities fed into consultation processes, and was also used to produce local audio soundscapes, which allowed others to hear both the noise and its startling effects on wildlife.

CS aspect: The collaborative design of the project produced better evidence of noise impacts and engaged audiences not directly affected by the flight noise.

OS aspect: The use of open hardware ensured accessibility and long-term availability of the data.

Thus CS and OS can be combined to create forms of evidence that are useful for affected groups, allowing them to challenge environmental and urban development policy when needed.

Linked to this first aspect is the potential to *respond to diminishing societal trust in science*. OS can improve access to scientific results, increase transparency and foster reproducibility of scientific research; CS contributes to the same goals through active participation in research, technology development and innovation and learning about science and technology.

Another important facet of OS and CS is how their initiatives can *contribute to the creation of common goods and shared resources* (Case study 4). Examples include a body of knowledge, methods and tools, or a pool of data that then serve as infrastructures for further research and civic action.

Finally, CS and OS can *facilitate knowledge transfer between science and society to stimulate innovation*. For both approaches, it is common to cross disciplinary boundaries and contribute to knowledge integration between scientific domains. What is more, CS and OS can bring other kinds of expertise to bear on research questions indicating and addressing societal research needs, thus contributing to enable research endeavours that would not be possible otherwise.

Current Status & Future Challenges

Despite many potential synergies, CS and OS are only starting to grow together. While sharing results as openly as possible is considered a quality characteristic of CS, data sharing and interoperability are heterogeneous in practice[13,14]. On the other hand, most Open Science practice does not encompass dedicated efforts to facilitate participation by volunteers without a research background.

Nevertheless, key intersections with CS are becoming increasingly acknowledged in the field of Open Science through efforts like the EU Open Science Police[15] and by communities such as those aorund Wikimedia or Open Knowledge. In the CS field, pilot initiatives are emerging around CS data and metadata interoperability[16], principles for open and reusable software development[17], and the open-access journal "Citizen Science: Theory & Practice".

For moving onwards, the following challenges are central:

Openness

- Improve data management and stewardship for CS.
- Continue work on findability, accessibility, interoperability and reusability of CS data, with examples of implementing FAIR Principles[18]
- Acknowledge different types of contributions to science and find adequate ways of making them visible, traceable and reusable, regardless of whether the CS outputs are data, software or project platforms or something else.
- Work to resolve legal uncertainties and share approaches to intellectual property and licensing issues at the intersection of CS and OS.

Inclusion & Empowerment

- Expand the involvement of CS volunteers beyond data collection and analysis by opening all stages of the research cycle to participation and enabling more co-creation of research results and co-design of research projects.
- Foster equitable and sustainable science.
- Promote global-level dialogue and cooperation between stakeholders.

Education & training

- Include CS in research education and training on OS and vice versa, and include both in general research education and training.
- Ensure means for science education and communication to accompany CS initiatives.
- Build CS and OS into teacher training.

Funding

- Increase and diversify the opportunities for small seed funding for project prototyping and experimentation in CS and OS.
- Offer mechanisms for funding that address the different project characteristics of CS and OS initiatives, such as scoping phases for co-design of research agendas, flexibility in accepting changes to project execution, and recognition of civil society organisations as well as citizens as applicants and grant holders.
- Fund positions and horizontal measures for community management.
- Treat increased transparency and public participation in research projects as an opportunity to reduce bureaucracy around such projects.

Infrastructure & Reward Systems

- Recognise and support the integration of CS and OS as or within research infrastructures. In some sectors, there is a need for specific research infrastructures for CS, such as the Atlas of Living Australia, which supports biodiversity data collection through CS projects. In other cases, CS can also be part of domain infrastructures, e.g. My Ocean Sampling Day, an environmental sampling project that hosts their data at a global ocean data center. Lastly, CS and OS can be understood as providing a socio-technical research infrastructure in their own right.
- Open up research infrastructures in general, including for citizen scientists, and provide new ones where they are missing.
- Improve mediation between institutions and individual participants, different sharing cultures, and different reward systems.
- Adapt evaluation, promotion and incentive structures for rewarding OS and CS activities.

Further Research & Critical Discussion

- Deepen research on modalities and consequences of openness and participation in each step of a research cycle and across different disciplines.
- Promote opportunities of exchange between researchers and practitioners in order to detect and address adverse effects, including extended secrecy and control, exploitation of participants and infringements on the freedom of research.
- Enrich the Commons in ways that benefit communities engaged in CS and OS projects to ensure that they can contribute to sustainable development goals and other societal challenges.
- Continue discussing empowerment specifically in the context of CS and OS approaches, whether by increasing awareness through public engagement or through deeper engagement and co-creation.

Case study 3: Project SOHA - Open Science in Haiti & Francophone Africa

http://projetsoha.org/

Project SOHA explores the obstacles preventing the adoption of open and collaborative science in universities in Haiti and Francophone Africa and provides tools to overcome them. This action research project starts from the premise that universities practicing open science can become powerful tools for local sustainable development.

CS aspect: The project recognised that open science - that is, science for and with the public - cannot simply be an academic question. It must also be open to participation, demands, criticism and knowledge of citizens, bringing them in closer contact with researchers to develop solutions that address their concerns.

OS aspect: The research action was based on open access, open science hardware, cognitive justice, commons, collaborative work, openness in African academia.

The project has identified eight forms of cognitive injustice that prevent graduate students and scholars from Francophone Africa and Haiti to transmit and produce knowledge in service to the sustainable development of their communities.[19]

Case study 4: Wikidata - Collaborative Public-Domain Knowledge Graph

https://wikidata.org/

Wikidata is the edit button for Linked Open Data – a multilingual collaborative database collecting structured data to provide support for Wikipedias and their sister wikis, and to anyone in the world, including various research communities across domains.

CS aspect: Data is entered and curated by Wikidata editors – about 20,000 people contribute per month, in their language. They manage content, tools and policies and integrate Wikidata with external resources like governmental, cultural or research databases.

OS aspect: Wikidata is based on open standards, and every change to content or software is immediately recorded in public. The data is published under CC0 – the Creative Commons Public Domain Dedication 1.0 – allowing for reuse without restrictions. Wikidata provides sustainable infrastructure (e.g. persistent identifiers, queriability) that is useful to research in general, including OS & CS. Openness and multilinguality broaden the contributor, user and funder communities.

Conclusion

Citizen Science and Open Science are complex concepts in the making. Both are insufficiently studied, and there are no easy ways to survey the landscape of either paradigm. While CS and OS can save resources, they also require them to be successful, along with major shifts in culture and society. They do not promise instant rewards, but offer instead substantial transformations of research and how it is rooted in our societies. Citizen Science and Open Science are both powerful on their own, but due to their manifest synergies, they can be even more effective when combined. While CS practices depend on opening up science and making other adjustments to the research system, OS needs to include citizens more profoundly in order to deliver on its promises. Further support for both OS and CS is required for an open and inclusive approach to RRI. More case studies can be found at *https://ecsa.citizen-science.net/.*

Recommendations

Based on the points discussed above, the following recommendations are made:

1. Open Science and Citizen Science will often benefit from each other and should be jointly considered in research and innovation. While not all research is susceptible or will benefit to the same degree, there will often be synergies of being open and reaching out.

2. CS and OS should be explored and developed further with attention to synergies between them. Ensure support for continuing and expanding upon existing community-driven initiatives around OS and CS. The international nature of both approaches to research should also be taken into account and cooperations fostered.

3. Targeted actions with dedicated support to CS and OS are still required, as both trends are still evolving. At the same time, public funding for research should broadly facilitate OS and CS to exploit its full potential. Therefore, existing systems (funding, rewards, impact assessment and evaluation) need to be assessed and adapted in order to become fit for CS and OS.

4. Education and training is essential for CS and OS to spread and develop further. In addition, more research, critical reflection and exchange between researchers and practitioners should be fostered.

Tools and infrastructures, in particular shared ones for OS and CS, have a potential for leverage and require dedicated support. This includes considering particular CS needs when constructing infrastructures in support of OS (and vice versa).

How to Cite

DITOs consortium, (2017). *Citizen Science and Open Science: Synergies and Future Areas of Work.* DITOs policy brief 3.

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All web resources were accessed at the end of December 2017.

Colophon

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