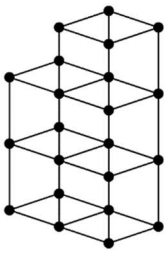

doing it together science

Grant agreement no. 709443

DITOs

Doing It Together science

Coordination & Support Action

D4.3 Policy Briefs 3

Work Package: 4

Due date of deliverable: Month 36

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

Contributors: ECSA, University College London, Meritum, Eutema, Waag Society

Reviewer: Margaret Gold (ECSA), Nadia Richman (UCL)

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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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Table of contents

1 Version log

Version	Date	Released by	Nature of Change
Brief 1: DRAFT 1	10/5/2019	Christian Nold (UCL)	First Draft circulated
Brief 1: Final	15/5/1019	Christian Nold (UCL)	Final version
Brief 2: DRAFT 1	03/12/2018	Alexandra Albert (UCL)	Draft Developed with ECSA & We Observe
Brief 2: DRAFT 2	28/02/2019	Alexandra Albert (UCL)	We Observe consortium review and internal review
Brief 2: DRAFT 3	05/03/2019	Alexandra Albert (UCL)	DITOs consortium approval
Brief 2: FINAL	03/04/2019	Alexandra Albert (UCL)	Formal release. Printed and launched at DITOs final event.
Brief 3: DRAFT 1	31/12/2018	Erich Prem (Eutema)	Input from partners, especially Kersnikova and ECSA
Brief 3: DRAFT 2	29/01/2019	Erich Prem	Updates from discussion in Vienna
Brief 3: DRAFT 3	14/03/2018	Erich Prem	Final text version
Brief 3: DRAFT 4	20/03/2019	Erich Prem	Final editing changes
Brief 3: FINAL	03/04/2019	Erich Prem	Launch at DITOs final event
Brief 4: DRAFT 1	15/11/2018	Pawel Wyszomirski (Meritum)	Input from ECSA WG Air Quality
Brief 4: DRAFT 2	30/11/2018	Chema Blanco Calvo (Medialab), Sven Schade (JRC)	Input from internal and external reviewers
Brief 4: DRAFT 3	11/12/2018	Pawel Wyszomirski	Input after presentation on COP24
Brief 4: FINAL	03/04/2019	Pawel Wyszomirski	Launch at DITOs final event

Brief 5: DRAFT 1	19/02/2019	Alexandra Albert (UCL)	First draft based on UK environmental policy roundtable in May 2018
Brief 5: DRAFT 2	01/03/2019	Alexandra Albert (UCL)	UCL policy unit internal review
Brief 5: DRAFT 3	25/03/2019	Alexandra Albert (UCL)	DITOs consortium approval
Brief 5: FINAL	03/04/2019	Alexandra Albert (UCL)	Formal release. Printed and launched at DITOs final event
Brief 6: DRAFT 1	14/02/2019	Roland van Dierendonck (WS)	First draft based on update DIYBio Policy Paper
Brief 6: DRAFT 2	28/02/2019	Roland van Dierendonck (WS)	Internal review Waag (Lucas Evers, Tamar ter Steege)
Brief 6: DRAFT 3	03/05/2019	Roland van Dierendonck (WS)	Rewriting, with feedback Bruno J. Strasser (University of Geneva)
Brief 6: DRAFT 4	05/05/2019	Roland van Dierendonck (WS)	Rewriting with feedback by external reviewer Anneke ter Schure (University of Oslo)
Brief 6: FINAL	07/05/2019	Roland van Dierendonck (WS)	Rewriting with input from three external reviewers; Final draft compiled
Brief 7: DRAFT 1	5/4/2018	Gaia Agnello (ECSA) & Andrea Sforzi (Maremma Natural History Museum & ECSA Advisory Board)	Gathering input at first round table in Rome
Brief 7: DRAFT 2	15/09/2018	Gaia Agnello (ECSA)	Review report from the round table and develop an action plan
Brief 7: DRAFT 3	01-02/02/2019	Gaia Agnello (ECSA)	Gathering input at second round table in Rome and suggestion of the outline

Brief 7: DRAFT 4	22/02/2019	Gaia Agnello (ECSA)	Final draft compiled
Brief 7: DRAFT 5	28/02/2019	Gaia Agnello (ECSA)	External review
Brief 7: DRAFT 6	14/03/2019	DITOs consortium	Internal review
Brief 7: FINAL	03/04/2019	Gaia Agnello (ECSA)	Launch at DITOs final event

2 Definitions and acronyms

Acronyms	Definitions
CSA	Coordination and Support Action
DITOs	Doing It Together science
DIY	Do It Yourself
DIYBio	Do It Yourself Biotechnology
DoA	Description of the Action
ECSA	European Citizen Science Association / Verein der Europäischen Bürgerwissenschaften
Eutema	EUTEMA GMBH
EWI	Earth Watch International
GA	Grant Agreement
GRIN	GRIN: How to let people be themselves
ICM	Institut de Ciències del Mar
H2020	Horizon 2020 Programme
KI	Kersnikova Institute
M	Month
Meritum	Centrum Szkolen I Rozwoju Osobistego Meritum
NERC	UK Natural and Environment Council
PEBR	Public Engagement with Biological Recording
RBINS	Institut Royal des Sciences Naturelles de Belgique
RI	Research Insight
RRI	Responsible Research and Innovation
SCIS	Sci Starter
SDGs	Sustainable Development Goals
SEI	Stockholm Environment Institute
SMEs	Small Medium Enterprises
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

3 Management Summary

Deliverable 4.3 consists of seven policy briefs. Brief 1 is based on the WP5 evaluation of the science buses and uses ethnographic observations of workshops. Brief 2 draws on iterative cycles of gathering information and checking understanding with project coordinators. Brief 3 was developed in close collaboration with DITOs partners and with input from artists active in the art/science field. Brief 4 has been developed in collaboration with the ECSA working group on Air quality. Brief 5 is based on findings from the round table in London in May 2018 which engaged national and international stakeholders working across environmental policy and citizen science. Brief 7 has been developed in collaboration with the Italian citizen science network, an informal group of citizen science practitioners, scientists, and decision- and policy-makers who have engaged with the lead authors during two DITOs round tables in April 2018 and February 2019. More details about each of the 7 briefs are:

Brief 1 - A Tale of Two Science Buses: Diversity of Knowledge and Inclusion Practices

This research insight is an analysis of the two DITOs science buses by the Waag and the RBINS. It suggests that science communication and citizen science involve diverse framings of scientific knowledge which influence potential inclusion practices.

Brief 2 - Making Citizen Science Work - Innovation Management for Citizen Science

This policy brief, produced in collaboration with the We Observe consortium, draws on a preliminary study that identified the main operational archetypes of citizen science and DIYBio science projects. The clustering of specific operational models of citizen science, as presented in the brief, is an indication that commonalities can be found, and that the landscape of citizen science can be understood from a social innovation perspective, and therefore supported by innovation management techniques.

Brief 3 - Citizen Science and Art/science - Synergies and Future Potential

This brief takes inspiration from Brief 3 “Citizen science and open science. Synergies and future areas of work” and recent developments in Europe to foster the involvement of artists in scientific practices. Artistic projects can have strong synergies with the objectives of citizen science and citizen outreach activities. However, we have barely scratched the surface of the interaction between citizen science and art/science practice and the brief recommends actions for improving the synergies between the two fields.

Brief 4 - European Clean Air day - Citizen Science for Clean Air

This policy brief presents a framework for organizing a yearly European Clean Air Day, starting from 20th June 2019, with the objective of scaling up European awareness of air quality issues, and ways in which air quality can be improved. The brief presents a range of financing options and tools for air quality monitoring for grassroots organisations.

Brief 5 - Citizen Science in UK Environmental Policy

This research insight draws on discussions from a policy roundtable in May 2018 on the current state and future directions of citizen science in UK environmental policy. The findings suggest that citizen science needs to have proper infrastructure and resources to play a role in policy; and the integration of citizen science and policy-making should be seen as an iterative process.

Brief 6 - Open Sharing Platforms and Affordable Lab Spaces as Drivers of Innovation in Biodesign

This brief focuses on the influence of the DIYBio movement on innovation in Biodesign. Specifically, it focuses on the sharing of knowledge and expertise through courses and open sharing platforms, and the facilitation of prototyping in affordable lab spaces. This leads to a series of recommendations on how to support these material and immaterial resources, as well as individuals within DIYBio and Biodesign communities.

Brief 7 - Towards a Shared National Strategy: Guidelines for the Development of Citizen Science in Italy

This policy brief summarises the main actions needed to promote the development of citizen science in Italy and aims to provide guidelines and recommendations for a structural recognition, both through its adoption in existing legislative and planning instruments, and through specific strategies.

The policy briefs presented here have been adjusted in order to reflect policy dynamics and external demands. This third and final series of briefs within the DITOs project consists of five policy briefs and two research insights, which cover the themes of biodesign, environmental sustainability, aspects of Responsible Research and Innovation (RRI), quality evaluation and the involvement of SMEs and industry. The policy briefs have been developed using a community-oriented approach for selecting the topics and writing the content, as conducted for the first two series of briefs in D4.1 and D4.2.

Most of the briefs have been reviewed, formatted and printed before the submission to the EC in order for them to be available at the DITOs final event “Pan-European Policy Round table on citizen science and DIY science” on 3rd April 2019 at the RBINS, Brussels. This deliverable concludes the successful completion of WP4 facilitating policy engagement for RRI.

DITOs ‘Policy Briefs 3’ is Deliverable 4.3 (D4.3) from the coordination and support action (CSA) Doing It Together science (DITOs), grant agreement 709443.

4 Introduction

DITOs' Work Package 4 (WP4) concerns policy engagement for 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 RRI policies to policy makers at different levels, especially in the fields of Biodesign and Environmental Sustainability.

WP4 was designed to strengthen the two-way link between the DITOs network and policy-makers to promote sustainable and resilient RRI governance. It fostered a learning process among DITOs practitioners, elaborated and mainstreamed RRI standards, and engaged policy and decision-makers at local, regional, national, EU and international levels.

Activities in WP4 included structured knowledge creation and exchange, the 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 led WP4 which ran from Month 1 to Month 36 of the project. During this time, three series of policy briefs were produced (M12, M24 and M36).

This deliverable covers the production of the third set of briefs (M36), namely:

- A Tale of Two Science Buses: Diversity of Knowledge and Inclusion Practices
- Making Citizen Science Work - Innovation Management for Citizen Science
- Citizen Science and art/science - synergies and future potential
- European Clean Air day - Citizen Science for Clean Air
- Citizen Science in UK Environmental Policy
- Open Sharing Platforms and Affordable Lab Spaces as Drivers of Innovation in Biodesign
- Towards a Shared National Strategy: Guidelines for the Development of Citizen Science in Italy

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

5 Activities carried out and results

5.1 Adjusting the set of policy briefs according to the policy development

In the Description of the Action (DoA), the original plan for policy briefs in D4.3 was to deliver a total of 6 policy briefs covering the themes: 1) cross-border research and cooperation for environmental sustainability; 2) biodesign, 3) RRI for DITOs activities; 4) ethics and quality evaluation; 5) open access, data, science; and 6) Involvement of SMEs and industry. However, consortium partners decided to develop a set of seven briefs, some of which cover multiple themes as they are not necessarily mutually exclusive. There is one more brief than was promised in the project DoA. Therefore, the number of briefs included in D4.3 was changed with respect to what was planned in the DoA. This decision was taken in response to emerging interests among the policy and citizen science practitioner communities. For example, the enthusiasm and interest received for the Science Bus, a very successful DITOs activity run by the WS, led the consortium to develop a brief on this particular activity as a standalone research insight fitting in the broader theme of Quality Evaluation. This decision was taken in response to an interest shown by stakeholders, and recommendations received during the mid-term project review. Another example is provided by policy brief 4. The idea for the European Clean Air day was presented during the United Nations Framework on Climate Change, 24th Conference of the Parties in Katowice, Poland (COP24) and provided a great opportunity for developing an associated DITOs policy brief. As this initiative will take place on 20th june 2019, policy brief 4, covering the theme of environmental sustainability, contributes to promoting the initiative to municipalities and other stakeholders across Europe and provides a framework for organising the event.

Policy brief 7 was developed in response to the growing interest for citizen science in Italy. Recently, citizen science has received increasing attention in Italy, particularly following the First Italian Citizen Science conference held in November 2017 in Rome and organised by the National Academy of Sciences. The motivation of the Italian citizen science community to further promote citizen science to the public and policy makers, has provided ECSA with the opportunity to collaborate with national stakeholders and to establish a participatory process to come up with a set of guidelines to devise a national strategy. Upon the recommendation of key national stakeholders, the guidelines have been published as a DITOs policy brief, in order to reach Ministries and other public authorities in an effective way, as well as through citizen science champions, such as the National Academy of Science. The case of this policy brief shows the impact of DITOs in providing valuable support at the local level, in countries where no DITOs partners were based. The development process allowed us to engage stakeholders, expand the network and strengthen emerging initiatives, ultimately, responding to external demand, current policy development and opportunities for advocating for citizen science effectively.

5.2 Diversifying Policy Brief format, and creating Research Insights

In D4.3 we have included both formats developed during the project, namely policy briefs and research insights. The policy brief format provides a general introduction to

activities and topics related to citizen science research and policies. The research insight format presents results from the citizen science activities that have been conducted within DITOs. For example, the brief “A Tale of Two Science Buses: Diversity of Knowledge and Inclusion Practices” has been developed from the WP5 ethnographic evaluation of the DITOs Science Bus participatory exhibition.

5.3 Sources of information and methods of working

The information presented in all 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.

The main motivation for creating policy briefs in DITOs was to make more information available on citizen science and DIY science, and to communicate the innovation potential of these practices to decision makers. In order to do so, it was essential to engage with networks of practitioners to gather case studies and inputs reflecting the views of experts in the subject matter. As a matter of fact, the development of briefs has provided opportunities for collaboration, engagement and network expansion, contributing towards the achievement of milestone 4 (engagement and networking). For example, brief 2 on innovation management in citizen science was jointly developed with the We Observe consortium, fostering and open and collaborative dialogue on the topic. A community-oriented approach was adopted for determining the specific topics of each brief (in the framework of the broader topics stipulated by DITOs) and elaborating the content. 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 for each policy brief.

The research insight “**A Tale of Two Science Buses: Diversity of Knowledge and Inclusion Practices”** is based on ethnographic observations of participatory workshops. In addition, it uses formal and informal interviews with participants and science bus facilitators. The analysis was extracted from notes and transcripts via thematic clustering.

The policy brief “**Making Citizen Science Work - Innovation Management for Citizen Science”** is based on a preliminary study of the innovation landscape of citizen science. The study focussed on two critical elements - the organisational structure within which citizen science projects happen, and the form of funding that is used to finance these projects. Firstly, desk research was undertaken to accumulate general information on citizen science and DIY science projects. Then those responsible for the projects were contacted to check that the information on such projects was complete and accurate. The activities carried out thus formed an iterative cycle of gathering information, checking understanding with project coordinators, asking for further recommendations of projects and adding to the project summaries.

This process was completed once insights began to repeat themselves. In total, 35 different types of citizen science and DIY science projects were reviewed. Five broad 'archetypes' of operational models in citizen science were identified, whilst seeking to retain acknowledgement of the unique nature of the formation and aims of each project. The projects were analysed and qualitatively mapped onto an axis of geographical scale and length of time (temporality) of a project. The funding scale of the projects was also mapped to observe clustering.

The first policy brief on open science (policy brief #3) inspired the policy brief "**Citizen Science and Art/science - Synergies and Future Potential"**. It is both based on experiences with DITOs events - in particular from partner Kersnikova - and outside DITOs events, such as eutema's involvement in the EU project FEAT ('Future emerging art and technology'). The brief establishes the connection between the recent trend of artistic interaction with scientific work and explores the synergies with citizen science. Among other aspects, the public visibility of works of art, their physical presence and durability lend themselves nicely to reaching broad audiences. The brief was developed in close cooperation with DITOs partners and with input from artists active in the art/science field.

The third follow up version of the policy brief on environmental sustainability focused on the "**European Clean Air day - Citizen Science for Clean Air"**. The brief was inspired by the discovery trip held in September 2017 which brought a delegation of Polish guests to visit London and exchange knowledge on how to improve air quality. Meritum promoted citizen science as an opportunity to initiate grassroot actions in the Polish area. The idea of establishing the European Clean Air Day was developed during a workshop organized at the Lorentz Center in Leiden in January 2018. The primary focus of this initiative was to engage citizens in conducting research and raise awareness on air pollution across Europe. In June 2018 a new ECSA Working Group was established on the theme of Air Quality. Meritum joined the group as a member and proposed a collaboration for the development of this policy brief which could be used as a tool to promote the European Clean Air Day.

An additional research insight on "**Citizen Science in UK Environmental Policy"** was developed following the organisation of a policy roundtable in London in early May 2018. The aim of the roundtable was to discuss the current state and future directions of citizen science in UK environmental policy. It was organised with support from UCL Public Policy Unit and the UK Natural and Environment Council (NERC) funded OPENER project. The roundtable engaged with national and international stakeholders working across environmental policy and citizen science. It aimed for broad coverage, extending beyond the 'usual suspects' such as those already involved in the field of citizen science and that are familiar with it. The aim was to follow a recruitment strategy that would provide representatives from different organisations at different scales of operation (local, national, international) with diverse insights into environmental policy and citizen science. The event was coordinated in collaboration with DITOs project partner Tekiu Ltd.

The aim of the roundtable was to explain the current state of policy support to environmental citizen science and produce a set of recommendations for better integration of citizen science in the field of environmental science. The tool selected to allow participants to share their insights and views is Rich Picture. Rich Picture (Checkland, 1984) is a Soft Systems Methodology (SSM) used for mapping out and problem-solving complex and ill-defined issues in which there is no obvious linkage between different actors. SSM is based on systems concepts - the idea that a problem can be tackled by taking a broad view that tries to understand the different parts of the system and the interactions among them. SSM is a set of guidelines to perform the analysis, while allowing for considerable scope for personal interpretation (Checkland, 1984; Checkland 1999; Checkland and Scholes, 1990). The mostly widely used tool that characterises SSM is the Rich Picture - a diagrammatic representation of the problem. It represents what the human system is "about" and can be considered as a mental map (Avison and Fitzgerald, 1995).

To construct the inherently multi-perspective representation of a given situation that Rich Pictures require, participants were allocated into small groups (5-6 people) containing a variety of different individuals/organisations (NGOs, academics, citizen science project officers, policymakers and regulators). Four different categories were pre-selected, from which the groups were invited to construct the Rich Picture. Two of these categories related to ecosystems (Environmental Policy Landscape, Science and Innovation), while the other two were framed by issues (Data, Public Engagement and Behavioural Change). For all four themes, the groups were encouraged to consider the main actors shaping the perspectives and the relationships between them, including the dynamics of influence and sources of conflict. The morning session was dedicated to the current state of the use of environmental monitoring citizen science projects in policy, and the afternoon session focused on visions for the coming decade. The findings from these discussions were analysed and synthesised into the research insight entitled *Citizen Science in UK Environmental Policy.*

The policy brief on "Open Sharing Platforms and Affordable Lab Spaces as Drivers of Innovation in Biodesign" started as an update on the 2017 policy brief 'Do It Yourself Biotechnology' (DIYBio) for open, inclusive, and responsible Biotechnology[1] which assessed the potential and challenges of DIYBio for the progress of the European Open Science and RRI agendas, by highlighting four dimensions of DIYBio: art-science, ethics, innovation and education. Because those last two dimensions, innovation and education, were only briefly mentioned, we chose to focus on them in this policy paper, specifically by looking at the role of academies and laboratory spaces for innovation in Biodesign. Content was partly derived from interactions with BioHack Academy staff and participants, and earlier informal talks in other contexts, with Helene Steiner and Thomas Meany from OpenCell and others. After initial feedback by Lucas Evers (WS), Tamar ter Steege (WS) and Bruno Strasser (University of Geneve), it was put to external reviewers that are active in the Biodesign and DIYBio field. Anneke ter Schure (University of Oslo) helped as an external editor to re-order and concretize the text. External reviewers were Raphael Kim[2], a biohacker and designer currently affiliated with the Queen Mary University of London as a PhD,

[1] DITOS consortium. (2017), *'Do It Yourself Biotechnology' (DIYBio) for open, inclusive, responsible biotechnology*. DITOS policy brief 2

[2] https://biohackanddesign.com/

Chan'nel Vestergaard, a multitalent that provides educational programmes in S.T.E.A.M. subjects with Littlepinkmaker and organizes the creative open science space Co-lab in Copenhagen, and Fara Peluso, a Berlin based artist designer connecting human beings with nature, living organisms and biological materials. Apart from comments on the running text, reviewers were asked specifically for their recommendations, which were then grouped and synthesized to become the final set of recommendations in the policy brief.

The policy brief "**Towards a Shared National Strategy: Guidelines for the Development of Citizen Science in Italy"** is the output of a participatory process coordinated by ECSA and the Maremma Natural History Museum within the framework of DITOs and under the auspices of the National Academy of Sciences. Following the First Italian Citizen Science conference held in November 2017, DITOs has enabled the organisation of two round tables with the goal of identifying guidelines for the development of a national strategy for citizen science and strengthening the national network of practitioners. The process involved over 50 experts from universities, research institutes, scientific museums, associations and Italian public bodies with various levels of experience in the field of citizen science.

During the first roundtable "Towards a shared national strategy for Citizen science in Italy" held in April 2018 in Grosseto and Rome, which was timed to coincide with a Discovery Trip, macro-topics of what is needed in terms of actions and instruments for developing citizen science in Italy were identified and analysed through thematic focus groups[3]. Results were reviewed by participants of the two-day round table and subsequently published in a complete report filed in the UCL repository[4]. The report served as a reference document to develop a preliminary draft of the guidelines which were presented at the second roundtable organised in February 2019 in Rome[5].

This event allowed the facilitators to collect comments and integrations and work on a final document. It was proposed that this be published in the form of a DITOs policy brief. The entire process was conducted in Italian to be inclusive and allow everyone to contribute; for this reason the report of the first roundtable and the original version of the policy brief was produced in Italian. The policy brief was subsequently translated in English by a professional translator.

5.4 The briefs: outlines, target audiences, purpose and status

5.4.1 A Tale of Two Science Buses: Diversity of Knowledge and Inclusion Practices research insight considerations

Outline:

1. Executive Summary
2. Science Bus Context
3. Comparing the two DITOs buses
4. XperiLAB

[3] https://ecsa.citizen-science.net/events/ecsa-events/italian-round-table-citizen-science
[4] http://discovery.ucl.ac.uk/10070105/
[5] https://ecsa.citizen-science.net/events/ecsa-events/secondo-incontro-nazionale-verso-una-strategia-condivisa-la-cs-italia

5. Do-It-Together Science Bus
6. Analysis
7. Afterthought
8. Conclusions

This Research Insight is an analysis of the two DITOs science buses by Waag and RBINS. It suggests that science communication and citizen science involve diverse framings of scientific knowledge which influence potential inclusion practices.

The full content of the *'*A Tale of Two Science Buses*'* research insight can be found in Appendix 1.

Target audience: Policy makers, academic researchers, citizen science project coordinators, funding bodies.

Purpose: To compare two DITOs activities and draw conclusions about the diversity of knowledge and inclusion activities.

Status: Completed.

5.4.2 Making Citizen Science Work - Innovation Management for Citizen Science policy brief considerations

Outline:

1. Executive Summary
2. Citizen science and social innovation
3. Definition: Operational Model
4. Citizen science and innovation management
5. Definition: Popular Topics
6. Methods
7. Outcomes
8. Recommendations and implications

The policy brief draws on a preliminary study that identified the main operational archetypes of citizen science and DIY science projects, referred to as 'operational models'. It outlines a set of five broad 'archetypes' of operational models in citizen science, whilst seeking to retain acknowledgement of the unique nature of the formation and aims of each of the 35 different projects considered in the preliminary study. The brief makes a series of recommendations suggesting that commonality can be found across the citizen science landscape, and that citizen science can be understood from a social innovation perspective, and therefore supported by innovation management techniques.

The full content of the *'Making Citizen Science Work'* policy brief can be found in Appendix 2.

Target audience: Policy makers, citizen scientists, citizen science project managers, funding bodies.

Purpose: To outline the potential of innovation management within the context of the distributed network of citizen science and DIY science activities.

Status: Completed.

5.4.3 Citizen Science and Art/Science: Synergies and Future Potential policy brief considerations

Outline:

1. Executive Summary
2. Creative sense-making of our world
3. Links between citizen science and the arts
4. Art/science - a long tradition
5. Variety of art/science interaction and public outreach
6. How the arts facilitate citizen outreach
7. How citizen science enables art/science
8. Examples:
   - 8.1 Example 1: Anna Dumitriu: Make Do and Mend
   - 8.2 Example 2: Making Sense: citizen sensing toolkit
   - 8.3 Example 3: From art exhibition to living lab
9. Joint challenges and benefits
10. Current status and recommendations
11. Conclusions

Recently, programmes in the arts, in science, and to a limited extent in technology include actions targeting the interaction of artists with research projects. This policy brief was developed with contributions from a mixed group of experts from both fields. It aims at informing decision makers who have worked at the interface of citizen science and artistic approaches. There are clear synergies between these concepts and the benefits of considering them together. By showcasing initiatives implemented in Europe, this document highlights how Art can support citizen science and vice versa.

The arts can effectively respond to diminishing societal trust in science, contribute to the creation of public discourse and understanding of science, facilitate knowledge transfer between science and society, and stimulate innovation. Artistic interaction with science opens new pathways far beyond illustrating science. Artists can enter into a dialogue with researchers and scientists that is either critical or supportive. Art has the power to emotionally reach out to citizens and to interest but also engage them in a scientific process.

The document concludes by recommending considering citizen science and the Arts jointly, to strengthen synergies by building on existing initiatives, to launching targeted actions regarding education and training, and finally, to launch art-science initiatives. This policy brief is developed within the framework of the Horizon 2020 project ‘Doing It Together Science’ (DITOs) to establish a collaborative and open network between DITOs partners, external organisations and decision makers throughout Europe.

Target audience: Policy makers, research managers and funding authorities in the fields of arts and science.

Purpose: Exploring the synergies between art/science and citizen science movements; improving the understanding of the benefits of artistic practice for citizen

science and vice versa, overcoming the current strict boundaries between the arts and (citizen) science.

Status: Completed.

5.4.4 European Clean Air Day - citizen science for clean air policy brief considerations

Outline:

1. Executive summary
2. Air quality and public health issues
3. Air pollution and climate change
4. Citizen science and air quality monitoring
   4.1 Diffusion tube method for measuring Nitrogen Dioxide and Sulfur Dioxide
   4.2 Low-cost sensors and sensor systems
   4.3 Low tech do-it-yourself at home methods
   4.4 Community platforms with citizens-created online air quality maps
5. European clean air day initiative
6. Novelty of approach
7. Funding and resources
8. How to join European Clean Air day
9. Timeframe for actions

According to health research and the World Health Organization (WHO), air pollution in urban areas leads to 3 million premature deaths annually. Concerns about the human health impact of air pollution have prompted the development of many community-led air quality monitoring initiatives, which has helped to bring the topic to a wider audience and mobilise policy change. However, as yet there is no large scale coordinated effort for community-led air quality monitoring. This policy brief presents a framework for organizing a yearly European Clean Air Day, starting from 20th June 2019, with the objective of scaling up European awareness of air quality issues, and ways in which air quality can be improved. The brief presents a range of financing options and tools for air quality monitoring within grassroots organisations.

The full content of the 'European Clean Air Day - citizen science for clean air' policy brief can be found in Appendix 4.

Target audience: Policy makers, researchers, citizen scientists, journalists.

Purpose: Promote idea of organising European Clean Air Day on 20th June 2019.

Status: Completed

5.4.5 Citizen Science in UK Environmental Policy research insight considerations

Outline:

1. Executive summary
2. Introduction

3. Background
4. Definition: Environmental Citizen Science
5. Mapping stakeholder relationships
6. Roundtable topics
7. Key points of the discussion:

   7.1 Flows of power are seen to be very top-down

   7.2 Citizen science lacks a clear mandate

   7.3 Data collection and policymaking is disconnected
8. Open data
9. Responsible agents
10. Scales of engagement
11. Recommendations for policymakers

It is possible to argue that because of existing practices, the integration of citizen science in the UK is already happening, and therefore no wider policy response is required. However, as technologies, societal response, and the type of projects in citizen science, continue to evolve rapidly, a 'business as usual' approach is unlikely to maximise the potential that citizen science can offer in the UK. To address this challenge UCL organised a policy roundtable in early May 2018 to discuss the current state, and future directions, of citizen science in environmental policy in the UK. The research insight draws on the discussions of the policy roundtable, particularly on the four topics of data, environmental policy, science and innovation, and public engagement and behavioural change. The research insight provides more detail on three thematic areas that emerged from discussions: open data; responsible agents; and the scales of engagement at which citizen science operates. The findings suggest that citizen science needs to have proper infrastructure and support to play a role in policy. Finally the brief provides 5 recommendations for policymakers, highlighting that the integration of citizen science and policymaking should be seen as an iterative process of ongoing engagement

The full content of the *'*Citizen Science in UK Environmental Policy*'* research insight can be found in Appendix 5.

Target audience: Policy makers, researchers, citizen science community.

Purpose: To better understand and maximise the potential of that citizen science can offer in the UK.

Status: Completed.

5.4.6 Open Sharing Platforms and Affordable Lab Spaces as Drivers of Innovation in Biodesign policy brief considerations

Outline:

1. Executive Summary
2. Introduction: Biohacking and Biodesign
3. Open Sharing Platforms and Academies
   a. Case Study: BioHack Academy
4. Lab Spaces as Infrastructure

   a. Case Study: OpenCell
5. Recommendations

The full content of the *'*Open Sharing Platforms and Affordable Lab Spaces as Drivers of Innovation in Biodesign*'* policy brief can be found in Appendix 6.

Target audience: Policy makers, researchers, media labs and other institutes, Biodesigners, biohackers.

Purpose: To highlight actual and potential innovation in Biodesign through open sharing platforms, academies and affordable lab spaces, and summarize the needs to support these material and immaterial resources.

Status: Completed.

5.4.7 Towards a Shared National Strategy: Guidelines for the development of Citizen Science in Italy policy brief considerations

Outline:

1. Summary
2. International recognition of citizen science
3. Regulatory frameworks for citizen science
4. Citizen science in Italy
5. Participatory development of guidelines for citizen science in Italy
6. Objectives for the development of citizen science in Italy
7. Guidelines for developing citizen science in Italy

   7.1 Engage key citizen science actors

   7.2 Integrate citizen science into strategic and economic planning tools

   7.3 Develop effective, reliable and accessible methods

   7.4 Communication

8. Final recommendations

This policy brief was developed to support the Italian citizen science community and facilitate the process of capacity building to grow a citizen science national network. Two local stakeholder roundtables and one Discovery Trip were organised within the framework of DITOs (WP4 T4.3) in April 2018 and February 2019. Information gathered during the events was used to draw guidelines divided into macro-topics and also the main action needed to promote the development of citizen science in Italy.

The full content of the *'*Towards a shared national strategy: guidelines for developing citizen science in Italy*'* policy brief can be found in Appendix 7.

Target audience: Ministries, public authorities and administration.

Purpose: To provide guidelines and recommendation to develop citizen science in Italy.

Status: Completed.

5.5 Design and presentation of policy briefs

The design and presentation of policy briefs remains the same as for policy briefs included in D4.1 and D4.2 which have been well received and are in accordance with the branding and publication standards defined in D6.2.

5.6 Dissemination of policy briefs

Policy briefs are 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. The community-oriented process of writing the policy briefs will also be leveraged for their distribution. The briefs were presented, handed out and discussed at the DITOs final event on 3rd April 2019 in Brussels and will be distributed at future ECSA and DITOs partners' events, even beyond DITOs.

Furthermore, partners in the consortium have discussed ways to strengthen the dissemination of the briefs, also in response to the comments received in the mid-term review of the project. Policy brief dissemination is discussed in section 6.4.7 in D6.8.

6 Conclusions

This deliverable concludes the successful third and final stage of WP4 and the timely deliverable of 7 policy briefs. It provides evidence of the firm foundation and network built by the consortium's activities on policy engagement for RRI. The key achievements in this phase have been:

- **Guidelines:** collecting, developing and reviewing best practice documents on citizen science and DIY science that are openly accessible. Publishing a policy brief on guidelines for developing citizen science at the local level (in Italy), which can be used as a reference for similar actions in other countries.
- **Mechanisms:** establishing collaborative, open networks around the topics of citizen science 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. In many cases, policy briefs have been developed with a participatory approach and by leveraging existing networks, such as the Air Quality Working Group at ECSA.
- **Mechanisms:** Carrying out open and community-oriented processes for determining the specific themes and content of the policy briefs and thereby piloting participatory processes along with accompanying communication strategies;
- **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 the ECSA Working Group on Air Quality in Europe – 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 and Discovery Trips (T4.3), carried out by various partners thus improving programmatic cohesion, as well as coordination between partners.

7 References

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

Avison, D. E. and Fitzgerald, G. (1995). Information Systems Development: Methodologies, Techniques, and Tools, McGraw-Hill, New York, NY.

Checkland, P. (1984). Systems Thinking, Systems Practice, John Wiley & Sons, Chichester, UK.

Checkland, P. (1999). Soft Systems Methodology: a 30-year Retrospective, John Wiley & Sons, Chichester, UK.

Checkland, P. and Scholes, J. (1990). Soft Systems Methodology in Action, John Wiley & Sons, Chichester.

8 Appendices

Appendix 1 – A Tale of Two Science Buses: Diversity of Knowledge and Inclusion Practices

Executive Summary

Public engagement activities labelled in the same way can generate very different practices and experiences for participants. The key difference appears to be the way scientific knowledge is framed and the engagement activity is designed. This affects the scope and parameters of public experimentation and inclusion of social groups. It is important to use appropriate materialisations of ‘science’ to achieve intended public engagement goals.

Science Bus Context

Science buses are a common public engagement approach used by public museums and science institutions across the world. Their physical mobility is used to bring scientific experiments and knowledge closer to the public. This form of public engagement has a long history. For example, in India the first mobile science exhibition launched in 1965[6] and involved buses traveling to rural areas to reach illiterate populations, and a 1983 UNESCO report provides a design manual and

[6] Ministry of Culture Government of India, 2014. Mobile Science Exhibition [WWW Document]. Natl. Counc. Sci. Museums. URL http://ncsm.gov.in/ mobile-science-exhibition/

organisation advice for science buses[7]. Today, in Europe and the US, science buses tend to target children and involve them in hands-on small-scale experiments that are tied directly into the school curriculum. Typical experiments include “how a potato clock works, what causes optical illusions, how to test for acids using red cabbage juice”[8]. The concept being, that these experiments will illustrate well-established scientific concepts for the students. This tends to mean that the experiments are carefully designed and standardised for pre-defined age groups and with a specific scientific topic focus.

Comparing the two DITOs buses

This research insight focuses on the two science buses from Doing it Together Science (DITOs) project which is a H2020 funded Coordination and Support Action that is building citizen science and science communication across Europe. This report is an ethnographic vignette that compares the two science buses from DITOs to highlight some differences that have broader pertinence. The XperiLAB truck was created by the Royal Belgian Institute of Natural Sciences (RBINS), while the official Do-It-Together science bus was coordinated by the Waag, an organisation focused on emerging technologies as instruments of social change. Both of the science buses were specially outfitted and staffed and carried specialised equipment for participatory workshops.

XperiLAB

The XperiLAB truck, created by RBINS, has been operating since 2010 and travels across Belgium from school to school bringing structured science experiments to enhance the existing education programmes. The stated goal is that the activities should teach the inductive method to the children. The XperiLAB activities take place inside the truck via custom designed workstation consoles that each focus on single scientific concepts from biology, chemistry and physics such as hydrodynamics. During the workshops, energetic music plays as the pupils enter the science bus, change into lab coats and move towards the consoles that are illuminated with lighting, providing a dramatic atmosphere. Working in small groups, the school children simultaneously work on a series of hands-on activities that involve physically manipulating and submerging objects and collecting data, guided by an on-screen computer persona that gives instructions. The activities, while closely based on scientific concepts, also use playful metaphors from popular media such as spy films, that are combined with game mechanics of team competition, button presses, time limits and point scores to reward progress through the activity. At the end of a workshop, the children are all gathered together for a collective discussion with the instructor who highlights the pedagogical value of the activities to the children.

Do-It-Together Science Bus

The scope and focus of the Do-It-Together science bus coordinated by the Waag was different. It started by recruiting multiple ‘science bus captains’ from the public to drive the bus across Europe and make 17 stops at a variety of community centres, small towns, public festivals and museums to run participatory workshops and document the process on social media. The goal was to involve a broad public in ready-made

[7] Bose, A., 1983. Mobile Science Exhibition. New Delhi.
[8] Ahlstrom, D., 2000. Science bus brings mobile laboratory to schools. Irish Times. Herman, E., 2015. Today’s “Junk Genies,” tomorrow’s engineers [WWW Document]. CHESS Cornell High Energy Synchrotron Source. URL https://www.chess.cornell.edu/about/news/todays-junk-genies-tomorrows-engineers (accessed 4.27.19).

activities from the bus and ask the participants to contribute their own folk remedies and recipes that the bus would take on its journey to bring them to new places and people. During the four workshops observed in Birmingham, the participants were a diverse age mix of children accompanied by parents and a significant number of elder members of the community. The ethnic and cultural breakdown was also highly diverse, including British people, as well as those from newly arrived and long-term ethnic communities. The main science bus activities were yoghurt-making and sun cream making[9], which involved participants sitting on long wooden benches in front of metal pots that they used to mix and heat ingredients such as milk or beeswax. The diverse mix of ages and 'homely' activity gave an atmosphere of a cooking lesson, with adults chatting and getting to know neighbours while kids were playing rock-paper-scissors. The science bus captains used the sun cream making activity as an opportunity to explain the physical properties of sun-rays and the yoghurt to teach about bacteria. Yet based on discussions with participants, some had come to the activity because they usually took part in the community centre's activities while others had come for pragmatic reasons. One mother needed sun cream that would not irritate her child who was allergic to commercial sunscreen. Similarly, with the yoghurt, the participants wanted to take it home to eat. Thus, many of the participants used extra jars to mix additional batches of sun cream and yoghurt to give to friends. This seemed to surprise the science bus captains, who perceived the activities as demonstrating scientific principles that were more pure and educational than playing such a pragmatic part in people's everyday lives. At the end of the workshop, the local coordinator of the community centre where the event was hosted, thanked the science bus captains and told the group how pleased she was that the event showed that "*also normal people go to university - and you don't look like nerds*". Interviewing the community centre coordinator afterwards, she explained that the local area was a highly deprived area, and this meant local people didn't aspire to science because it was seen as remote and the people who carry it out, as 'other'. She saw the benefits of the science bus workshops as creating intergenerational bonds and connecting different community groups as well as offering an alternative to the 'guns and crime narrative', usually attributed to the area.

Analysis

As the ethnographic vignettes of the two buses illustrate, both buses involved different practices and framings of scientific knowledge and publics. The XperiLAB bus targeted a specific age range of school children with activities and took place during lesson time and in the physical vicinity of the school and included the class' teacher. The XperiLAB framing is that the bus is an extension of the school classroom. In particular scientific knowledge is defined by the workshop activity and the experiment constrained to the consoles that the children stand around within the bus. In contrast, the Waag science bus had a looser concept of scientific knowledge and publics that revolved around the notion of 'instructables'. These are text and image guides that are created by people within online forums to share instruction for a variety of projects. Crucially instructables are peer-created and shared amongst 'makers' without any clear assertion of knowledge authority or expertise. The workshop activities were available as printed instructables as well as website downloads, which meant the participants could carry out the experiment on their own at home. The bus workshops where thus a physical run-through of the instructable information as guided by the

[9] Waag, n.d. DIY sunscreen [WWW Document]. URL https:// togethersciencebus.eu/wp-content/uploads/2017/07/EN-DITOS-07- Sunscreen.pdf (accessed 5.4.19).

science bus captains. Furthermore, the Waag bus was collecting folk remedies from the workshop participants as a two-way knowledge exchange process. By framing folk remedies as 'life hacks', they positioned them similar to the instructables already created for the bus. For the Waag bus, the scientific experiment was the bus trip itself that extended across the whole of Europe gathering recipes. A key part of the Waag bus, were the video blogs and social media content produced by the science bus captains on their European journey documenting their experiences. For the Waag team, this social media presence was a key outcome of the project and the main way in which it was documented. Thus, the scientific experiment extended across Europe, and via the instructables entered into people's homes.

The different concepts of knowledge of the two hosting organisations had an effect on the design of the two buses and their experiments. Furthermore, this had an impact in the reach and make-up of the potential audiences and publics they could involve. The notion of the instructable presents an expansive concept that allowed practically useful activities such as sun cream and yoghurt making, as well as the inclusion of different kinds of knowledge via the concept of folk remedies. This had a direct impact on the possibility of reaching an age, and ethnically diverse audience. Both the pragmatic and homely nature of the activities allowed the intergenerational as well as cultural mixing. Interviews with the Waag bus organisers and science bus captains suggest they were not specifically targeting cultural or social inclusion. The majority of the Waag bus stops did not explicitly target deprived areas but visited a wide range of different settings including rural areas such as the small town of Aranda de Duero in Spain as well as large public festivals and science museums. Rather, it was the expansive notion of scientific knowledge in the form of the instructable that allowed the workshops to function in many different settings and with different audiences. In the last years, it was possible to see the emergence a new model of scientific outreach derived from internet communities, 'maker cultures' and DIY science that is premised on qualities of openness, pragmatism and two-way exchange. An example of one these maker science buses is 'Junk Genies' run by Cornell University, which focuses on student initiated ideas, 'self efficacy' and 'just-in-time teaching'[10].

Afterthought

During the process of the DITOs project, there was a shift in the way RBINS were engaging with the XperiLAB bus. Previously the bus would visit any Belgian school that would invite them to come and pay the fee. Yet during the process of the DITOs project, the location of the Xperilab workshops were geographically mapped and analysed for the first time. Having this overview, and discussions around inclusion, have led to discussions in the RBINS team about whether deprived areas should be specifically targeted by the bus in the future. If this approach was adopted, it would be part of a shift towards framing inclusion a part of science education and lead to an expansion of scope of the bus experiment. These discussions can be attributed to the XperiLAB participation in the DITOs project.

Conclusions

This ethnographic vignette suggests that the way scientific knowledge is framed defines the scope of public engagement activities and impacts the inclusion of social

[10] Herman, E., 2015. Today's "Junk Genies," tomorrow's engineers [WWW Document]. CHESS Cornell High Energy Synchrotron Source. URL https:// www.chess.cornell.edu/about/news/todays-junk-genies-tomorrows- engineers (accessed 4.27.19).

groups. There is potential for cross-fertilisation between 'classic' models of science outreach and fresh approaches from DIY science and maker cultures

Appendix 2 – Making Citizen Science Work - Innovation Management for Citizen Science

http://discovery.ucl.ac.uk/10073927/

Appendix 3 – Citizen Science and Art/Science - Synergies and Future Potential Policy Brief

http://discovery.ucl.ac.uk/10073928/

Appendix 4 – European Clean Air Day - Citizen Science for clean air

http://discovery.ucl.ac.uk/10073029/

Appendix 5 - Citizen Science in UK Environmental Policy

http://discovery.ucl.ac.uk/10073026/

Appendix 6 - Open Sharing Platforms and Affordable Lab Spaces as Drivers of Innovation in Biodesign

Executive Summary

The DIYBio movement facilitates innovation by creating communities of people from different backgrounds, sharing knowledge and expertise through courses and open sharing platforms, and facilitating prototyping in affordable lab spaces. This brief focuses on the influence of these material and immaterial resources on innovation in Biodesign. It looks at designers that work with living materials or take inspiration from the life sciences, with practices such as growing new sustainable materials, crafting accessible scientific tools, or imagining future (bio)technologies. Specific drivers of innovation in Biodesign are knowledge hubs such as educational efforts or open sharing platforms, and affordable lab spaces that provide access to tools as well as potential partnerships. The BioHack Academy is an example of a knowledge hub, functioning as a gateway to Biodesign by way of teaching laboratory skills and facilitating project-based learning. The Biofabforum is an example of an online forum for sharing and discussing research results and protocols within biomaterials. Academies and forums create communities and offer a knowledge base for new biodesigners. However, the process from initial idea to end result, involves experimentation and many iterations; it thus requires time and extended access to resources such as space, skills and tools. Affordable but well-equipped and well-

connected labs therefore play a key role for innovation in biodesign, an example being Open Cell in London. This leads to a series of recommendations on how to support the infrastructure of lab spaces, programmes and platforms, as well as individuals within DIYBio and Biodesign communities.

Introduction: Biohacking and Biodesign

It is possible to observe how Do-it-yourself Biology (DIYBio), also called "biohacking"[11] or, more recently, "community biology", has become a movement. This was demonstrated at the BioFabbing[12] event held in 2017 at CERN in Geneva and the 2017 and 2018 Global Community Bio Summits[13] at MIT MediaLab in Cambridge, Massachusetts, both of which hosted several members of European DIYBio spaces. DIYBio is a movement fuelled by a distributed network of institutes and individuals, to which, over time, nodes are added and subtracted.[14] In 2019, Hackteria, the web platform and open source biological art collection will celebrate its tenth anniversary[15], while over the last few years numerous new European DIYBio spaces and networks came into existence.[16] These spaces host communities of people from different backgrounds, making interdisciplinary exchange possible. Among the DIYBio spaces and their members there are commonalities and differences; some are using the spaces to carry out hobby activities, but others are investing time in them with more of a professional motivation. Biodesigners can be considered in the latter category; these are designers that work with living materials or take inspiration from the life sciences, with practices such as growing new sustainable materials, crafting accessible scientific tools, or imagining future (bio)technologies[17]. Biomaterials, materials made out of growing matter such as mycelium, are an increasing trend, with several hybrid company / DIYBio spaces especially dedicated to them.[18] [19] The DIYBio movement facilitates innovation in Biodesign in multiple ways, two of which will be discussed: (1) academies, workshops and open sharing platforms that enable the sharing of knowledge and expertise (2) affordable lab spaces that facilitate prototyping and cooperation.

Open Sharing Platforms and Academies

One of the pillars of DIYBio is the open online sharing of experiments, protocols and designs for tools. Within the research domain of biodegradable and bio-based

[11] https://www.merriam-webster.com/dictionary/biohacking
[12] http://citizensciences.net/biofabbing/
[13] https://www.biosummit.org
[14] For a database of spaces and projects, see the DIYbiosphere platform, http://sphere.diybio.org/
[15] http://www.hackteria.org/about/
[16] https://diybio.org/local/
[17] For a list of literature about biodesign, see the Biodesign Challenge: https://biodesignchallenge.org/faqs#whatisbiodesign
[18] https://biolab.farm/
[19] http://www.fungus-sapiens.com

materials such as bioplastics and mycelium materials, online forums such as the Biofabforum[20] promote the open sharing of recipes and experiences. Online sharing platforms allow people to learn methods, and contribute their own findings, both of which can help in accelerating innovation. The benefit of open sharing is that knowledge is accessible for potentially everyone, and not hidden behind pay-walls. This sharing of knowledge happens outside of academia and industry, and within realms that are accessible to citizens with no prior background in a topic. Moreover, the do-it-yourself and low-cost nature of recipes allows for easy adoption and adaptation. Creating and moderating such platforms takes effort in terms of time and resources, but with these things in mind, the function of such platforms should be appreciated. A set of available DIYBio educational programmes and workshops offer practical skills, as well as a project-based learning approach, allowing participants to develop their own research projects and deviate from given protocols. This approach is different from traditional, top-down, educational methods, and fits into the goals of lifelong learning and keeping up with technological developments. An example is the BioHack Academy at Waag's Open Wetlab (Case Study). Other examples include workshops at BioTehna (Ljubljana, Slovenia), MediaLab Prado (Madrid, Spain), and many others.

Case Study: BioHack Academy

The BioHack Academy is a 10-week programme wherein participants learn about biological techniques, microbiology, genetics, and biosafety, and are encouraged to build their own open source laboratory hardware. During the academy, students develop their own research questions, following their own interests, varying between practical and critical, applied and artistic.[21] Several Biodesign projects have developed beyond the academy programme, including a modular incubator for growing organisms, by designer Candyce Dryburgh[22], Jan-Maarten Luursema's bio-digital slime mould explorations[23], and Matthijs de Block's endeavours on soft robotics and self-measurement.[24] Alumni of the academy continue to play a role in DIYBio, with a prime example being Chan'nel Vestergaard, who provides educational programmes in S.T.E.A.M. subjects with Littlepinkmaker, and organises the creative open science space Co-lab in Copenhagen.[25]

Coordinating the process of developing these projects and aiding in the documentation so as to make the results open source, is of critical importance to the success of such programmes. The BioHack Academy has grown a community of individuals that have

[20] https://biofabforum.org/c/biofab
[21] https://waag.org/en/article/three-impressions-biohack-academy
[22] Candyce Dryburgh - BioHack Academy blog - https://dcandyce.github.io/
[23] https://medium.com/@slime_mold_Andi
[24] https://www.instagram.com/matthijstheblock/
[25] https://www.colabcph.org/

become active in various DIYBio spaces and strong voices in the movement as a whole. Educational programmes in the DIYBio sphere thus also strengthen the growth of the movement and the possibilities for innovation. The open sourcing and sharing of educational methods and tools allow for a broader public to be included in these educational efforts and serve as an entry into the DIYBio movement. Open source and free platforms enable those outside of academia to be enabled rather than distanced, engaging in a new way of learning and exploring science together.

Lab Spaces as Infrastructure

Besides DIYBio spaces opening up their doors to the public for workshops or community nights, there is a small but growing number of dedicated professional coworking laboratories that allow affordable space and instrumentation and access to a bigger network of partners for small start-ups and projects within biotechnology and biodesign to develop. La Pailasse[26] in Paris is an early example; a more recent one is Open Cell in London (case study), which provides affordable facilitation for prototyping.[27]

Case Study: Open Cell

Open Cell was co-founded by Helene Steiner and Thomas Meany in Shepherd's Bush, London. It consists of a series of self-contained lab spaces, which were built and designed by the Austria-based Biotop collective[28], which demonstrates a cross-border collaboration in Europe.[29] Current residents include Olombria, managing crop pollination by fly species through chemical volatiles; WASE, developing decentralized wastewater treatment systems; and BIOHM, researching and developing circular solutions for the built environment, such as their Triagonomy construction system.[30]

Affordable coworking laboratories not only allow projects and small companies to progress, but also create grounds for developing new ideas into innovations. Low cost lab spaces are founded because they are expected to create a change, creating new possibilities as to who can be included in the developments and work with new (bio)technologies, attracting designers, engineers, scientists and others to solve critical problems, and build tangible results. The start-up costs related to DIYBio spaces can be a burden, especially with regards to creating the laboratory infrastructure and getting necessary equipment. While sources of funding for projects and networks exist, infrastructural developments are harder to acquire funding.

[26] https://lapaillasse.org
[27] https://www.opencell.bio
[28] http://biotop.co/en/
[29] https://vimeo.com/298588531
[30] https://www.opencell.bio/residents

Several labs are housed within universities,[31] or are supported by local municipalities. Some DIYBio spaces resort to crowdfunding campaigns to finance their infrastructure.[32],[33] There is potential to help DIYBio spaces in this development phase. In the urban context space is a crucial issue, in which municipalities can play a role. This policy brief sought to elaborate on the potential for innovation in Biodesign through DIYBio platforms, programmes and spaces. Following this brief, a number of recommendations are offered below.

Recommendations

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

1. Infrastructures that promote innovation in Biodesign, including affordable and accessible lab spaces, need to be supported. This includes acknowledging that stability for these spaces is vital in establishing a structure to retain expertise and to enable further developments of Biodesign projects. Beyond being networking hubs, lab spaces need to be supported to become creative outlets for bio-based knowledge and business ventures, by ensuring funding from different sectors.
2. Increase the possibilities of support for open source DIYBio platforms in an effort to grow networked innovation, all the while acknowledging the challenges of open source approaches.
3. Stimulate the transitions between different organisational and financial models of open sharing platforms, biodesign programmes and affordable lab spaces.
4. Encourage or advocate long-term support for DIY biologists and biodesigners beyond prescribed educational programmes. This would allow them to further develop their skills and outputs, including political and organisational skills that enable them to ensure that DIYBio is seen as safe and legitimate.
5. Promote collaboration at all levels, including between groups of people with different backgrounds, and cross-border enterprises.
6. Strive to strike a healthy balance for lab spaces to provide a diverse range of benefits for users. Such benefits include teaching basic technical biological skills, fostering an open mindset for creative projects to flourish, as well as practical advice for potential commercial enterprises.
7. Promote, support and foster cross-country connections, and strengthen the sharing of experiences and knowledge between and across local DIYBio and Biodesign communities.

[31] https://hybridformslab.wordpress.com/

[32] https://www.spacehive.com/opencell#/

[33] https://www.indiegogo.com/projects/toplab-the-first-community-biolab-in-berlin-art-science#/

Appendix 7 - Towards a Shared National Strategy: Guidelines for Developing Citizen Science in Italy

Italian version: http://discovery.ucl.ac.uk/10073921/

English version: http://discovery.ucl.ac.uk/10073924/