Grant agreement no. 709443

DITOs

Doing It Together science

Coordination & Support Action

D5.3 Final Evaluation Report

Work Package: 5

Due date of deliverable: Month 36

Actual submission date: 30 / 05 / 2019

Start date of project: June 01 2016 Duration: 36 months

Lead beneficiary for this deliverable: Dr. Erich Prem (eutema)

Contributors: Cindy Regalado, Pawel Miedzinski, Georg Melzer-Venturi and Christian Nold

Reviewer: Simon Gmajner (Kapelica); Brigitte Tiefenthaler (Technopolis), Dietmar Lampert (ZSI – Center for Social Innovation)

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)	

Put the 'X' in the correct column above and the footer accordingly

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 709443

Disclaimer

Copyright Notice

Acknowledgement

The DITOs project has received funding from the European Union Horizon 2020 programme under grant number 709443.

Reference

Please cite this work as:

DITOs Consortium, 2016. *Doing It Together science: Final Evaluation Report,* eutema, Vienna.

Document Identification Sheet

Project ref. no.	709443
Project acronym	DITOs
Project full title	Doing It Together Science
Document name	DITOs-D5.3-20190524.pdf
Security (distribution level)	Public
Contractual date of delivery	End of project month 36: 31.5.2019
Actual date of delivery	30.5.2019
Deliverable number	D5.3
Deliverable name	Final evaluation report
Type	Report
Status & version	Version 4 (new data)
Number of pages	69
WP / Task (responsible)	WP5 / T3 (eutema)
Author(s)	Erich Prem (eutema)
Other contributors	Cindy Regalado (UCL, Tekiu), Christian Nold (UCL) and Pawel Miedzinski (eutema)
Project Officer	Colombe Warin
Abstract	D5.3 Reflect on the entirety of the DITOs project, reviewing all key qualitative and quantitative data and analysing the results and impact of the activities with particular reflection on the project's impact, capacity building, influence on policy and legacy. The report will also reflect on and address wider questions of evaluating citizen science activities.
Keywords	Public engagement in science, citizen science, DITOs, evaluation
Sent to peer reviewer	3.5.2019
Peer review completed	20.5.2019
Supervisory Board approval version 1.0	24.5.2019

Table of contents

List of figures

List of tables

1 Introduction

This deliverable presents the final evaluation of the DITOs events, reviews key data from the project and presents a framework for assessing outreach and public engagement in science activities. It is based on the results of and experiences with DITOs, a 3-year endeavour that realised more than 750 science outreach and engagement activities. Science outreach activities (e.g. exhibitions) are at one end of the spectrum of Citizen Science while interactive workshops are at the other. The DITOs consortium organised a wider range of events than that outlined the project's proposal, and these were delivered across and beyond Europe. The task of evaluating such a large number and broad range of activities with many actors involved has been an arduous task. This report summarises the approaches taken by the evaluation team, the results, conclusions, and recommendations for future Citizen Science activities.

1.1 Evaluation: assessment, appreciation, or prediction?

Evaluation derives from the old French word 'value' and the verb 'valoir': to be worth. This in turn stems from the Latin word 'valere': to be strong, be well, and be of value. Today, evaluation still concerns aspects such as *merit, significance,* and *worth* (Scriven 1999, Prem 2014) - and a procedure to clarify those aspects. The notion of *merit* is usually associated with a backward-looking assessment of - in our case - a project's achievements: it concerns *the past* and what the project has achieved to date. *Significance* on the other hand, is about the meaning of something for us *today*. It relates to the question as to why something is important - and what it means or should mean. Finally, the aspect of *worth* concerns a forward-looking estimation of an entity's value for *future* actions. All three aspects are legitimate and rather different aspects of evaluation. Which of these is most meaningful, depends on the reason for first asking about the value of something.

In policy-related project or programme evaluations, all three aspects play a key role. The retrospective aspect of evaluation is used to assess whether an activity was worth it in the sense of money well spent. The assessment of the current significance is a guiding aspect in policymaking. Likewise, the prospective, forward-looking prediction of what we may have gained with an activity is most important in learning for the future. Most importantly, all three aspects are conjoined in the policy narrative: the story that underlies decision-making, for example regarding decisions about research investments by demonstrating their meaningfulness for us today and the hope for a better future. The important role of the performative aspect of demonstrating science is a central aspect of in the recent work of Bruno Latour (2016). DITOs is no exception: it needs to demonstrate proper use of the public resources, it should be meaningful for Citizen Science today and we hope to have created something of value for those involved in the project and for others who are interested in bringing Citizens closer to Science.

1.2 The DITOs approach to evaluation

From project onset, the evaluation in DITOs was designed as an evolving system. It was clear from the beginning that changes to evaluation procedures and criteria were necessary as we gained deeper insights from partners delivering events and as we gained more experience with the very large numbers of events and participants involved. On the quantitative monitoring part of evaluation, what began as a more traditional effort to monitor and eventually demonstrate goal achievement, soon turned into a more interesting effort to better understand efforts to engage citizens in a scientific way of making sense of the world. On the qualitative aspects of the evaluation, a continuous process following our iterative learning design and emergent design flexibility strategy (D5.1 section 4.5.1) led to an increased understanding of project progression from an often-overlooked perspective: that of the events and activities facilitators themselves.

A central component of the DITOs approach is the notion of the Citizen Science escalator of public engagement (Figure 1)[1]. It suggests a hierarchy within a broad range of activities, from a perhaps mostly passive consumption of science (e.g. listening to a presentation or partaking in an exhibition) to more engaging activities such as hands-on experienced-based workshops and activities involving data analysis and goal-driven search for facts and hypotheses. DITOs activities targeted all these different layers of the escalator model to different degrees. The model assumes that people can enter at a level of participation that matches their needs, interests, and abilities, while DITOs encourages them to move beyond or “up the escalator” to more engaged types of activities. Many event participants were reached with lower-level engagement activities, e.g. online and a few moved along the escalator towards fully involved and goal-oriented scientific activities to make their world a better place. However, others ‘jumped around’ the escalator, experiencing the range of activities but not necessarily in an ascending order, for example, attending a hands-on workshop and then visiting an exhibition.

[1] M.Haklay, Introducing “Doing It Together Science” – an EU citizen science project. Extreme Citizen Science blog, April 29, 2016. https://uclexcites.blog/2016/04/29/introducing-doing-it-together-science-an-eu-citizen-science-project/

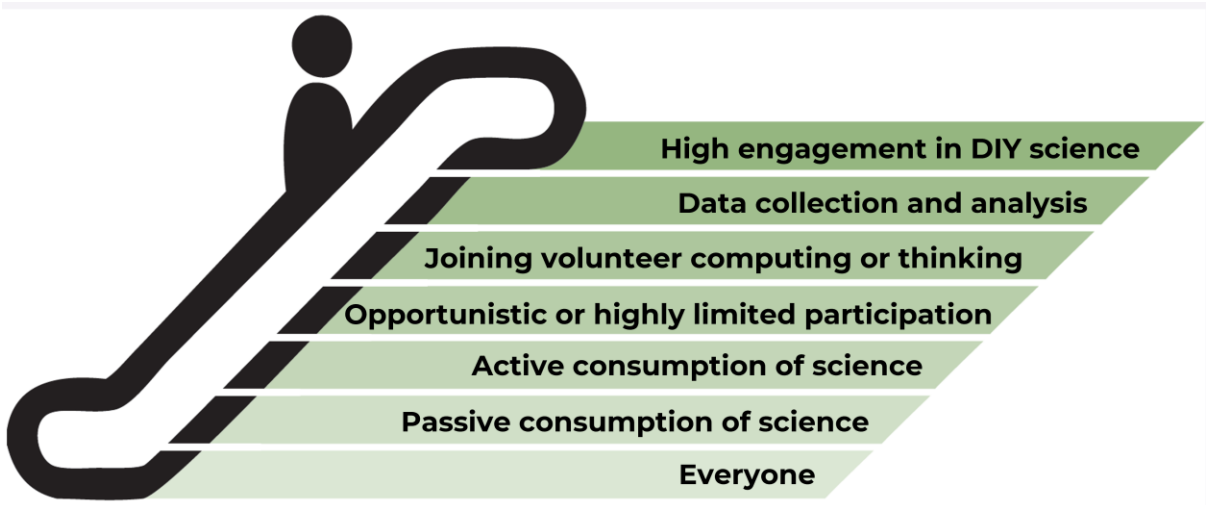

Figure 1 The escalator of engagement

Evaluation in DITOs fulfilled a range of purposes: it aimed to provide a measure of goal-achievement and progress towards the very high target figures regarding total number of events and event participants. It also aimed to provide insights in the Citizen Science engagement progress from various perspectives: the participant, the event facilitator and organisation. In addition, it aimed to understand better some individual stories of Citizens, in particular as they moved along the escalator. All of this is unlikely to be met with just counting events and event participants (what we call 'summative evaluation') as this cannot inform about qualitative aspects, individual stories, nor the experiences of event facilitators.

For this reason, the DITOs evaluation was designed to bring together different approaches under one umbrella (see Figure 2):

- **Summative evaluation:** The evaluation of event and participant numbers and related data;
- **Formative evaluation:** The evaluation of quality (how activities are planned and implemented) and expectations (including, facilitator journeys including roles, strategies, and lessons learned and how these relate to partner organisations); and
- **Ethnography:** The observation of partner practices and the collection of case studies about event participants.

For further detail and explanation of the three approaches, see DITOs Deliverable D5.1.

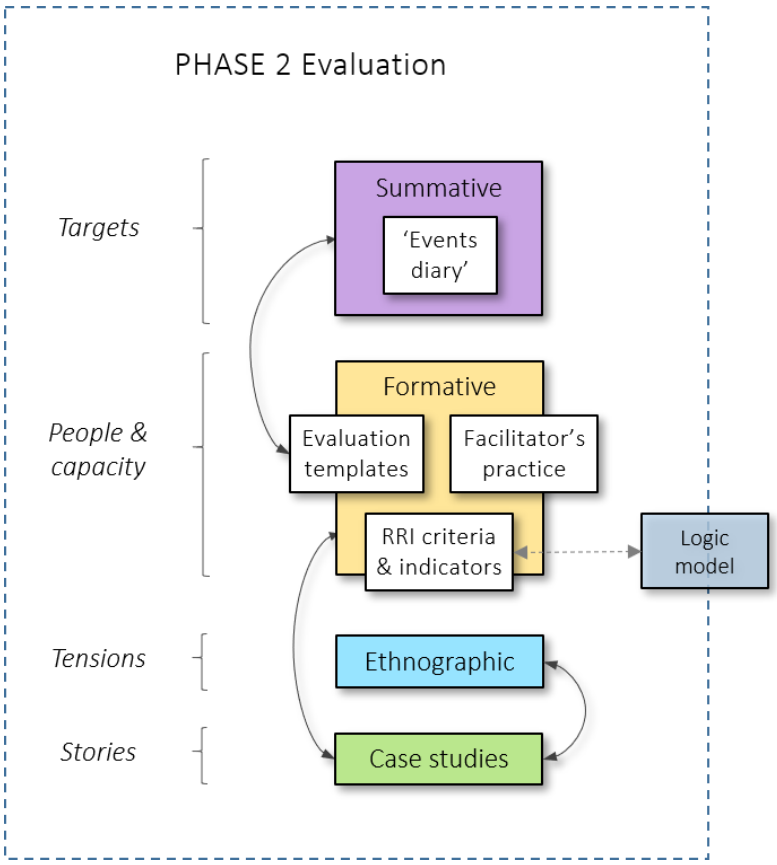

Figure 2 Evaluation approaches in DITOs

Early in the project, the consortium developed a logic model and a scheme for a theory of change emerging from DITOs.[2] The logic model not only describes resources, activities, participants and immediate outputs. In addition, it also details expected short-term and medium-term outcomes and longer-term impacts. While the outputs mostly consist of the contractual deliverables and events, the outcomes are concerned with objectives intended by DITOs participants, facilitators and of course the funding body, i.e. the European Commission.

Examples of expected DITOs outcomes include:

- Public awareness of science and responsible research and innovation
- Increased participation in citizen science and its improved visibility
- Social and gender inclusiveness in citizen science
- Increased knowledge and skills

[2] A.Shepard, Breaking the barriers to citizen science. Presented at the Citizen Science Association Conference, 18th May 2017. http://schd.ws/hosted_files/csa2017/16/D-04%20Tools%20for%20People%20Running%20Projects%20-%20Abstracts.pdf, https://www.slideshare.net/AliceSheppard/breaking-the-barriers-to-citizen-science, https://uclexcites.blog/2017/05/31/presenting-the-ditos-logic-model-at-the-citizen-science-association-conference/

- Tools and methods for citizen science
- Policy awareness for citizen science
- Engagement of citizens in shaping and conducting research
- Capacity (improvement) of local science actors

This (abbreviated) list from the logic model suggests that any approach to evaluation that focuses entirely on only the events and the citizens reached will be insufficient. It is vital to consider the facilitators and participating organisations as a key component of the evaluation exercise. In addition, it is important to consider a more in-depth inquiry in the individual citizen science participant given our interest in 'knowledge and skills', but also in the escalator model and the interest to engage citizens in shaping research.

The chosen threefold approach to evaluation can address most of the expected outcomes and can inform about the effectiveness of the chosen approaches in DITOs. The following diagram shows how the various dimension of the evaluation framework are addressing expected impacts of the logic model.

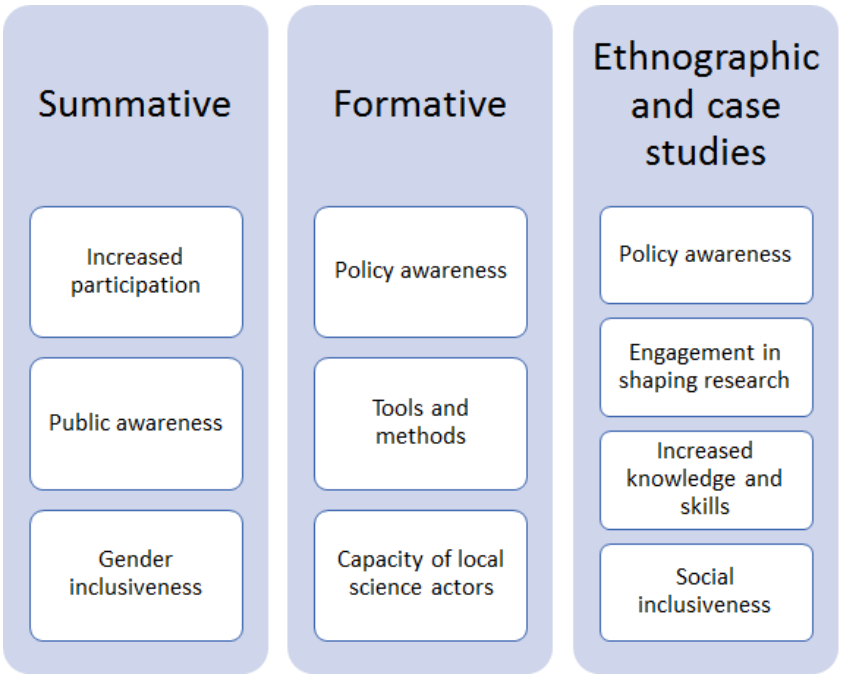

Figure 3 The different components of the DITOs evaluation framework evaluate different outcome dimensions

In section 4.4.2 of our Evaluation Terms of Reference (D5.1), we set out questions assessing impact of DITOs activities:

- What change can be observed in relation to the objectives of DITOs (e.g. is there increased public awareness of science and of RRI)?
- To what extent can observed changes be attributed to the intervention? Are there unintended impacts?

- What mechanisms delivered the impact?
- What are key contextual features for these mechanisms?

The following table summarise the impacts. Note that some impacts are described in more detail in the DITOs final report and other final deliverables, e.g. D3.3.

Table 1 DITOs objective, detected impacts and results

DITOs objective	***Impacts and results***
To engage citizens, scientists and policy makers in shaping and conducting research in bio design and technology (WP1)	Public awareness of science and responsible research and innovation Increased participation in citizen science and its improved visibility Social and gender inclusiveness in citizen science Increased knowledge and skills Development of tools and methods for citizen science Capacity (improvement) of local science actors
To engage citizens, scientists and policy makers in shaping and conducting research in environmental sustainability (WP2)	
To develop clear guidelines, mechanisms and institutions to extend the development of public engagement in citizen science and DIY science across Europe. This includes support for exploration, learning and innovation (WP3)	Although this was not part of the focus of WP5 as outlined in our *Terms of References* for evaluation in D5.1, our analysis indicates that facilitator/partner exchanges contributed an enriched development of guidelines and mechanisms for public engagement for each and across partner organisations. Exchanges also provided support for explorations, learning, and innovation amongst partners, some of which is evidenced in D2.3.
To develop clear guidelines, mechanisms and institutions to extend the development of policy engagement in citizen science and DIY science across Europe, fostering RRI, linking the pan-European citizen science and DIY science community to decision-makers at various levels and supporting innovation (WP4)	Policy awareness for citizen science Increased policy network for each partner organisation

To develop a robust framework for evaluating citizen science and gathering feedback on DITOs activities, including the engagement of citizens, scientists and decision-makers (WP5)	WP5 developed a combined approach based on summative, ethnographic and formative evaluation as a multi-level robust framework for evaluating citizen science.
To develop an innovation plan and identify suitable business models for citizen science and DITOs activities, including support for RRI (WP6)	This was not part of the focus of WP5 as outlined in our *Terms of References* for evaluation in D5.1 (as this falls under the monitoring of the consortium lead, UCL).

We now move onto presenting the results from each of the evaluation approaches: summative, formative and ethnographic evaluation.

2 Summative evaluation

This section summarises the results of the summative evaluation. This part of the evaluation exercise focuses on counting events and event participation, the analysis of event attributes such as location, gender distribution, event facilitators and other key features of the manifold of DITOs events.

2.1 Approach and main challenges

The idea of summative evaluation is straightforward: to sum up all events, count all participants to assess progress towards reaching the objectives of DITOs. However, given the overall size and ambition of DITOs, even just counting the events turned out to be a major challenge. The challenge was not only that several hundreds of events had to be properly recorded in an online database, but also the variability of event types. Additionally, many organisations were involved in the events including organisations that are not part of the DITOs consortium. This made it a difficult task to collect accurate data in a timely fashion and in many cases not all data could be made available, for example information about age or gender and in some cases also precise numbers of visitors to an exhibition could not be given. In several cases, gender distribution had to be estimated by event facilitators or was not available (for example in online events). Previous deliverables discuss these challenges in more detail.

Data was recorded in an online database. Originally, we used a simple online spreadsheet for recording of event participation. Early in the project, a dedicated online database was created to facilitate data sharing with the DITOs website. This made it easier to provide consistent information about the events, but the development of an online database that was easy and intuitive to use provided a challenge for the outreach and dissemination work package of DITOs.

The summative evaluation provides key data for assessing goal achievement and progress towards the project objectives in terms of event and participant numbers. It was a useful tool for assessing goal achievement for the mid-term review. This kind of data also provides important general-level information about geographic distribution, participant gender. It is important to understand that this type of data cannot shed light on any procedural aspects of the events and, most importantly, ignores the facilitation side of science outreach and citizen science activities. These aspects need to be addressed with the formative and ethnographic evaluation (cf. below).

2.2 Overall results

DITOs reached a far greater number of citizens in more events than originally anticipated. Even before the end of the project period, a total of 3,806,866 people participated in the DITOs event and outreach activities. The following figures include data from project onset until Month 30. Note that the project duration is in fact 36 months and some additional events also happened in the last 6 months. In the

following, we take a closer look at event data, in particular event numbers and participant numbers. The data is analysed with respect to a range of event types, location, gender of participants, work package, project period, organiser/facilitator gender etc.

It is important to keep in mind the enormous breadth of the events. They range from small and focused seminars to very large exhibitions. It is useful to distinguish between online forms of interaction with DITOs and physical events. Note however that this distinction is not completely straightforward as some workshops included significant online interaction. The following tables indicate event numbers and participants for all types of events:

Table 2 Number of events and participants per type of event

Event types	*# of events*	*# participants*
conference	27	3,393
exhibition	276	341,328
gaming-competitions	20	18,862
science-cafe	163	23,991
Travelling DITOS bus	17	1,840
workshop	241	120,679
online	20	3,296,773
Total	**764**	**3,806,866**

The following tables provide event and participant figures for the events per DITOs reporting period.

Table 3 Event and participant figures for events excluding online events (top) and only online events (bottom)

Period (excluding online events)	*# of events*	*# participants*
Reporting period 1 M1 - M15	449	205,448
Reporting period 2 M16 - M36	295	304,645
Total	**744**	**510,093**

Period (only online events)	# of events	# participants
Reporting period 1 M1 - M15	9	2,225,010
Reporting period 2 M16 - M36	11	961,763
Total	**20**	**3,296,773**

Let us take a closer look at the physical events, i.e. all event types excluding 'online' but including 'workshops with online participation'. Participation in events ranged from 2 to 100,000 with an average of 780 and a median of 38. A quarter of the events had less than or 16 participants. Also, a quarter of the events had more than 85 participants.

The following table provides descriptive statistics for all events excluding event type "online"

Table 4 Descriptive statistics for DITOs events (excluding online events)

Min participants	2
Max participants	100,000
Average # of participants	691
Median of participants	38
25% quantile	16
75% quantile	85.5

The following table and figure give some more information about the size distribution per number of participant classes. For example, 121 events had between 50 and 100 participants; in total 589 events had less than 101 participants (including 7 events without participant figures).

Table 5 Size distribution per number of events (excluding online events)

# of participants	*# of events*	*# of events (cumulative)*
na	7	

10	131	138
50	330	468
100	121	589
1,000	136	725
10,000	12	737
50,000	4	741
100,000	3	744
Total	**744**	

For online events, the minimum number of participants is 0 and the maximum number is more than 1,340,000 with an average of 173,514 (median 40). A quarter of the online events had less than 40 participants and a quarter also had more than 80,000 participants online.

Table 6 Descriptive statistics for online events only

Min participants	0
Max participants	1,340,037
Average # of participants	173,514
Median of participants	40
25% quantile	40
75% quantile	80,000

Table 7 Size distribution per number of participant classes

# of participants	*# of events*	*# of events (cumulative)*
na	2	
10	2	4
50	7	11
100	2	13
1,000	1	14
10,000	1	15
50,000	0	15
100,000	1	16
500,000	1	17
1,000,000	2	19
1,500,000	1	20
Total	**20**	

2.3 Analysis per event type

The analysis of the data shows that exhibitions and workshops are the largest classes of event types followed by science-cafés, conferences etc.

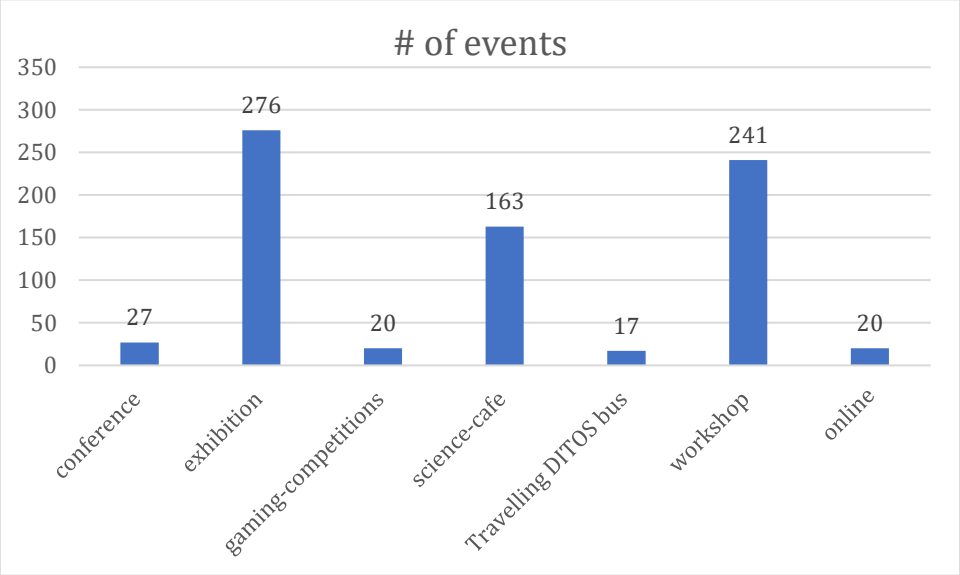

Figure 4 Number of events per event type

In terms of participants in the events, the largest number is the online events followed by exhibitions, workshops, gaming competitions, science-cafés, conferences, and the DITOs bus.

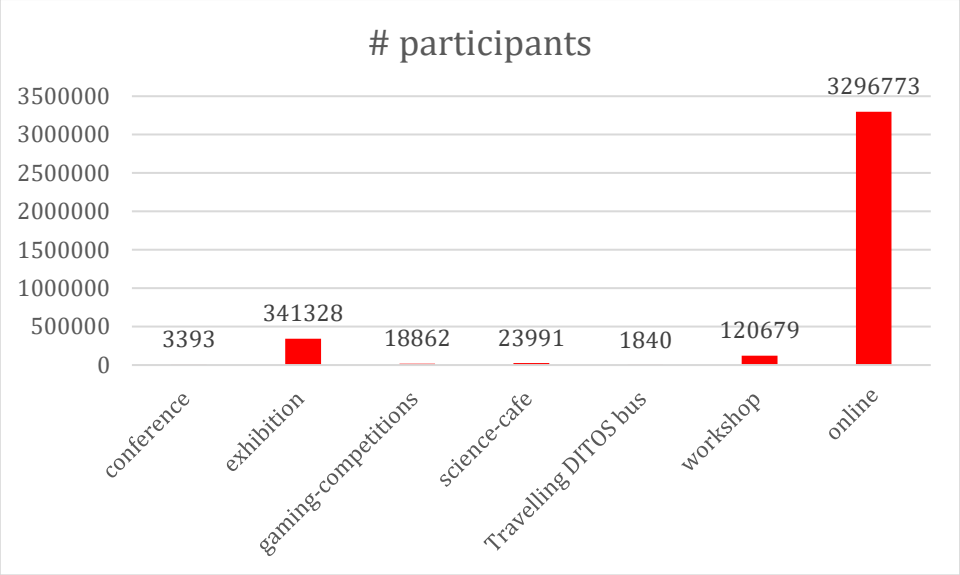

Figure 5 Number of participants per event type

The following figure depicts the same data, but without the online events.

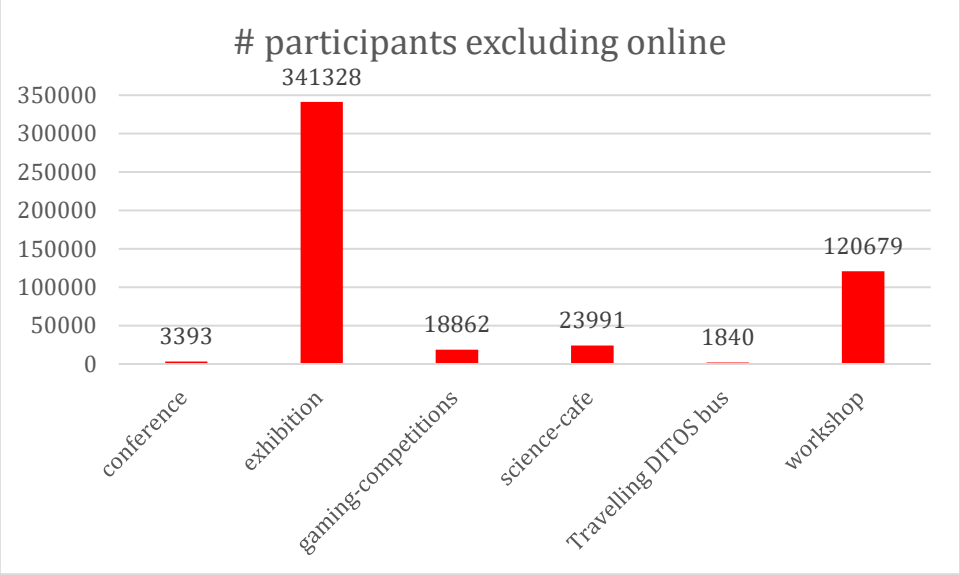

Figure 6 Number of participants per event type (excluding online events)

The data underlines that online events and exhibitions are instruments to reach out to large audiences. Both types of events are typically in place for longer periods and online events have the added advantage of not being bound to specific locations.

In addition to reaching broad audiences, DITOs placed strong emphasis on interactive events. The large number of participants in DITOs workshops (more than 120,000 people) exemplifies that it is also possible to reach broad audiences with

interactive formats. The majority of DITOs events were interactive (only counting workshops, science cafés, the bus, and gaming competitions). Online events vary in their degree of level of interaction while exhibitions and conferences are typically more unidirectional.

The DITOs bus reached the smallest number of participants. However, it did so in sometimes remote areas and places that may not have easy access to scientific museums or other citizen-science project spaces, and therefore increased the inclusiveness and reach of the audience.

2.4 Analysis per country

The following table provides all the data for events excluding online events for which countries could be reliably identified. The table lists event participants per country and number of events per event type per country. The table also includes information about the percentage of female participants. A more detailed analysis of gender information is provided further below in this section.

Table 8 Event participants per country and per type of event (excluding online events, NA= unavailable data)

	# of events	*# participants*	*% female*	*conference*	*exhibition*	*gaming-competition*	*science-cafe*	*Travelling DITOS bus*	*workshop*	***Total***
BE	343	438,499	50,0	3	265	0	48	1	26	**343**
UK	104	8,980	51,3	8	4	0	20	5	67	**104**
NL	63	1,078	43,4	0	0	0	43	2	18	**63**
SI	65	6,941	51,6	0	5	4	13	1	42	**65**
FR	50	18,603	50,7	3	0	14	0	1	32	**50**
CH	34	23,227	63,3	3	0	2	24	1	4	**34**
PL	20	1,006	50,4	1	0	0	13	0	6	**20**
ES	18	6,838	49,2	2	2	0	0	1	13	**18**
DE	11	1,063	61,9	4	0	0	0	3	4	**11**
IT	9	807	48,4	0	0	0	0	2	7	**9**
PT	4	750	55,3	0	0	0	0	0	4	**4**
US	4	995	59,2	2	0	0	1	0	1	**4**
IE	4	50	39,5	0	0	0	0	0	4	**4**
NA	10	1,133	na	1	0	0	1	0	8	**10**
DK	2	28	55,7	0	0	0	0	0	2	**2**
AT	1	55	30,0	0	0	0	0	0	1	**1**
LU	1	10	60,0	0	0	0	0	0	1	**1**
IL	1	30	50,0	0	0	0	0	0	1	**1**
Total	**744**	**5,10,093**		**27**	**276**	**20**	**163**	**17**	**241**	**744**

Sorting the data by number of events per country results in the following figures.

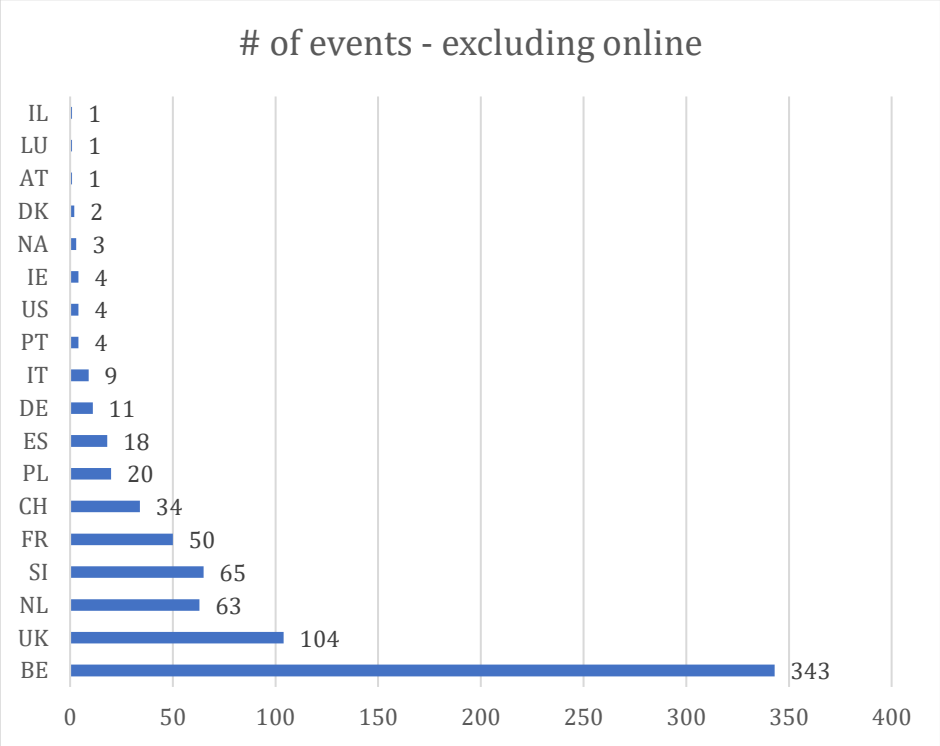

Figure 7 Number of events per country excluding online events

The large number of events and event participants in Belgium is due to the organisation of the Experilab event series spread over the whole country and exhibitions at the Natural History Museum in Brussels that attracted very large crowds, making it one of the major activities of DITOs.

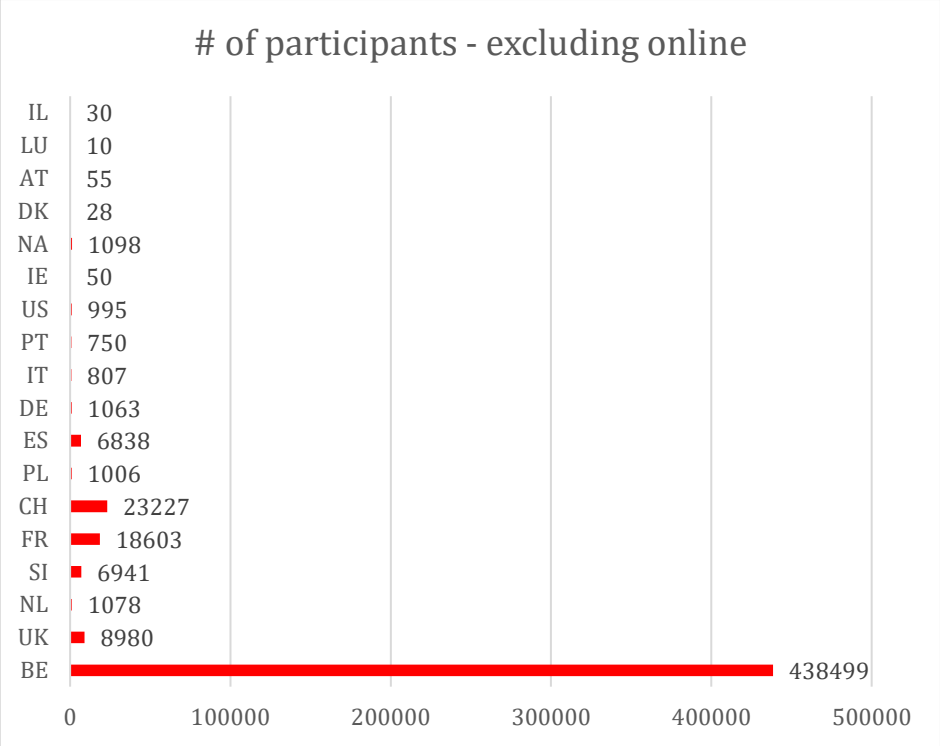

Figure 8 Event participants per country excluding online events

The following figure provides a graphical overview of all events per country per type of event (excluding online events).

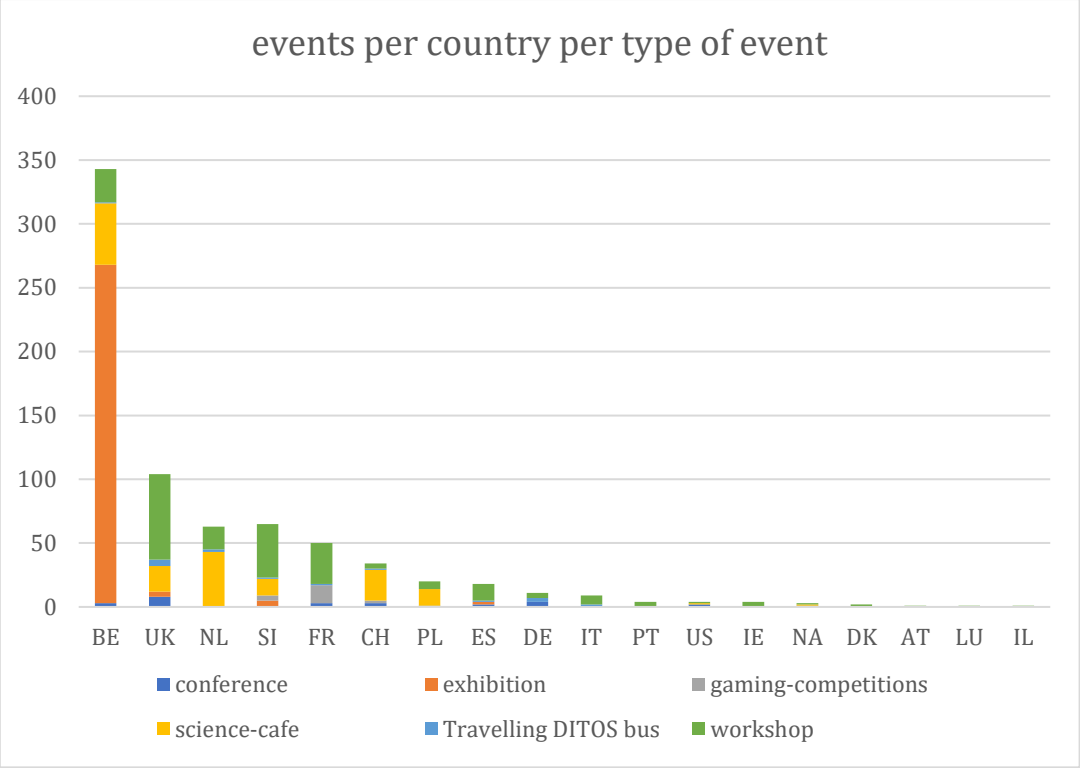

Figure 9 Events per country and per event type excluding online events)

2.5 Events per work package

In terms of work packages, the following table lists number of events and number of participants per organising work package excluding event type 'online'. It also lists the percentage of female participation. Noteworthy is that most events cannot be exclusively linked to a single work package (e.g. public facing environmental sustainability activities link to WP2 and WP3).

Table 9 Number of events, number of participants and percent female participants per DITOs work package (excluding online), na=not available

Work packages (excluding online)	*# of events*	*# participants*
na	1	1,028
WP1	182	49,006
WP2	472	455,666
WP3	62	3,265
WP4	27	1,128
Total	**744**	**510,093**

The following figure depicts WP data in percent of all events (excluding online events).

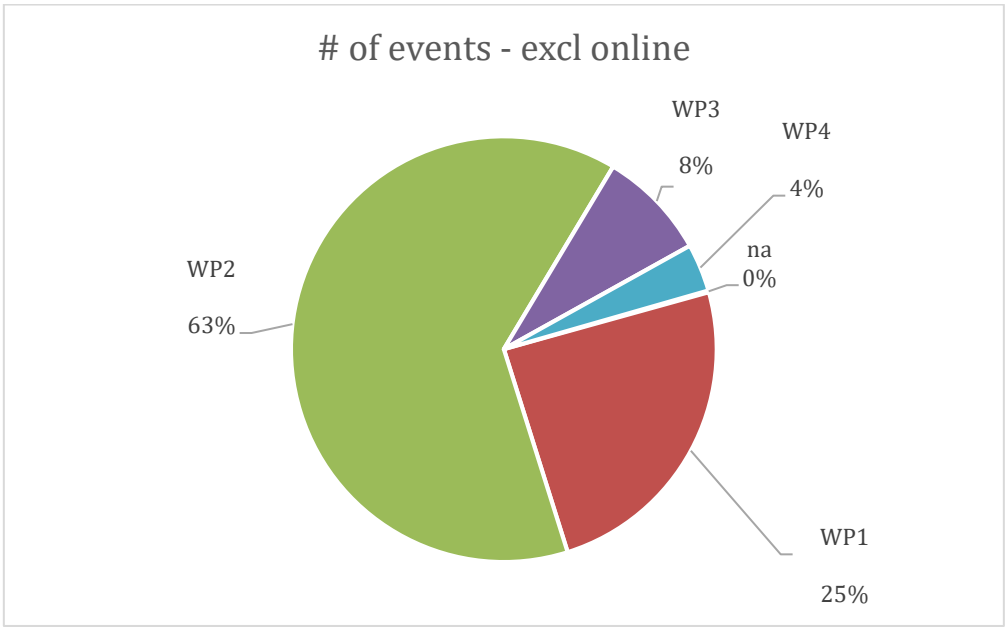

Figure 10 Number of events, number of participants, and percent female participants per DITOs work package in percent of total number of events excluding online, na=not available.

The following figure depicts WP data in percent of all participants (excluding online events).

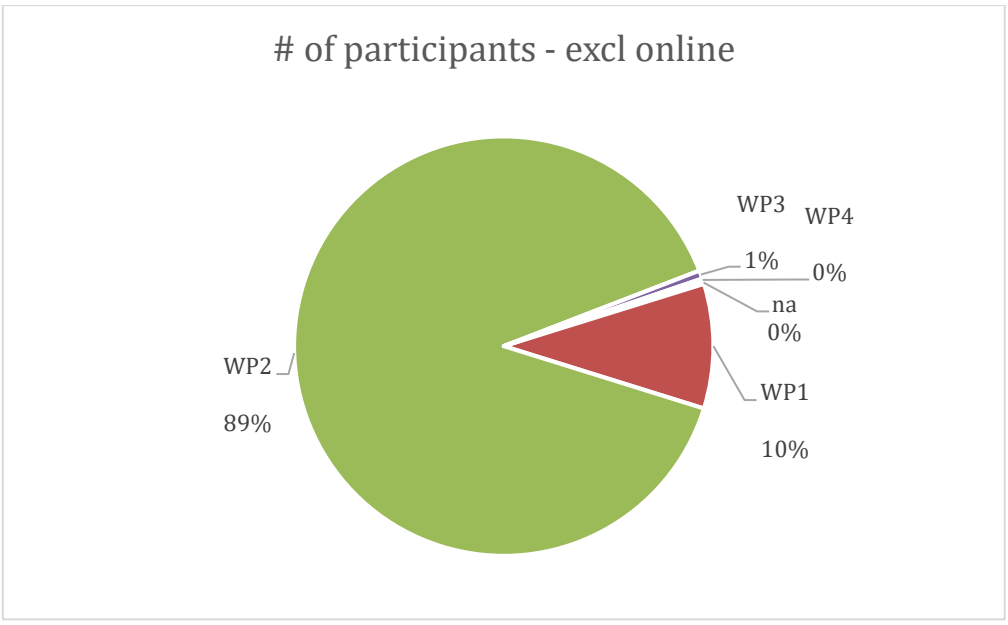

Figure 11 Number of participants per organizing work package excluding online events in percent of total

Comparing both diagrams it becomes clear that WP2 organized two thirds of the events, but reached nearly 90% of participants in physical events. This is mostly due to the large number of participants in some exhibitions, but also large conferences.

The following table presents the corresponding values for online events.

Table 10 Number of events and number of participants for DITOs online events.

Work packages (online only)	*# of events*	*# participants*
na	0	0
WP1	0	0
WP2	1	75
WP3	19	3,296,698
WP4	0	0
Total	**20**	**3,296,773**

It is obvious that WP3 dominates in number of participants as it included online events with enormous outreach and only a single online event happened as part of WP2.

2.6 Age distribution

For most events, it is also possible to study age distribution. In most cases, age of participants is based on information from the facilitators. Some events were also limited to specific age groups, e.g. children under a specified age limit. In a few cases, age information is based on participant questionnaires. The following table lists the events per age class of the age for the oldest participants (upper age limit) – for events excluding event type *online* (with *na* including the events for which no age distribution is given in the events database). **This table (and the rest of the section) should be assessed as a general indication and not as strong evidence of participation, since event organisers are asked to provide information on the age range of participants – bottom and top, without much indication about distribution.**

Table 11 DITOs events age distribution excluding online events

# age limits	*# of events*	*# of events (cumulative)*
na	67	67
10	4	71
12	185	256
15	89	345
20	31	376
30	4	380
40	37	417
50	50	467
60	93	560
70	84	644
80	85	729
90	8	737
100	7	744
Total	**744**	

For example, 256 events had participants that were younger than or 12 years old or where data is unavailable. Four events had an upper age limit of 10 years, i.e. clearly targeted kids up to 10.

The following figure shows that there are two apparent peaks in the age distribution: one large group of events targeting mostly kids or young adults up to around 20. Then, there is another peak of events that included participants up to 50-80. A possible explanation is a small participation of working adults in the events and a recurring interest in science in retirement.

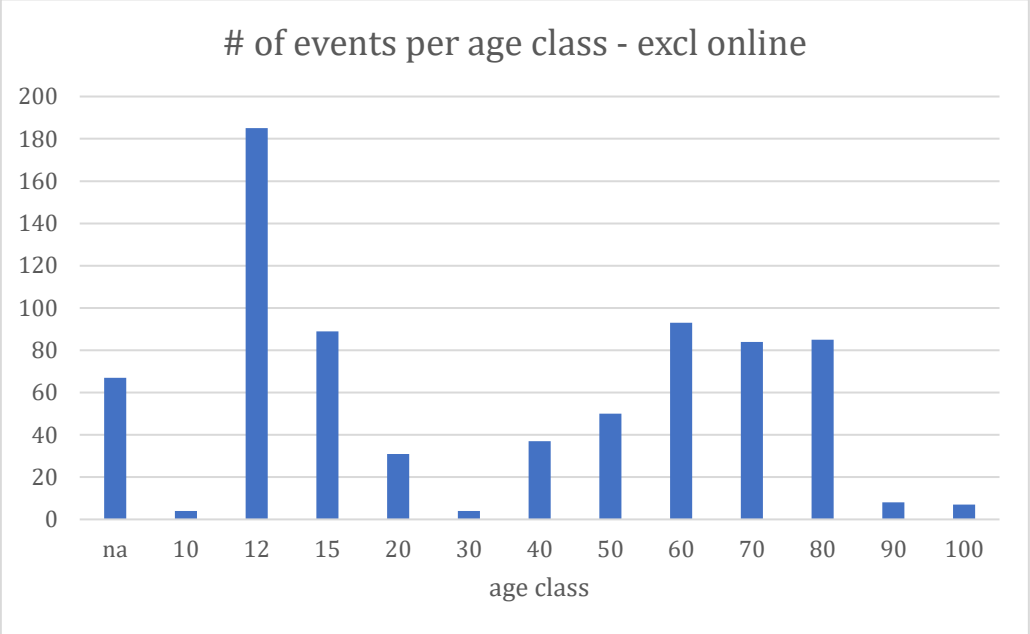

Figure 12 Number of events per age class excluding online (na data not available)

The following figure shows the same data in cumulative form. It shows that approximately 450 events (and thus approximately half of the events) had participants younger than around 45 years, similarly for other quantiles.

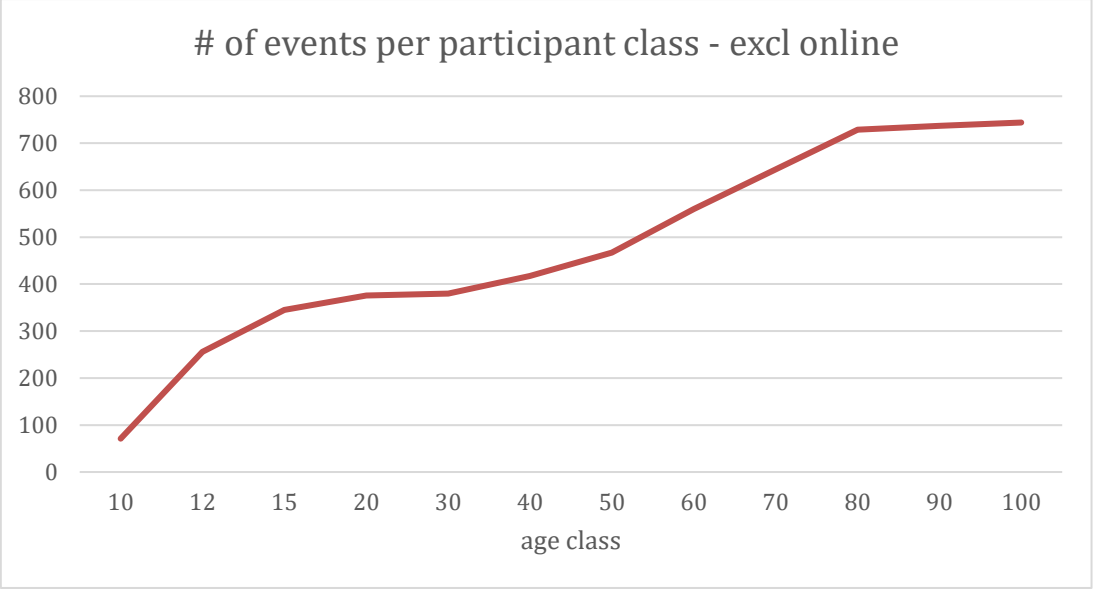

Figure 13 Cumulative number of events by age class excluding online events.

The following figure depicts the age data in percentages: Around a quarter of the events had an upper age limit for participants of twelve years.

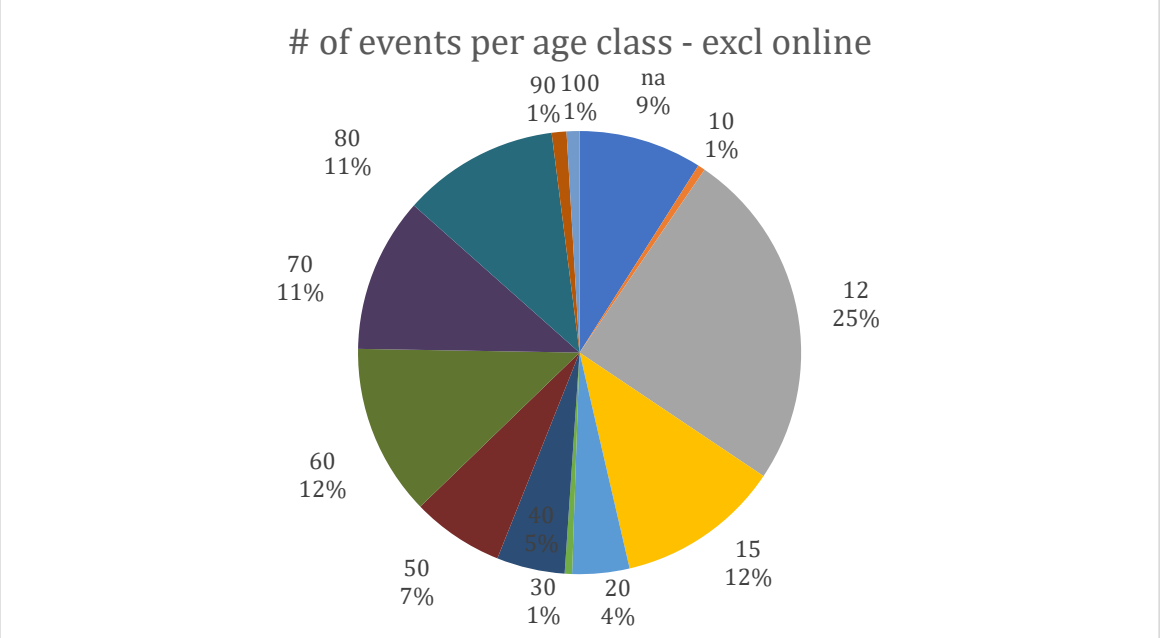

Figure 14 Number of events per age group (maximum age shown) in percent of total events excluding online events.

For online events only, the following table shows the age distribution. It is less informative due to many events missing age group data and a much smaller number of events.

Table 12 Number of events per age class for online events (absolute and cumulative).

# age limits	*# of events*	*# of events (cumulative)*
na	11	11
10	0	11
12	0	11
15	0	11
20	1	12
30	0	12
40	0	12
50	1	13
60	2	15
70	0	15
80	0	15
90	4	19
100	1	20
Total	**20**	

2.7 Gender distribution

Participant gender information is only available for events excluding event type ‘online’. Again, for most events, gender distribution is based on estimates from the event facilitators or organisers. For some events, gender information is based on participants questionnaires data. Note that the following figure shows a relatively equal distribution between just under 40% and just over 60% females. The age-axis has been scaled to emphasise any differences in gender participation.

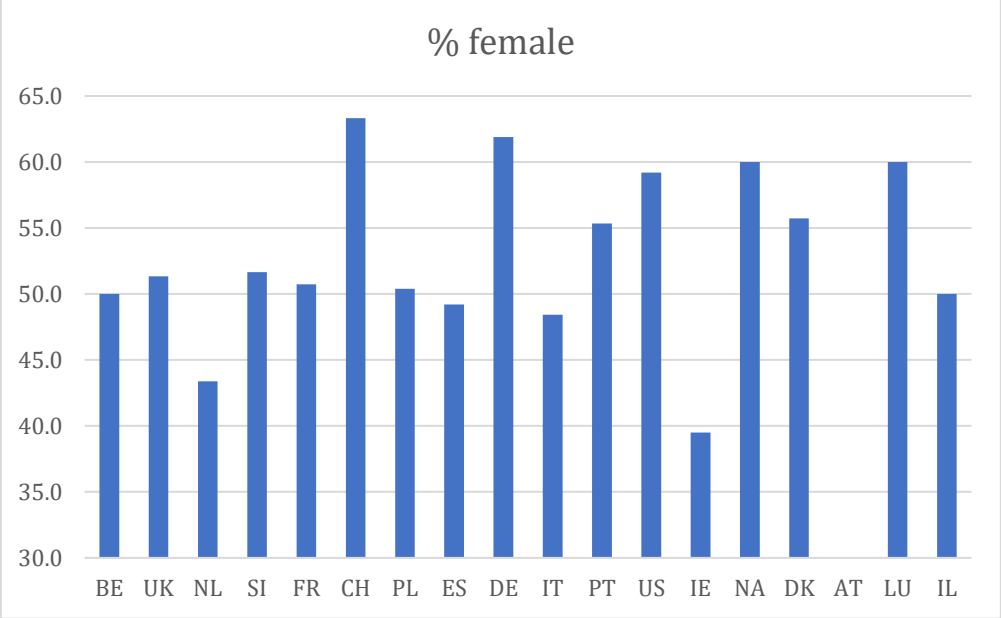

Figure 15 Percent female participation in events per country. No relevant data for the Austrian policy round table in the reporting period. Note the scaling between 30% and 65%.

Interestingly, some higher percentages of female event participation come from Switzerland, Germany, and Luxemburg – where traditionally female STEM (science, technology, engineering and mathematics) student rates are lower than average in Europe. Female participation per work package only varies between about 50% (WP2) and 59% (WP1).

Table 13 Percent female participation per DITOs work package (excluding online events)

Work packages (excluding online)	*# of events*	*# participants*	***% female***
na	1	1,028	**na**
WP1	182	49,006	**59.1**
WP2	472	455,666	**50.0**
WP3	62	3,265	**57.1**
WP4	27	1,128	**52.9**
Total	744	510,093	

The slightly higher percentage of female participation in work package one may be to the science cafés. This effect outweighs the fact that WP1 also includes the gaming competitions that attracted fewer females.

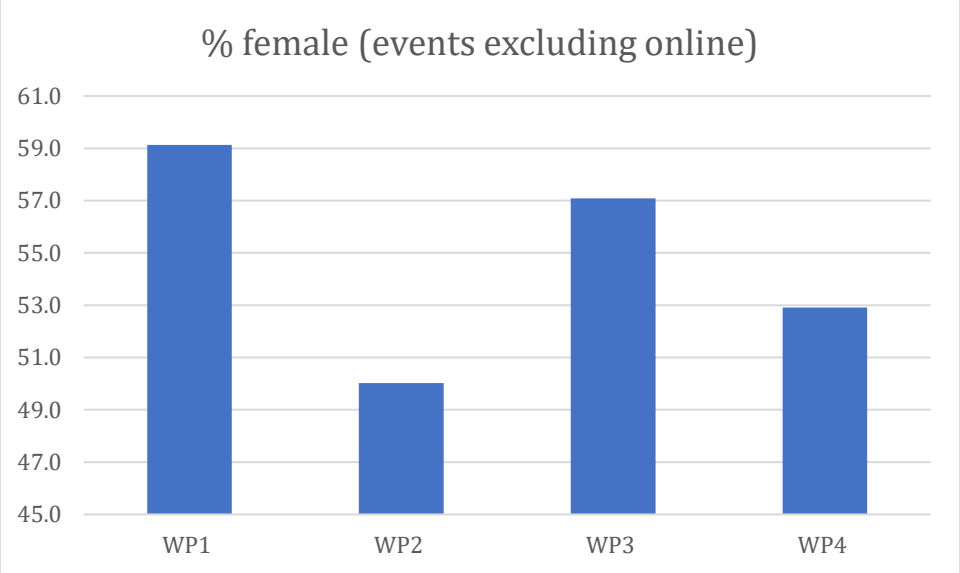

Figure 16 Percent of female participants per work package excluding online events. Note the scaling between 45% and 61%.

Our evaluation also shows no apparent relevant difference for female participation depending on the gender of the event facilitator:

Table 14 Number of events, number of participants and % female participants per gender (female, male, both and not available) of the event organizer(s), excluding online events.

Facilitator(s) gender	*# of events*	*# of participants*	***% female participants***
Female	399	194,091	**51.5**
Male	207	16,592	**50.1**
Both	89	31,187	**50.6**
na	49	268,223	**50.1**
	744	510,093	

Similarly, female participation per event type is not massively skewed. It ranges from 44.8% for the gaming competitions to 62.1% for science cafés. Female participation is also high for the Travelling DITOs bus with 58.7%.

Table 15 Percent female participants per event type.

Events (all)	*% female*
conference	53.0
exhibition	50.0
gaming-competitions	44.8
science-cafe	62.1
Travelling DITOS bus	58.7
workshop	50.1
online	53.1

This data is depicted in the following figure. It shows a slightly lower female participation in gaming competitions and a higher percentage for science cafés and the DITOs bus.

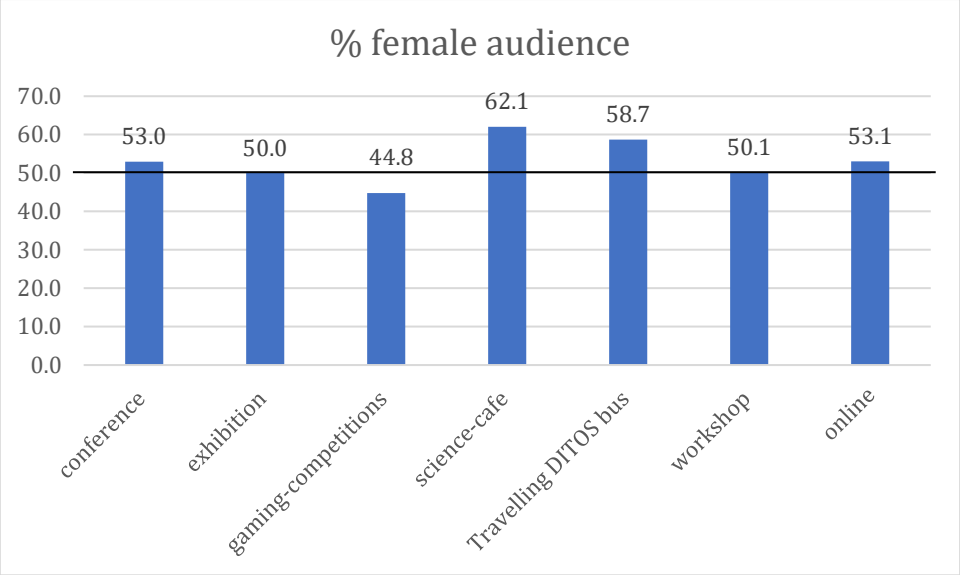

Figure 17 Percentage of female participants per DITOs event type.

Finally, there is no significant difference between the first and second project period in terms of female participation.

Table 16 Female participation per project reporting period over all events for which gender information is available.

Excluding online	*% female*
Reporting period 1 M1 - M15	50.78
Reporting period 2 M16 - M36	50.90

2.8 Summative evaluation: Conclusions and limitations

With *more than 3.8 million people*, DITOs reached an enormous number of participants. Events were organised in 18 countries - 15 EU member states, Switzerland, the USA, and Israel. Belgium saw the largest number of events followed by the UK, Slovenia, and the Netherlands.

Counting workshops, science-cafés, gaming competitions and the travelling DITOs bus, more than half of the DITOs events (441) used *highly interactive formats* involving 165,372 citizens.

DITOs events reached people of all ages. Younger ages (up to about 20 years) and those aged 50-80 were most present.

For DITOs, it is interesting to note that gender participation neither depended on the event facilitator's gender nor did it vary much between event types. If anything, gaming competitions attracted slightly fewer females while science-cafés and the DITOs bus attracted more women. Female participation varied, however, significantly between different countries. Our results seem to be in line with other studies demonstrating major difficulties to attract women to science studies, for example, in German-speaking countries (Kröll 2010).

In summary, DITOs went far beyond its original objectives, both in the total number of events and in the number of participants. Events covered a wide geographical area with many events also taking place outside the countries of the consortium members. Note that the wider impact of DITOs is covered in more detail in the DITOs final report and other deliverables, in particular D3.3.

Summative evaluation is the most frequently chosen approach to evaluation in general and citizen science is no exception. Summative evaluation in the form that is described in this document provides an indication of general achievement. In the case of DITOs and other publicly funded programmes, it also provides important information about goal achievement. Summative evaluation can also provide important insights in statistical aspects including certain dependencies.

However, summative evaluation has a limited scope; it does not cover many of the key learning points of DITOs. Event and participant figures tell us very little about the quality of the event or facilitators' roles in this. Summative evaluation also tell us nothing about individual pathways of event participants. Summative figures cannot step outside the limitations of the pre-defined observables (such as event and participation numbers, gender, location etc.) and have no means of critically investigating the outreach and involvement processes themselves. Hence, our approach for evaluation in DITOs brought together complementary forms of evaluation: formative and ethnographic. We now move onto formative evaluation.

3 Formative evaluation

This section summarises the results from reflective conversations with partners on their main lessons learned and advice on the practice of facilitating science events. This is specifically on the topics of accessibility, inclusion, context-based tailoring, excellence in support and facilitation, integration of local and scientific knowledge, and policy and institutional support.

The analysis and conclusions are based on interviews with DITOs event facilitators and organisers and at times on (participatory) observation. They include analysis of interviews from the first two project periods. The following therefore presents lessons learned and key notes on participatory engagement.

3.1 Lessons learnt

3.1.1 Accessibility: making science and technology accessible

Throughout their journey in the project, DITOs partners have experimented with range of topics, methods, materials, and settings to deliver their activities. For partners, a 3-year project has meant (both as facilitators and as representatives of their respective organisations) a unique opportunity to explore different ways of making scientific methods and tools accessible to a range of audiences. Their reflections and lessons learnt on accessibility include: designing for hands-on learning focusing on topics of interest to participants audience, collaborating with complementary organisations, and having patience.

Partners agree that hands-on activities that focus on topics "*close to home*" and that are directly relevant to people's lives are the most effective way to "*open up science*". It is "*by taking an active role – the philosophy of doing-it-together and DIY*", when participants can see that they are able to carry out experiments, make their own measurements, and test their own hypothesis that activities have the most impact in making science and technology accessible. As one facilitator reflected: "*education based on projects empowers citizens*". Some partners reflect on that having a range of events does expose people to science topics but that more passive events, which do not go into depth, do not necessarily make science more accessible. Others mention that because people learn in different ways: listening, touching, watching, etc. providing a range of events does make science more accessible. This holds true only for returnees who get to experience 'the range'. In terms of providing access to scientific understanding, a facilitator notes that science events "*do not replace theory or science learning – it complements it and extends it*" by fostering a "*critical thinking mindset: being curious and giving a taste of exploration hands-on*".

Naturally, facilitators designed their events based on their own orientations and strengths. For example, employing pedagogical approaches "*placing the participant as investigator*" or taking an action-oriented and "*topic-specific, bottom-up approach*" such as with air quality in communities, where pollution is a major concern and

people are motivated to take action. Partners agree that exchanges between facilitators enabled them to learn from each other and expand their perspectives and orientations and complement their strengths. For example, those who were action-oriented learnt to appreciate the importance of method (and patience) in following protocols and testing hypotheses – which, they implemented into the design of their events. This extension of experience, facilitators' comment, 'equips' them with a wider range of approaches to make science more accessible (cf. DITOs deliverable D2.3).

To design for accessibility, partners also advise - especially to those who do not have a science background – to partner and create a collaborative effort with practitioners or organisations who bring a strong scientific background but who also have sensitivity for science learning. They note that these are not to be 'tokenistic' partnerships e.g. as might happen between arts and science, policy experts and technologist, or community organisers and natural scientists but one that begins with discussions and co-design of facilitation methodologies. Bringing together these different 'profiles' takes patience and effort to explore mutual benefit and find common ground, to situate each other, explore each other's methodology. If achieved, the collaboration can result in science events with more depth. However, this can present an issue with project timeframes and budget limitations. Another aspect of making science and technology accessible through science events is to adjust terminology and settings, which leads onto the next topic: inclusion.

3.1.2 Inclusivity: making events / organisations more inclusive

All partners have rules of thumb for inclusion in event design and act as moderators and conscious observers making sure everyone gets time to speak and everyone feels comfortable and welcome. However, other aspects highlighted by partners are that creating inclusion begins within the organisation/team/facilitator making sense of the terms they are promoting and then designing events around that. They also highlight that inclusion means starting with the needs/interests of participants but that to be inclusive you need to be also exclusive.

Citizen science and public engagement in science have different meanings and recognitions around Europe. Some partners' first steps in delivering the project was to make sense of the various terms they needed to use, for example 'biodesign'. Partners "*were quite aware that many different stories had to be told – organisation and project-wise […] to welcome people into an activity and to draft the information that would be provided beforehand*". For some partners 'citizen science' and 'participatory science' was not an established term or does not have a direct translation into their language. In one case, the closest translation was a "*problem because a political party had the same name*". Partners note that after several iterations, they "*got better at it*" and their advice is that "*you need to invest [time and effort] in crafting the story" and "come together often as a team – as a consortium – to share and discuss these stories*". Partners felt that the consortium would have liked to dedicate more time to this but that there was limited time and stamina left after administrative tasks had been covered at face-to-face consortium meetings.

For other partners the term ‘citizen science’ is a barrier in itself as its terms are already charged with meaning. “*Science puts people off – they run away from it because they disliked it in school. We repel people.*” Several partners have overcome this by not employing the terms ‘science’: “*we just dive into it and even give it fun names*”. One partner notes that audiences have different expectations from events and that while some are looking for something fun, others want more seriousness and depth “*so as we learn this we design different elements into events that are both fun and intellectually engaging and as time goes by, we move to more hands-on activities*”.

Partners also highlight trust and building sustained relationships as an important element of inclusion. One partner noted “*instead of expecting people to come to us, we have to go to them but first we have to agree with them how we can work together, and this takes several months*” as you build a network built on trust at the grassroots level. Following this strategy, inclusion is considered a continuous effort of relationship building that endeavours to be relevant to participants’ lives: “y*ou have to first reach out to groups and communities – go to their gatherings – at schools or universities […] and be quite active and constant and not just giving announcements and sending articles – purely PR – but also being there to be known to show what you bring.*” This includes subjects or tools that complement their own work / needs. For example, promoting gender inclusion or serving as platforms to bring groups together e.g. academics and high schools. Other partners note that to reach some audiences you need to go through their children through playful and educational activities. For others, inclusion is about openness and flexibility: “*when I organise events I do not dictate what should be done; I invite others to present and share their work and include it to enrich the conversation. They run small workshops as part of the event. This enables creating a little community around topics that can lead to bigger or more established outputs like a policy brief or an event or extension of their work*”.

Ultimately, partners suggest that to make science events inclusive you need to go out and listen to your audience. It also involves immersing into the work of local organisations and community organisations and then design activities together. As noted above, local partnerships can provide gateways into new audiences. The resulting co-hosted events can be “*rooted in the needs of the people in that community*” and create “*something that can be useful for their needs*”. However, a partner notes that the fact that activities were already dictated in the DOA makes the project a “*top-down project*”. They reflect on that to be truly accountable to the public funds given by the EC we should design events based on the needs of the citizens.

Another partner notes that to be inclusive you need to be exclusive e.g. work with some organisations leaving out others, or create safe spaces for women only, or speak the participants’ terms, which may leave out some audiences, and even break some traditional rules. For example, one partner working with high school students decided to use tools that are part of their lives: “*usually teachers ask them to put their phones away but here we integrated it into the workshop methodology. They use it to communicate, share, learn, and ask questions about what they were doing. In this case, a communication channel was exciting and built networks. It was a great*

way to connect with other students too who then started following me and invited me to their schools to do workshops there". Hence, 'inclusion' is not something you can provide simple or clear guidance on – it is context-specific, which leads to the next section.

3.1.3 Context-based tailoring for event design

For all partners events were changed when iterated. They designed events tailored to their audiences, especially if they were recurring events such as cafes or film nights or longer-term events such as academies or trainings. For policy events, *"the number one driving factor in design is the outcome*". However, facilitators note that a shortcoming of the project is that the purpose of the round tables is very vague as is the purpose and audience of the policy briefs: "*they do not have a clear target audience*".

Science cafes were adapted and changed according to the topics or the type of people attending. For examples, the design for controversial topics required additional moderation and more space for discussion, a more relaxed setting, and additional refreshments; recurring cafes would have new and previous attendees and hence, facilitators adapted the events to provide novelty to previous attendees while also making new ones feel welcomed and part of the group. One partner would ask attendees about their previous experience with the tools/topic of the event and paired attendees so that 'experts' would mentor or help 'novices' during technical workshops. Partners also learnt from direct feedback from participants and from other partners changed the design of their events accordingly. For example, events combined discussions and hands-on to enrich learning experiences and provide the opportunity to put 'theory' into practice or to discuss the applications, implications, or limitations of the tools or devices they worked on hands-on. Also, for events involving data collection or that were action-driven, proceeding events were exclusively to address the groups' needs. Some events also adapted organically, where a receptive facilitator, sensitive of the groups' needs, adapted events as opportunities and needs arose. For example, an event would begin by introducing the topic of Air Quality and the tools to collect data (e.g. diffusion tubes), and as participants went out to gather data, the facilitator created a Facebook group that allowed people to share and discuss their activities and pose questions. These would then advance the conversation and the face to face event would draw on those online discussions. Events were also adapted to fit with other events to reach new audiences such as organising satellite events linked to conferences or taking a more market-style approach. For example, one facilitator was able to reach audiences whom they might have never reached when they linked their event to a Christmas market, which attracted people from around the country. The facilitator notes "*but we did not call it science because for some there are barriers against science or using scientific terms or language. So, we marketed it through the theme of the Expo and the context of making Christmas gifts while making events relevant to their lives*".

Events which lasted several months (e.g. academies and training events) had a set format, but "*no session was like any other*" as "*people start to get to know each other and move forward as group, and inevitably shape the events based on this*". Also, those who partook in community action shaped the events as their interests and objectives became more focused.

A main insight and lesson learnt was that to be inclusive, accessible, and to truly reflect the local context, you need start by meeting the audience or communities to build a relationship so that you can understand their needs in their own terms: "*you need to look for the audience before you look for your topic; it is a flaw of EU projects to do it backwards – but we need to take this into account to shape the rules of the EU project structures*". But partners also reflect that the adaptability and flexibility that enables 'context-based tailoring' takes time and experience and it is essential to making an event successful, which is the topic of the next section.

3.1.4 Excellence in support and facilitation

This topic has been covered in the research brief 'D4.2 RRI indicators that reflect practice' and more in-depth guidance is given in deliverable D2.3. Here the focus is on how partners' reflection on what makes an event successful.

One important aspect of 'excellence' is success, as highlighted by Strand et al. (2015). Partners/facilitators can tell if their event design strategies have been successful when people stay longer than the event was scheduled for and are having engaged conversations, when they keep coming back and bring others along, or ask how they can get involved or organise their own event: "*we know we've done something right when people say that they want to get involved personally because they want to be part of it*". You also know, as facilitator that you have had impact "*when you are invited by ministries to design an exhibition […] you can see the snowball effect*".

The main reflection from partners is that, as one facilitator notes "*you have to be a good observer and have a good understanding of your audience – but this takes time and patience*". As facilitators gain experience and become sensitised to the needs and reactions of the audiences, they are better able to incorporate feedback and "*use their notions as suggestions to change the programme but without sacrificing your own image and identity – as institution and oneself – and prototype in every event, to try to improve based on previous events*". Another lesson learned is to not have a fixed programme or to be very flexible "*because activities keep changing – especially if you have repeat audiences you have to grow with them to include them as new ones join*". Facilitators also suggest "*talk to participants – get evaluations from them one on one so that they feel listened to*". While getting feedback from participants is important, one facilitator notes that filling out forms censors participants "*especially if they feel they are going to influence the event. It is a psychological effect of evaluation so try to keep evaluation as intimate as possible to get their thoughts directly and to gain a true image of what happened*" and to be able to ask for clarifications. Several partners integrated evaluation into their practice as

'group check outs' to share and reflect as a group what they have gain and what was missing from the event.

Another more subtle aspect of 'excellence' in facilitation is 'reflective practice'. Partners note that they valued having one on one time to share and reflect about their work:

- "*Sometimes I felt like I was running, running, running, and sometimes without giving time to reflect and so one of the things I value from the project was the facilitator interviews - just like pressing 'pause' and just talking freely about what is going on and reflect*".
- "*Another thing that I have learnt is the fundamental value of having these interviews - from the very beginning of the project. And then summarising this to share with the rest of the group. These conversations allow you to reflect on your work - you use this knowledge for future activities*".

A partner notes that you "*need to ask yourself difficult questions - you need to have good set of questions ready that can guide you to design a proper thing for people - a guide for future projects*". This helps to "*identify the incoherencies and inconsistencies that we have throughout the project, which could have been solved*" making the next project likely better and more coherent. One example of this is "*the need for a website in English when people work in different languages*" or questioning the purpose of citizen science "*is it about people or is it about science - or both?*"

3.1.5 Integration of local and scientific knowledge: bringing together different perspectives

For partners, bringing local and scientific knowledge together requires several considerations: from event setting and co-design to tactful selection of guest speakers/experts and considerations for identity, image and reputation.

One aspect that helped partners to bring participant and scientific perspectives together was to design their event settings to "*make people feel that they can enter the discussion and ask questions*". This includes arrangement of the room and placing of seating to create welcoming environments but also communicating openness through body language. Partners also worked through defining their roles and situating themselves as mediators, facilitators or "*as connectors*" in their events and as such take on responsibilities to enable links between different perspectives. Facilitators also use 'ice breaking' or 'checking in' activities at the beginning of an event so that they and their guest scientists get a general feel for participants' expectations, interest in the topic, or previous experience. This then guides the facilitators' and guest's next steps in opening up the topic. As noted above, it requires skill in observation and listening to take what participants share and integrate it (spontaneously) into the design of the event. Part of being a 'connector' between scientists and the audience is that "*you also have to learn to speak their language and translate meanings of fringe action to them too*".

For some partners bringing perspectives together is about creating arenas or mediating 'discussion platforms' where people can share stories and represent their own organisations or "*have a space for them to bring in and contribute something*" to the discussion. For example, in workshops that require explaining and working through a scientific protocol and identifying a hypothesis, the facilitators ask participants if they find parallels in their work / personal life and are then invited to design hypotheses based on their own knowledge and observations. Other partners create arenas where guests can share their stories from their own perspectives and it is through stories that they are able to invite the audience to enter their world.

A partner notes that because of the nature of our events, bringing together local community and scientific knowledges was very limited. One partner organised a citizen science event gathering air quality data with a specific community. Together they discussed with local residents where the data should be collected based on their own interests, concerns, and understanding of their local neighbourhood. Other partners' approaches are to take what it known about a topic and discuss how it applies in the local perspective. One partner calls this 'localisation' and mostly applies to round table or policy events.

Some partners also take into account the potential consequences to their guests when inviting them – whether that be in the science or policy fields. One partner recommends thinking about the profile of your guests – especially when addressing controversial topics: "*We bring specialists that have a long and deep career – established academics – those whose careers are no longer under threat*". When working with younger or early career researchers one partner recommends building a connection and explore step by step what you want to achieve through the event and what the consequences of their involvement might be. When profiling for guests, partners also recommend studying their previous public engagement experience and approaches "*which are different in different professions*" and to considering international perspectives – and to explore both the pros and the cons of their involvement.

3.1.6 Policy and institutional support

Following from reflections on excellence in support and facilitation, some partners noted that because the administrative demands from the EC are so high, the focus of the project meetings is dominated by them – coordination of partners to try to fulfil these demands. This has meant that limited focus was given to discussing important aspect of actually doing the project and what it means to do it successfully. It has also meant that partners are left feeling disconnected from each other and "*undervalued and underappreciated*" for the engagement work they have done. Specifically, partners note that using consortium meetings (both calls and face-to-face) to discuss administrative tasks and placing them as the first points on the agenda "*drains any enthusiasm and inspiration that could be used to share experiences*" amongst facilitators and learn from one another.

A main lesson learnt on the side of institutional support – especially for coordinators and partners in EC projects is to separate discussions on administrative work from

delivery work and to design projects with dedicated spaces for exchange and sharing between partners. This should be combined with workshops early on in the project on how to fulfil administrative paperwork such as interim reports and create a joint plan to not only gather the necessary information but also make it useful to discuss project delivery and avoid it becoming burdensome.

A unique aspect of DITOs that partners highlight is that while several of them felt lonely and/or with limited support within their own organisations, they felt inspired and greatly supported by consortium partners: "*I might have felt lonely at my organisation but found support and care in DITOs partners*".

With regard to policy support, partners note that they had limited impact and that their efforts were mostly "*about raising awareness telling different policy makers about citizen science and what it is about*". For one particular partner, people who attended their workshop then became involved in city council. They note "*we invited different kinds of people to our activities so it might be coincidence and I think we had many people attending who wanted to take action already – move toward being city councillors or vice mayors; they had motives already and maybe having come to our events was one of these*".

Partners advice is to recognise that policy engagement is going to be a long process and that "*it will not happen in a year or two or because you have an EU project; you have to in small doses and build up your rapport and be conscious about your approaches and who you talk to*". The policy arena can be relatively small and this latter point is especially recommended for those in smaller countries. One partner notes that some policy makers are "*very reluctant and want to do things the safe way but if you present them with work slowly like through a policy brief and let it simmer – for a few years – and then they come back with their own ideas, which were our own ideas but now they have worked through them*". Another point of advice and lesson learnt is to involve their children: "*If their children are involved in our projects then there is common ground and there a way in because they want to support what their children are doing*".

Another partner recommends to "*go local; the closer the more effective – municipal level. Politics must be designed with a bottom up approach – with an understanding of local situations*". Local authorities "*are more interested and flexible and willing to listen because they are not so big*". It is not until you are able to demonstrate "*have amazingly large social and scientific results that then we can go to the national level*".

From a higher-level perspective, one partner notes that "*it is important to set up an EU structure to ensure that a high-level impact occurs. Even if the commission did not pay for all of the events it ensured, as an umbrella, that they happened - it was a guarantee*". Hence, working more closely with the EC now that the project has been highlighted, it is important to continue to establish that support structure.

3.2 Formative evaluation: Conclusions and reflections on enhancing an evaluation framework

As noted in the introduction, traditional approaches to evaluation have a strong focus on quality – usually measured and expected in numbers. This is not to say that, for example, tracking numbers of participants, number of women, or number of events per type is not important. It is very useful because conveys patterns, as we have seen in the summative evaluation section. Formative evaluation, as carried out for DITOs offers a conceptualisation, comprehension, and conveying of quality by capturing change. Capturing change in the life of people involved in a project requires detailed, in-depth, and holistic descriptions that represent people in their own terms. In addition, the focus on partner organisations and facilitators provides insight into the organisational infrastructure that supports public engagement in science and responsible research and innovation and how it contributes to excellence in science, which is often taken for granted. Formative evaluation, and a qualitative approach that complements summative results provides quality control for the evaluation process. That is, in this evaluation framework, quality is about understanding what people value and the meanings that they attach to their experiences, from their own personal and cultural perspectives (Patton, 2015).

4 Ethnography

This section describes ethnographic observations of both public-facing DITOs events, as well as internal-facing observations of the project process. It highlights detailed and specific narratives in order to raise broader conceptual reflections. Its aim is thus not to evaluate DITOs but raise themes for discussion within the project as well as beyond. Unlike the summative evaluation, this detailed approach can only focus on a small number of instances while unlike the formative evaluation it does not provide a longitudinal overview. The analysis of the findings is divided into three themes that emerged.

4.1 Methodology

The ethnography observed around twenty DITOs public events as well as the internal DITOs process itself across the length of the project. The engagement with the public involved joining in with activities while discussing the events with participants and project organisers. This physical proximity allowed activities, behaviour and actions to be observed as well as enabling a smooth transition to more formal interviews with participants and organisers. This distributed frequency of observations means that this approach has similarities with what has been termed 'quasi-ethnography' (Murtagh, 2007). The internal observation of the DITOs process focused on decision and tension points that occurred during the project, during informal as well as formal meetings. Documenting the internal DITOs dynamics required a position of both inside and outside observer of the project in order to allow reflection on the issues occurring during the project. This allows the ethnographer to observer what Mackenzie (1996) calls '*insider uncertainty*'. Both the ethnographic observations of the public interactions and project process were documented in a research journal, where notes were kept and interviews transcribed. The analysis of this material occurred through a process of clustering and thematic triangulation with fellow DITOs personnel.

Theoretically, the ethnography uses a loose Actor Network Theory approach (Latour, 1987) that pays attention not just on people but also objects and notions as possible actors. This aims to decentralise the position of DITOs organisers and the participants and allow other structures entities to be examined as well.

4.2 Multiple knowledges & publics

This first case study reports on the two science buses of the DITOs project. The official DITOs bus coordinated by the WAAG and the XperiLAB truck hosted by RBINS. Science buses are a common approach used by public museums and science institutions across the world, where they are used to bring scientific 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 and involved buses traveling to rural areas to reach illiterate populations (Ministry of Culture Government of India, 2014), and a 1983 UNESCO report provides a design

manual and organisation advice for science buses (Bose 1983). 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" (*para 3, Ahlstrom, 2000*).* The concept being, that these experiments can illustrate well-established scientific concepts for the students. This requires the experiments to be carefully designed and pre-defined for the right age group and scientific topic focus.

Returning to the DITOs case study, a comparison of the two buses highlights some interesting differences. Both DITOs science buses were specially outfitted and staffed and carried specialised equipment for participatory workshops. The XperiLAB bus 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 bus' stated goal is that the activities should teach the children the inductive method. 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.

The scope and focus of the DITOs science bus coordinated by the Waag was different. It started by recruiting multiple 'science bus captains' from the public to drive the bus across the whole of 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 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 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, 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 my 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 purer and more 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.

As the ethnography 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 classes 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 one their own at home. The bus workshops where thus a physical run-through of the instructable information as guided by the 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 framed them as 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 the whole of Europe, and via the instructables entered into people's homes.

In this case study, 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 the age and ethnically diverse audience in Birmingham. 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 culture, 'maker practices' 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' (Herman, 2015).

Interestingly during the process of the DITOs project, there has been a shift in the way RBINS have been 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 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 led to an expansion of scope of the bus experiment. These discussions can be directly attributed to the participation in the DITOs project.

This case study demonstrates that the way concepts of scientific knowledge are framed in terms of the 'scope' of the experiment influences the inclusion of publics. The case study also suggests that there is potential for cross-fertilisation between more classic models of science outreach and newer concepts of DIY science and maker cultures.

4.3 Material practices not just 'knowledge'

This second case study highlights questions about the specific nature of the practices taking place during the workshop. The case study focuses on the Interactivos?'17 workshop hosted by the Medialab Prado in Madrid which invited 35 international makers and designers to collaborate for 15 days. The topic of the workshop was 'mobility in the city' and focused broadly on urban sustainability which was framed as a problem requiring creative as well as practical solutions to be built

in the form of prototypes. The idea was that the participants would collaborate as small teams for the duration, while focused on designing the prototypes that would be the exhibited outputs from the event.

In the initial introductory discussions with the groups, the workshop participants described the prototypes they were going to build using a formal and institutionalised language. They talked about using the prototypes for "*making the public aware*" and "*educating them*". The implication was that the public was somehow responsible for causing urban problems such as pollution, and the prototypes would solve these problems by addressing this public. In this way the workshop participants invoked a deficit model where the problem was one of a public lack of knowledge, something that is long discussed within the science communication community (Smallman 2016). Yet this was surprising, since almost all of the participants were designer and artists who were highly familiar with the hands-on practically of making objects and prototypes. Yet, the participants framed the prototypes as immaterial, discursive devices rather than as material objects with physical properties. The participants perceived the workshop concept as created by Medialab Prado as placing formal responsibility on them to come up with solutions to urban problems. In this way using institutional language became a way of acknowledging this responsibility which they associated with the deficit model of a public knowledge.

Yet, during the process of the workshop, the focus shifted towards the specific aspects of the project the designers were working on rather than notions of public knowledge. One team that had focused on disability moved away from trying to communicate 'disability' as a universal concept to the public. They experimented with playing group trust games that included a blind team member. These experiments led to a final prototype of what they called a 'social prototype' in the form of an experimental party. At the party visitors could play a variety of sensory games that connected with other people's bodies while dance music and alcohol were present to creating a playful atmosphere. In their social prototype, the team had rejected an institutional language of disability as well as the designation of an amorphous public. Thus, the prototype did not assume a public deficit about disability but reframed it into something more specific and material that reflected the unique differences of the project team.

The air quality team went through a similar transition. Initially the concept of the game they were building was that '*air quality data is the enemy*', with the players being given pollution information which would allow them to battle against pollution. Yet in the process of building the prototype this deficit framing became more complex and contested. Testers of the game got into heated arguments about the game's assumptions. Some suggested that the game needed to feature 'citizens' as an additional player while another suggested that omitting industry as an actor was "*shifting responsibility onto people and hiding the parties responsible for creating pollution. It's not a force of nature*". Another mentor argued the game should focus on communicating individual responsibility for pollution and not worry about complex issues.

The final prototype the team presented in the exhibition involved a God's eye view of Madrid while rising pollution levels were shown as grey fog that came to gradually block out the view of the city. The player could use a game controller to enact government or citizen actions to make coloured pollution bars go up and down, yet these didn't have any clear impacts on the city. The prototype jammed together visual signifiers of different approaches to air quality from computer games, governmental pollution visualisations and affective artworks. Yet the prototype did not resolve these genres or clarify the prototype's political position on air pollution. The effect was a refreshing lack of a punch line or behavioural message. Instead of assigning blame as in a deficit approach or offering technical solutions, the prototype embodied multiple contradictory visual and political languages. In this way the game echoed a discussion that suggested that "*games can be wonderful tools for seeing how systems really work instead of how we are told they work. Why do you think there is no way to solve pollution?*". In this sense the prototype did not aim at a solution but became a material object that acted as a reflexive site of politics where different logics of responsibility could be simultaneously modelled and contested.

The aim of the Interactivos?17 workshop was not to produce polished products or institutional messaging but a collective educational process. The facilitators emphasised that all the designs and computer code from the workshop would be publicly released in an online repository and under an open source licence. The idea being that this would allow others to build on the prototypes. The Medialab introduced the workshop by saying, "*the project is part of the documentation*". Thus, the hands-on prototypes weren't self-contained entities but part of a larger movement that the Medialab facilitators described as 'social prototyping'. This was particularly illustrated by an incident that took place halfway through the workshop where there was conflict within one of the project teams. One of the facilitators interrupted all the teams to gather them together for a lecture about power relationships. In the talk it was striking that the facilitator connected together the neutral terms of 'experimental, open and collaborative' with an explicit politics of interpersonal and technical relationships suggesting, "*experimental means not just technology but also social innovation*" and emphasised that the goal of the workshop was prototyping a collective transformative practice. This approach was reflected in the way the facilitators supported the participants in socialising and night-time explorations of the city, which were all seen as part of the Interactivos prototyping process.

This case study picks up on the importance of material hands-on activities as already mentioned in the formative part of the evaluation. The ethnography of the workshop identified the complexity of material and interpersonal transformations that can take place in a long-duration workshop. Critically the prototypes were not trying to generate scientific knowledge to pass upstream to policy makers but a process towards collective transformative education. Amongst the group, it was possible to see a group shift away from abstract concepts of a public knowledge deficit and a move towards specificity, material complexity of problems. By building prototypes the teams were directly addressing a local audience in Madrid. This can be seen in the

way the air quality project dropped a deficit concept of data as the enemy and shifted to representing the complexity of air pollution without naively assigning blame.

The case study opens up question about how to evaluate the impact of an event that would be missed by merely focusing on demographic breakdown and inclusion of participants. It raises the possibility of evaluating a variety of local impacts from workshop activities such as experiential learning and transformative experiences as well as direct impacts on an area.

4.4 Concepts and framings that shaped DITOs

This third case study reports on ethnography of the internal coordination process of the DITOs project itself and focuses on the impact of the concepts and framings on the process of the project.

Throughout the three-year project many of the tensions that appeared, seemed to derive from the initial project framing; in particular the project's relationship with Responsible Research and Innovation (RRI). As discussed in D5.1 and D5.2, DITOs evaluation framework was based on categories derived from the Strand et al. (2015) paper that included Public engagement, Gender equality, Science Learning, Social inclusion. The issue was how the project should practically the project focus on inclusion on these categories. Both D5.2 and the DITOs research insight on RRI indicators, propose ways of dealing with these evaluation metrics. For example, the research insight proposes that "*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".* Yet, these insights are merely proposals that were developed during the process of DITOs and not something that was actually implemented.

Instead, DITOs was using an RRI-based evaluation framework that did single out gender as an individual category. Each event was recorded within the project's 'Event Diary' system, which allowed public event information to be entered, as well as internal evaluation data. Each event included a box that asked the project coordinator to account for the number of women as well as age range of participants (see section 2 of this deliverable). This system of accounting became the central part of DITOs due to the amount of time involved in maintaining it as well as its importance for tracking the project's overall progress. In addition, there was a similar system for tracking the social media impact for each event.

It was notable that every biweekly consortium meeting involved detailed discussions about this system and process (see comment in section 3.1.2). This involved the teams being encouraged to fill it in and correct existing data but also the technical problems with the event diary system. During these meetings, members of the teams often said things like "*we are not facilitators, we are managers*". The feeling was that maintaining the event diary data was taking so much time that it was taking away from running the participatory events themselves turning the event facilitators into bureaucratic managers. The sense was that this accounting process involved a vast amount of bureaucratic labour that become a displacement for the public events

themselves. This is also strongly emphasised in the formative evaluation (section 3.1.2).

Observing these internal meetings, it was interesting to note that the event diary with its number logic came to dominate the representation of the events. While the teams took many photographs and video of participants and the material practices taking place these were not shown or discussed in any detail. It was only in mid-2017 at the time of writing the second deliverables of D1.2 and D2.2 that photographs of the events were included. This had a dramatic impact on clarifying what the project partners were doing in their events. Previously the teams had largely related to the work of other organisations via the evaluation metrics and categories of the event diary. While running the events was seen as creative by the coordinators, the purely numeric recording did not allow this energy to be represented.

Team members often said things about '*entering the stupid numbers.'* Yet, evaluation number were perceived as 'stupid' not just because of the labour involved, but also the sense that they were inarticulate and not sensitive enough to represent difference. One of the issues was that the DITOs events were radically diverse in scope, length and intensity of involvement. Some were short online events while others involved physically working together intensively with new people for two weeks all day long. The DITOs team felt this differential level of involvement and engagement could not adequately be differentiated in the event diary and evaluation framework. The feeling was that there was an imperative to reach larger numbers of participants but that this missed the quality of what mattered in these events. This created a kind of cynicism with these accounting procedures. Part of this is obviously due to H2020 programme and funding requirements and the tight bounds of work packages, deliverables and numerical objectives.

Many team members talked about wanting to tell the "*real story of the project versus accounting*". This is partly why the escalator story component was added to the evaluation framework to better represent the qualitative and transformative aspects of partaking in DITOs. The team often expressed feelings that the topics of inclusion were important, but that numerical accounting for number of women and educational level was insufficient. As identified in D5.2, inclusion was seen instead as something specific and context-specific to the activities being organised. There is good reason for some events to have uneven gender or age distributions while being highly innovative in terms of social inclusion. What many of the DITOs team asked for, was more time to reflect on these issues since it was often something they had never faced before.

One conclusion that could be drawn is that these observations suggest problems with the WP5 evaluation and WP6 management. Yet interestingly these statements were also often made by the WP5 and WP6 teams who had created the evaluation framework. The sense was that this bureaucratic load of evaluation was not locally defined but remotely specified and coming from outside of the project. Interestingly the Strand et al. (2015) report, which is the basis for the DITOs evaluation, on pages 13-15 cautions about the potential dangers of applying RRI metrics to evaluate projects. In particular it warns about the potential for "*distraction from the real thing:*

working towards the measure and not towards the goal of activity" (p.14). Furthermore, it highlights "*the costs of collecting indicator data*" (p.15) in terms of labour. The report even suggests that, "*indicators can be destabilising and take away legitimacy from current practices*". It seems then that many of the issues observed in the DITOs project can be directly traced back to the RRI indicators and general H2020 programme and funding requirements.

This raises questions about the RRI indicators themselves as well as how they are translated into practical projects. Indeed, within the academic literature there is significant scepticism about the value of the concept of RRI with the PROSO report suggesting there are "*nagging questions of what RRI exactly means*" (p.2 PROSO 2016) and Oftedal (2014) suggesting that the "*specific content of RRI is largely left open. Some will for this reason deem the concept too vague but giving an exact definition of RRI is not necessarily fruitful*" (p.1). Similarly Felt (2016) suggests RRI can act as a 'technology of humility' to acknowledge complexity, or as a 'bureaucracy of virtue' that merely creates tick box ethics. Other researchers argue that RRI involves normative 'big words' that steer research but don't necessarily have any fixed meaning in themselves (Bos 2014). What these papers have in common is a sense that RRI might be both underspecified in practice, while at the same time creating additional bureaucracy.

This case study suggests that specific concepts and framings of the DITOs project such as the RRI based evaluation metrics which were materialised as the 'event diary' had a significant controlling impact on the process of the project. This raises questions about how to best measure project impacts and do so without placing an undue bureaucratic burden on a project. In this case study it raises questions about how to translate RRI objective into a workable evaluation framework. Furthermore, the design and implementation of metrics into technologies such as the event diary needs to be a priority for future projects.

4.5 Ethnography: Discussion

The three ethnographic vignettes highlight a number of specific aspects of the DITOs events. The first case study suggests that across the DITOs events a range of different framings of scientific knowledge were involved and that this created different practices. While two partners used the same term to describe an activity ('science bus') this involved very different material practices and experiences for participants. How scientific knowledge is framed affects the 'scope' of a participatory experiment and defines the parameters of public inclusion. This study suggests that there is potential for cross-fertilisation between different models of science outreach. The second vignette open up question about how to evaluate the impact of an event that would be missed by focusing on demographics such as experiential learning and transformative experiences, as well as direct impacts on an area. The third vignette illustrates the impact of evaluation itself and raises questions about how to better gauge the quality of projects without creating unnecessary bureaucracy.

5 The impact of DITOs

The DITOs project has significantly changed our understanding of Citizen Science and outreach activities. It reached hundreds of thousands of participants throughout Europe in a concerted action that would not have been possible without support from the European Commission. The project also impacted on the organisations involved and on the facilitators of hundreds of events. It supported organisational change as well as mutual learning. In several cases, the project also impacted on the research environment, for example through the involvement of research managers and policy makers and by bringing together groups of people for the first time. In the following, we take a closer look at the impact on the primary target group of DITOs: the citizen involved in one of the DITOs events.

5.1 Capacity building: participants' journeys (the escalator of participants)

To better understand the perspective of the citizens involved in DITOs events, eutema collected a range of case studies. Given the large number of event participants, a comparatively small selection of case studies cannot and indeed should not be regarded a statistical analysis. Rather, the interviews shed light on selected participants, their motivation and journey.

eutema performed interviews with European nationals from different countries about their experiences with citizen science in general and DITOs events in particular. The purpose of this task was also to collect credible narratives about citizens who have moved along the citizen science escalator successfully. This already means a focus on people whose level of participatory engagement in citizen science could be assessed using qualitative methods in the form of personal interviews.

The identification of suitable interviewees relied on DITOs Consortium partners who identified citizens that liked had moved along the 'escalator'. eutema then contacted the citizens and performed the interviews. In total, seven candidates were chosen to share their experiences as well as to tell their story about what their involvement was driven by. Where suitable, the collected cases should also serve as narratives so that eutema also collected personal details, photographs, and the permission to use this information in publications. Special care was used to collect informed consent from the interviewees including the information that they could stop the interviews at any time, decide not to have their data included or published without any negative consequences for them etc.

The interviews were conducted between October and November 2018 and were done via Skype. Each interview consisted of eight open questions that the interviewee could answer voluntarily. The following list of questions was discussed during the interviews:

- Tell me about yourself please (age, nationality, origin, background, profession)
- How did you first get in touch with the events/citizen science projects?

- Have you had any contacts with similar activities before that?
- How often have you been involved in citizen science activities between your first activity and today?
- When was the last time that you did it?
- Why do you like it?
- What was your biggest surprise?
- Where would you like to go from here?

The interviewees represent a broad range of ages, origins, and - not quite as broad - their background. The age of the interviewees varied between 12 and 45 years. The group was represented by different nationalities such as French, Dutch, Italian, Slovenian and Spanish. Interviewed people had a different background including pupils, students but also a male nurse and a researcher. While this may be considered broad, it is also clear that the selection is tuned toward a more educated group of Citizen Scientists. It turned out to be important that the first opening questions helped to get to know the interview partners and to break the ice for further questions.

In the next question, we asked how people got in touch with different event or citizen science projects. It was very interesting to hear how different events made people either participate in a citizen science project for the first time or continue already existing adventures with citizen science activities. Most of the Citizen Scientist have been members of societies, institutions or any other organisations that introduced them to a different kind of citizen science activities on both a local and international level. For most of the citizens on the escalator, DITOs was the first contact with Citizen Science. However, some interviewees had already participated in other activities before DITOs project had started.

Participants emphasised the fact that Citizen Science activities bring people together who share the same interests, and how it allow them to learn and experience what Citizen Science is. Especially the science bus that was going around Europe to host workshops and scientific experiments was a big opportunity for people to get involved in citizen science projects. People appreciated the fact that - although some projects might seem a little bit unusual - they still attracted a big audience. Moreover, the escalators who are involved in research activities by themselves could present the results and take part in interesting discussions with other participants.

Most of the interview partners agreed that citizen science includes and empowers normal citizens to participate in research and be a part of the scientific process. It also encourages them to start their own projects. However, the involvement in science does not have to necessarily mean conducting own research. Collecting data for researchers might be the first step in the research career though.

Here are two abbreviated examples from the case studies:

5.1.1 Mattia - winner of the glass aquarium

Mattia R. is a 19-year-old student from Massa Lombarda, Italy, a small town in the Emilia-Romagna region. He is in the first semester of his biology studies at the University of Bologna. He decided to study biology because of his interests in nature and animals, but especially a big love for insects.

His first experience with DITOs began in 2016 where he received an invitation to the Phasma Meeting- an event offering phasmid (stick insect) enthusiasts an opportunity to meet other taxonomists, amateurs and professionals from all over Europe and share their passion. He had been a phasmid breeder himself for 5 years and as a member of a Facebook group amalgamating Italian phasmid lovers, was encouraged to join an annual meeting in Brussels.

Mattia used to participate Phasma events in Italy, but they were focused on the local region. He joined a couple of projects where children are taught about insects, given lectures on taxonomy and told that there are particular sorts of insects that can be eaten. However, those projects were not focused on the topic of Citizen Science like the Phasma meeting in Brussels where he participated in a seminar from Royal Belgian Institute of Natural Sciences that explained how primary school pupils can help scientist by describing a new stick insect. It was his first contact with Citizen Science.

After the first meeting in 2017, he joined this event a year later and is now planning on attending the Phasma event next year as well. He has been involved in citizen science activities only through DITOs.

Mattia liked the possibility to get to know other people interested in taxonomy with whom he was able to exchange information and to share experiences. He liked learning more about taxonomy and classification of insects and listening to interesting lectures about stick insects. It was a big surprise to learn that there is an event like Phasma, where almost 100 people meet and network with each other. One of his personal highlights was a visit at the Royal Belgian Institute of Natural Science where he saw a scientific collection of Phasmids and participated in an expedition with experts in several parks and forests. From here, he keeps visiting such events in both Italy and other European countries.

5.1.2 Pauline - impressed with children's knowledge

Pauline Chevalin is 20-years-old and comes from Paris, France. She is in the 3rd year of her Bachelor Studies at the Paris-Descartes University, where she studies Interdisciplinary Sciences, which include biology, physics, chemistry, mathematics and computer science. She works partially at the Center for Research and Interdisciplinarity and is also a trainer of athletics in a sport association for children. At the moment, she is doing an internship at the organisation called Simplon, which empowers young people from low-income communities and underrepresented groups, including women and people with disabilities through professional training in the field of web development and programming.

Pauline got in touch with the citizen science in her Bachelor Studies meeting one of the DITOs facilitators from the Center for Research and Interdisciplinarity. She introduced her to some projects and found it amazing. She was attracted by the idea of workshops with children about science. She joined a workshop at the Kids Expo where children made natural sun cream and soap, and extracted DNA by using soap, water and salt. They used the difference in density between a mixture with soap, salt, DNA, water and alcohol. The mixture is to extract the DNA from mouth cells by breaking all the membrane and when this mixture is in contact with alcohol, the DNA will precipitate and become white.

Before this event, she had no contact with citizen science activities. Her last activity was in October 2018 during the National Science Festival in Paris where she ran a workshop about the awareness of what we eat. She made chemical-free candies and learned a culinary process of spherification that enables shaping liquids into spheres and so called “bubbles”.

Pauline said she liked everything about those events: “*It was so amazing to see smart kids who are interested in science and can understand complex processes in Science. I learned that my simplifying science to people, you make science more accessible to people who had never experienced it before. Even some parents of those children found it fascinating. I realised that science can be done in a fun way*”. She has become critical of how science is simplified in the media.

The biggest surprise for her was that running workshops for children she realised that they sometimes knew more than her. She expressed this as giving her “*so much hope that there are so many kids who want to learn more about science*”. She would like to participate in more citizen science activities in the future: “*It would be a great experience to teach children what I like the most- both science and sports*”.

5.2 Capacity building: partner’s journeys

Partners in DITOs gained experience, networks, skills, and tangible outputs – as individuals and as organisations (see also D3.3). One of the general highlights of partners’ increased capacity was for partners who had limited experience working in EU-funded projects. For example. they learned how to collaborate in large international and interdisciplinary projects but also the ‘tricks of the trade’ and “*learning to embrace the vagueness of EU proposals to see them as opportunities*”. Another overarching highlight is that in some project localities ‘citizen science’ was “*not a well-known term*”, which meant partners needed to create the terminology, the stories, and “*create a transition into it*”. They set foundations: the forms of entry, the perspectives e.g. art and science or participatory science, the methodologies, and links to government institutions, etc. Linked to this, partners also note the “*tremendous reach of the project*” through activities such as the science bus in “*making citizen science more visible*”.

5.2.1 Organisational growth and development of new practices

Partners have grown their networks through the large number and types of events they organised reaching a "*vast network of people, associations, institutions, that are carrying out different citizen science activities*". For example, "*I had not been involved in things like writing policy briefs and it became a key document for the [new] Clean Air working group in ECSA*". Other partners extended their reach within the "*public engagement community – I didn't know about it so it was very good exposure for us and we had different audiences*".

In addition, Partners have built their capacities to design and deliver events by iteration of their own events, reflecting on results, sharing the tools with partners or collaborators, and by exposing themselves to a range of topics opened up by the guests they invite and the discussions they stimulate: "*it is through the range of events and learning that we have had ourselves and the methods developed*". Also, they have gained "*inspiration from other partners - I would not have done BioDesign if it were not because of DITOs and getting ideas from everyone in terms of actions like the BioBlitzes*".

The medium-term financial support offered by the project increased some partners capacity to support and extend programmes in a way that "*acknowledges commitment through compensations not just volunteering and therefore committing more*". This type of organisational capacity building involved creating the infrastructure to support mentoring programmes, trainings and academies that *"would not be sustainable both monetary and intellectual"*. These new programmes enabled partners to "*upskill people*" such as mentors or interns and "helped us design methodologies" that form a lasting structure to share with collaborators, partners, and apply in future projects. One example is Kersnikova Institute's lab books that not only define the steps and protocols of training programmes but also "*It gets [mentors] into a mindset; they get something out of it – it creates something meaningful and structured that is useful and functional*". Specifically, through DITOs, activities were made into sustainable programmes to which mentors to could commit and identify with.

For some partners, DITOs enabled defining new roles, as noted in the lessons learnt section above and the capacity for 'increased responsibility'. *"For example, being aware that we are collecting data and that we have the responsibility to make this available. It might be obvious for a researcher but for me it became a very important lesson learnt. I am very action oriented and don't think about this. So, adding a hypothesis so that we can have accountability and then measurements and some goals helps us situate where we are - and see how we succeed – or not".*

DITOs also enabled 'organisational standing' for some partners. DITOs enabled the creation of groups (e.g. Science has no Borders) and for organisations to gain regional and national recognition. This is a very important stepping stone "i*n light of the new schemes and policies and call for future funding – [government authorities] know that they have a reliable partner*". Some partners are even developing new educational programmes such as online MOOCs at CRI, UCL, and at Kersnikova: *"We are now developing an MSc module on Art, Science and Technology, combining*

methodologies and practices that will intertwine the academic sphere closely with the industry realms, and we just got a national support (of 4.5M€) for setting up a platform, a mutually complementary network of hubs and laboratories across Slovenia to create an ecosystem for the critical development of the future."

5.2.2 Personal journeys of learning

Individual partners' growth is often inseparable from organisational growth as we all work for and deliver DITOs on behalf of our institutions. However, it is worth noting that, as one partner noted "*it is not about the project is the people - the technical mentors, the participants, the commissioners and the partners*" and hence, individual journeys are what have made the project possible.

Over the past 3 years, individual partners have extended their knowledge base, skills, awareness, reflectivity, sensitivity, and appreciation of what is possible in large collaborations. In terms of technical skills, many partners report having "learnt so many things about biodesign and the lab" and "*now I can talk about these things and I have become fluent and have become part of the team in content production*". Another partner notes, "*The most valuable thing from DITOs is developing critical thinking – that one can also question the world around us and that we can find solutions or opinions or alternatives to explore. It was about creating a mind-set of researching, learning, seeking and comparing information […] I managed to make the link between science and DIY because from my own experience*". For some partners, DITOs has enabled "a deeper understanding of citizen science and its capabilities and limitations".

For some partners DITOs has also meant a journey of struggle and steep learning curves and "*having persevered and getting the team up and running and having managed to create a work culture*". It is about "*living through a difficult phase and giving support – I gave all that I could and feel I am leaving behind a structure to support work going forward*". Some partners experienced limited internal support, budget, time, and administrative pressures, but who still endured because they aspire to do their best: "*all aspects were a struggle because of budget and limited support but also I wanted to organise the event not for the sake of organising it – I wanted people to leave the event having learnt something*". DITOs has also signified deep lessons learnt and realisations and a wish to take forth that learning to apply it to new projects and new collaborations. Partners are leaving DITOs with "*new friends*" but also with "*with the pleasure of knowing all of you – and having become more reflective and also more caring about people and my limitations and I have learnt a lot on how to pursue goals - what is important and how to hack things – insightful ideas from meeting you all*".

5.3 Influence on policy and legacy

5.3.1 Legacy: How partners see what has been done in DITOs (including tangibles and intangibles) can be used in the future

Our legacy will be discussed in more detail in deliverable D3.3. Here we discuss what, for partners, can be taken into the future from what has been achieved in DITOs. This ranges from tangible to intangible accomplishments. For partners, tangible legacies include instructables and lab books, methodologies and protocols, equipment and tools developed, as well as the "procedure of making a tutorial / instructable / lab book is going to be used in the future in the process of developing / prototyping new workshops". Event designs and templates such as 'make-do-cafes' and the Kersnikova Freaktion Bar concept (science café type discussion) will be used, further developed, and 'hybridised' in future projects – "just as the methods that went into DITOs came from other projects and experiences", and "Earth Day is also a legacy – it was done because people care and it was done without budget".

Other tangible outputs taken forward include the content of deliverables "*such as the evaluation and our good practice report*", and policy briefs. And as one partner notes "I have done projects with EU funds for 15 years and I know that when projects are done you end up with just papers but here the most important network is ECSA and I know that Muki and DITOs have helped that. Policy briefs will live there not just lost in the net. I think our policy briefs will be well placed there and many people from the ECSA working groups who were involved will remember". Partners also value the "connections we made with institutions", working as 'allies' "to create win-win situations". On the policy side "we pushed ideas about citizen engagement through ministries and major topics have been put on their radar". But, as one partner noted, "I wish we had left ambassadors who continue to champion and spread the message – the things we stand for like open science".

Moving onto more intangible outputs, "*I want the good practices to be shared - this is the number one thing*" also "*the knowledge that we have gained through interviews – I think this will last*". Other "non-tangible parts are the relationships that have been established amongst colleagues but also with the partners" and, as many partners noted, "the network we built with new partners will most likely be a cornerstone for new future projects and collaborations".

Partners consider that the discussions that we started, the awareness, and the momentum, where in some cases activities and initiatives have taken their own path, are all legacies. Engagement with communities, while more limited, are considered a legacy: "DIY science has always existed but we created networks between people. We gave some people a taste of DIY science and shared tools and methodologies. They are the able to replicate or adapt what we shared – giving autonomy". Partners consider that for participants, what we leave for "those who were already engaged is connecting them with others like them who didn't know each other. And then publics who did not know they could engage with science – for them it was developing their critical thinking and raising awareness that it is possible to engage and create tools".

5.3.2 Influence on policy: challenges and opportunities

The promise of reaching out to broad audiences and popularising scientific research has clearly put Citizen Science on the agendas of policy makers in Europe and elsewhere. There is a huge interest from research funding bodies, but also from high-level research policy makers to make science more understandable to the public and to involve more people in science and research. There are several objectives for policy makers in this respect: they range from interesting more (young) people from scientific fields thus filling a gap in STEM-education in many countries. Also, there is the interest to justify apparently large budgets spent on topics that are notoriously difficult to justify to the layman, e.g. in high-energy physics etc.

While this interest is certainly laudable, it is less clear from DITOs that it can be easily addressed with just a large-scale outreach activity. Results from the formative evaluation make it very clear that event facilitators are often much more interested in their own audiences rather than in establishing contacts with policy makers or preparing presentations and documents for policy makers. Consequently, dedicated effort is required to establish and maintain such links between the audiences, facilitators and policy representatives.

In DITOs, the main activity reaching out to policy makers was the creation of dedicated policy briefs. This activity meant that DITOs experts - including facilitators of events - needed to think about the relevance of their activities to policy making. It provided a real opportunity for reframing DITOs event activities in a larger picture of policy making. The process itself often led to important workshop activities and exchanges with a range of stakeholders - typical of policy processes such as the creation of a policy document. There were also interesting synergies between different topical aspects of policy briefs.

For example, DITOs partner eutema was involved in the creation of a policy brief on the synergies between open (digital) science and citizen science. This brief involved large groups of experts and was presented to the European Commission in a dedicated meeting in Brussels. From this event, a second policy brief emerged that targeted potential synergies of art/science and citizen science. This resulted in a local stakeholder roundtable in Vienna with members of the Austrian art/science, the open science and the citizen science communities. This was the first time for many members of the respective groups to meet although many had already heard about each other or were interested in each other’s work. The result was an extensive dialogue on many different policy aspects from art and research funding to university curricula and innovation policy. This event also made it very clear that there are still many unexplored directions for citizen science and outreach and we may have barely scratched the surface of future developments in this area.

6 Analysis of the Escalator

DITOs started with the idea of the escalator, a concept focused entirely on the citizen and how she moves along from passive consumption of science to being fully engaged in DIY science. After the end of the project, the escalator concept has become clearer and more complex. Firstly, the escalator has evolved from a first and focal point for the narrative to a concept used beyond the DITOs project. It is now an element in several other research projects (or proposals) that include the aim to involve citizens not only as data collectors or passive consumers in science activities. Instead, the aim is to activate creative scientific skills, analytic work and science-based citizen engagement.

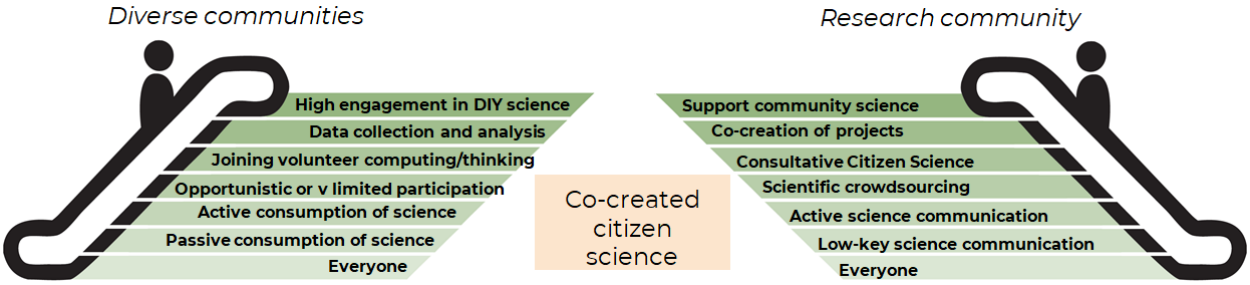

Figure 18 The escalator concept originally used for diverse (citizen) communities (left) expanded to include the research community (right). See text for further explanation.

Secondly, the escalator model has now evolved from a model mostly focused on the citizens to a concept that also includes actors from the research community. In our understanding, there is now a double escalator - one for citizens, but another one for facilitators, researchers, and organisers. Based on the experience of DITOs participants, the latter group also experiences a process in which event organisers and science communicators may initially start with low-key science outreach activities, e.g. presentations or online sites. From such science communication activities, facilitators have moved to more complex and involving activities such as scientific crowdsourcing and consultative citizen science with strong components of citizen interaction. Finally, some facilitators have arrived at co-creation projects or projects that support community science as a whole - rather than being limited to just a narrow part of the full range of scientific activities. This second escalator tends to co-evolve with the citizen escalator and it is not possible to picture it just as a result or driver of the latter. Rather, as facilitators and citizens interact, there seems to evolve a growing interest in richer, more complex, more participatory and independent forms of interaction in many cases. Note that this can only happen where the organisational boundaries allow for such expansion and not all environments are similarly conducive for such a development.

Thirdly, it became clear during DITOs that there is danger to misunderstand the escalator model as a deficit model, i.e. as a model where the passive involvement of citizens is regarded as a deficient mode of doing citizen science and citizen outreach. Rather, it is important to understand the escalator as a variant mode of

forms of interaction, which are suitable for different types of audiences, interests of citizens, capabilities of organisations and facilitators. Not all citizens would like to move along the escalator and not all organisations are interested in 'educating' citizens to become autonomous researchers.

6.1 Evaluating public engagement in science: beyond the obvious

The methodological approach chosen for the evaluation of DITOs evolved over two years in parallel to the event activities of the project. In our view, the method that emerged from various learnings and challenges has proven useful, practical and efficient and it delivered a whole range of interesting insights. This combined approach brings together multiple voice of participants, event facilitators and the voices of the evaluators as social scientists.

On a basic level, the evaluation exercise demonstrated the dimension and impact of the outreach activities. At a different level, some of the learnings from the evaluation exercise go beyond the expected results (i.e. citizen science and citizen outreach) from the DITOs events. They point to interesting future directions for public engagement in science:

- *Case studies show the importance of early citizen science experience for scientists*

  Although necessarily anecdotal as evidence, the case studies suggest that an early involvement in and training on citizen science prepares scientists for their later career stages. This means that young scientists who were involved in such activities may tend to evolve a durable interest in citizen science in later, more mature stages of their careers. This in turn suggests that university curricula should include some citizen science activities in order to disseminate its practice more widely.

- *Reaching parents through children*

  It is perhaps unsurprising, but was reconfirmed in DITOs events that involving children and young people in science activities may also affect their parents. There were several anecdotes of children's enthusiasm about their involvement in science exercises in DITOs that seemed to inspire also their parents. Such parents may then have joined in some events or even became interested in participatory science projects to address a specific environmental challenge.

- *The role of variety and context*

  There is a clear lesson from DITOs that conditions for science outreach events vary greatly between organisations, countries, funding authorities etc. This variety needs to be appreciated and taken into account when, for example, designing and setting up citizen science programmes. It would be a mistake to believe that citizen science only follows a single objective or one specific format. The very variety of the activities in DITOs made it such a rich

source of insights and lessons to be learned from each other - in particular as regards facilitators and organisations.

- *The importance of trained facilitators*

  In line with this last observation, DITOs made it very clear that facilitators play the key role in citizen science. Their experience can make the difference between a mediocre information session and a truly interactive, perhaps life-changing event for participants. The obvious example is the facilitator's ability to identify and distinguish people's interests, attitudes, excitement etc. during the events and reacting appropriately. The trainings of facilitators therefore is a key success factor for citizen science and engagement activities.

The size and breadth of the DITOs project in combination with the multi-faceted approach designed in the project produced another rather different insight that is commonly associated more with particle physics than with science education and outreach exercises: Measurement influences what is being measured. In the DITOs case, this became most clear in formative evaluation where the very process of reflection opened up the possibility for collection of good practices, setting new objectives etc. We also saw how the evaluation discussions provided opportunities for fostering organisational changes and shared learnings among facilitators.

6.1.1 Just a change of perspective - or a change in conceptualising science?

The evaluation first introduced a new focus of analysis - away from the citizen towards the facilitator. More than that, it examined the very relation of evaluation and the evaluated. Similar to the famous shift of cybernetics to second order cybernetics. This shift led to the study of the cybernetics of observing systems rather than that of observed systems, cf. von Foerster (03). Perhaps the most important practical result was the practice of cybernetics where cyberneticists understand themselves to participate in the system. Here in DITOs, it soon became clear that the question of Citizen Science facilitation (both the person and the organisation) and later even the evaluation of that part needed to become the object of study.

Just like in second order cybernetics, observing observers may help to identify the observers' blind spots, as the (first order) observers are typically unable to observe their own observations. This perspective means an inquiry into fundamental epistemological aspects of science in general and citizen science in particular: it suggests reconsidering the mediated truths in terms of unmediated truth - a function that we identified as most important in the DITOs practice of citizen science. It allows a view from inside and outside the project and it takes note of the sometimes problematic role of the evaluator as a facilitator (of processes and objectives) and the facilitator as an evaluator.

This important function became particularly clear with respect to potentially present pre-existing conceptualisations in citizen science and outreach activities. One such concept is the deficit model of the citizen where the citizen is regarded as an 'empty container' to be filled in a process of information and education with scientific facts.

In the three years of the DITOs project, its participants not only became more aware of this concept, but also shifted away from this view of the deficit model. This shift had several directions:

- *There was the move away from just the citizen to the relation of facilitator and the citizen. This is not such an observational shift, but a more fundamental recognition of the importance of the relational aspects.*
- *Moreover, practical aspects of science became the focus of attention. This relates to science-as-technology both in terms of practical work, but also in terms of objectives important for the citizen. On many occasions, citizens questioned what Heidegger (1927) called the merely theoretical and theorising 'staring-at' decontextualised entities in science. They insisted on a view that was much more interested in meaningful activities to improve their world; i.e. an at least partially technical endeavour.*
- *Finally, the focus shifted to the observation of changes induced in the overall system, leading us to second order cybernetics and potentially leading new RRI pathways.*

The greatest long-term impact - in particular for the participants in DITOs - may lie in the conceptual shift away from citizen science as a deficiency model. DITOs provides an opportunity for the epistemological renewal of citizen science that overcomes the deficiency perspective. It recognises the bidirectional nature of the science-citizen relationship that may even lead to an improved conceptualisation of not just citizen science, but rather science itself.

7 References

Ahlstrom, D. (2000) Science bus brings mobile laboratory to schools. *Irish Times*. 27 March.

Bos, C., Walhout, B., Peine, A. & van Lente, H. (2014) Steering with big words: articulating ideographs in research programs. *Journal of Responsible Innovation*. [Online] 1 (2), 151–170. Available from: doi:10.1080/23299460.2014.922732.

Bose, A. (1983) *Mobile Science Exhibition*.

von Foerster, H. (2003), *Understanding Understanding: Essays on Cybernetics and Cognition*, New York : Springer-Verlag. ISBN 978-0-387-95392-2

Felt, U. (2016) “Response-able practices” or “new bureaucracies of virtue”: The challenges of making RRI work in academic environments. *Pre-print; Published by the Department of Science and Technology Studies, University of Vienna*. (November).

Heidegger, M. (1927) *Sein und Zeit. Jahrbuch für Philosophie und phänomenologische Forschung.* Band 8, 1–438.

Kröll, D. (2010) Gender und MINT. Schlussfolgerungen für Unterricht, Beruf und Studium. Kassel: Kassel University Press. http://www.uni-kassel.de/upress/online/frei/978-3-89958-974-0.volltext.frei.pdf

Latour, B. (1987) *Science in Action: How to follow scientists and engineers through society*. Cambridge, MA, Harvard University Press.

Latour, B. (2010) *Cogitamus*. (Cogitamus. Six lettres sur les humanités scientifiques. La Découverte, Paris). Berlin: (2016) Edition Unseld, Suhrkamp.

Mackenzie, D. (1996) *Essays on Technical Change*. Cambridge, MA & London, MIT Press.

Ministry of Culture Government of India (2014) *Mobile Science Exhibition*. [Online]. 2014. National Council of Science Museums. Available from: http://ncsm.gov.in/mobile-science-exhibition/.

Murtagh, L. (2007) Implementing a Critically Quasi-Ethnographic Approach. *The Qualitative Report*. 12 (2), 193–215.

Oftedal, G. (2014) The role of philosophy of science in Responsible Research and Innovation (RRI): the case of nanomedicine. *Life sciences, society and policy*. [Online] 10 (5). Available from: doi:10.1186/s40504-014-0005-8.

Patton, M. Q. (2015). Qualitative research and evaluation methods: integrating theory and practice (Fourth Edi). New York, NY: SAGE Publications.

Prem, E. (2014) Evaluation as the construction of policy narratives. Vienna: fteval Journal for Research and Technology Policy Evaluation, No. 39.

PROSO (2016) *Deliverable D2.2: Societal engagement under the terms of RRI*.

Scriven, M. (1999) The nature of evaluation. University of Maryland, College Park, US: ERIC/AE Digest Series EDO-TM-99-06. http://ericae.net/digests/tm9906.pdf

Smallman, M. (2016) Public Understanding of Science in turbulent times III: Deficit to dialogue, champions to critics. *Public Understanding of Science*. [Online] 25 (2), 186–197. Available from: doi:10.1177/0963662514549141.

Strand, R., Spaapen, J., Bauer, M., Ela, H., et al. (2015) *Indicators for promoting and monitoring Responsible Research and Innovation: Report from the Expert Group on Policy Indicators*.