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Creative collaboration in citizen science and the evolution of ThinkCamps

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Highlights

- Creative collaboration events foster co-creation, co-design and collaborative thinking at key points in the citizen science research cycle. They can help to grow science capital and thus deliver on the principles of citizen science.
- Such events can be held at any or all stages of the project lifecycle, from initial development to sharing outcomes.
- The hybrid ThinkCamp event format is well-suited to citizen science and can diversify participation, support knowledge sharing and engage a wider audience in the development of new ideas and projects.
- ThinkCamps can support engagement with policymakers to bring community-based citizen science initiatives into the fold of existing scientific activities that inform policy and civic action.

Introduction

The global aim of citizen science is to actively engage the public in the scientific process, with an emphasis on the importance of being open and inclusive, and a desire to facilitate creativity, learning and innovation throughout (see also Hecker et al. 'Innovation' in this volume). Initiators

of citizen science projects are increasingly encouraged to engage more diverse participants to grow 'science capital' and deliver the benefits of science outcomes to as wide a population as possible (see also Edwards et al. in this volume).

While citizen science is traditionally driven and initiated by researchers who then reach out and engage citizens to help them solve research challenges, more communities are becoming active in devising and leading their own citizen science projects (see Ballard, Phillips & Robinson; Mahr et al., both in this volume). This provides an opportunity for practitioners to support grassroots community involvement throughout the entire research process: from defining the problems and framing the questions, through designing and launching the project, to collecting and making sense of the data – including writing academic papers, sharing findings widely, and taking action in their community (see also Novak et al. this volume, on digital social innovation approaches; and Kieslinger et al. in this volume, on outputs from citizen science projects).

This chapter discusses how to harness the potential of creative collaboration through ThinkCamp events – an 'unconference' style event with an open and creative environment designed to foster co-creation, co-design and collaborative thinking at key points in the citizen science research cycle. It draws on the authors' experiences of running (and participating in) creative collaborative events and explores their potential to support inclusive, co-creational approaches to citizen science. Finally, it makes specific recommendations for project initiators, event organisers and policymakers.

Science for all: The case for creative collaboration

The role of the 'citizen' in citizen science has been strongly emphasised since the mid-1990s, when the term 'citizen science' was first coined (Bonney et al., 'Public Participation', 2009; Irwin 1995). More recently, Schäfer and Kieslinger (2016) plea for even more diversity in citizen science to further close the divide between society and science, and recommend a wider range of approaches including 'the emergence of new forms of collaboration and grassroots initiatives'. (Schäfer & Kieslinger 2016, 1)

Citizen science project initiators are encouraged to pursue collaborative and democratic methods that involve the public in all aspects of citizen science, as in 'extreme' citizen science (Haklay 2013) where, 'Approaching and coaching communities to express their needs has the potential to generate very innovative projects that not only contribute to

knowledge making but also to true social change – this is part of a wider approach of participatory action research' (Cunha 2015). Extending this approach to also influence policy by engaging policymakers provides another political dimension to citizen science. We propose that Think-Camps might offer a way to facilitate this in practice, an approach that contributes to the field of participatory democracy (See Smallman in this volume).

The value of cross-disciplinary collaboration across traditional organisational boundaries is well recognised in business (Mattessich & Monsey 1992), in scientific research (Hara et al. 2001) and in facilitating radical innovation within industries (Blackwell et al. 2009). The role that cross-disciplinary collaboration can also play in citizen science, to broaden and deepen the role of citizens, is becoming increasingly clear:

> We thus ask ourselves how may the combination of insights from artist-designers, natural and social scientists, change the status and indeed the experience of engaged citizens beyond the denomination of mere 'data drones'?. . . . it is perhaps here that interdisciplinary collaboration becomes most relevant, allowing us to be more inventive with people and with technology . . . In this way the conventional parameters of what is expected of public participation and what counts as monitoring can be potentially shifted.
> (Hemment et al. 2011, 63)

The concept of creative collaboration arose in the business world in an effort to embrace a more grassroots approach, where collaboration is:

> an act of shared creation and/or shared discovery: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own. Collaboration creates a shared meaning about a process, a product, or an event.   (Hargrove 1997, 33).

These characteristics of creative collaboration – endeavouring to achieve shared value and create something new – are well-suited to citizen science, where the process is as important, if not more so, than the outcome (Freitag 2013). This diversity of input also improves the effectiveness of the approach and the quality of the outcomes of citizen science: 'Incorporating diverse ways of knowing into the analysis of a given issue increases understanding of the issue and offers solutions better tailored to the full context' (Freitag 2013, 2).

Growing science capital

One lens through which to view the role that citizen science plays in society is the concept of science capital, which looks at the level and depth of exposure that communities, families and individuals have to science knowledge and scientific thinking (see also Edwards et al. in this volume). Science capital is related to social capital and cultural capital in that it encompasses all the science-related knowledge, attitudes, experiences and resources that one acquires through life (Archer et al. 2015), and may lead to the pursuit of a career in science (Edwards et al. 2015). Citizen science projects can have a tangible impact on growing science capital by designing recruitment and engagement efforts to reach as broad a spectrum of people as possible, with an emphasis on involving children, young adults, and families with low science capital (Edwards et al. 2015; see also Makuch & Aczel; Harlin et al., both in this volume).

Organising creative collaboration events around community-specific issues that impact people's lives directly gives participants the opportunity to a) mingle with scientists to broaden their understanding of what science entails and what scientific careers look like; b) direct a line of scientific enquiry towards outcomes for their communities, incentivising active involvement and fostering ownership; and c) co-create new citizen science projects with a genuine local impact.

This approach builds on the spectrum of public involvement goals established by the International Association for Public Participation (IAP2), which begin with information sharing and build up to collaborative acts of partnership across the decision-making process, such that the final decision is in public hands (Ramasubramanian 2008). It is important to recognise the potential power dynamics inherent in community-based participatory research (Banks et al. 2013) and citizen-led digital innovation (Whittle et al. 2012), and to ensure these events present the opportunity to foster scientific citizenship among all participants (Irwin 2001).

Indeed, the first of the Ten Principles of Citizen Science is: 'Citizen science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding'. (ESCA 2015; Robinson et al. in this volume). This major central theme of inclusiveness and involvement is re-emphasised in the third principle, 'Both the professional scientists and the citizen scientists benefit from taking part', and again in the fourth principle, 'Citizen scientists may, if they wish, participate in multiple stages of the scientific process'. Delivering on these principles in practice requires

building in opportunities for collaboration between citizens and scientists throughout the project, from initiation to conclusion.

Ideally, this allows citizens to define at the outset what research questions are most relevant for them and their immediate environment, and how they can benefit from the process and outcomes (Sanders & Stappers 2008). Creative collaboration events provide a space to bring these principles to life, curating around the potential chaos of many voices.

Creative collaboration events

Management books are full of good advice about how to nurture creative collaboration within organisations (Hargrove 1997), or how to open the innovation process to a wide range of beneficial partnerships (Chesbrough 2003). These formalised methodologies are well-suited to a commercial context with either a shared profit motive or the desire to develop innovative new products and services, but are less useful for garnering public participation.

New online models of co-creation, collective intelligence and deliberation that foster scientific agency and democratic participation are emerging (see for example, Miah 2017; Saunders & Mulgan 2017), but the reality in citizen science is that individual participants can be widely spread demographically as well as geographically, with unequal access to the internet (see Haklay in this volume). Face-to-face events have therefore evolved to embrace the principles of citizen science and are designed to support creative collaborations locally, while also being compatible with cross-border citizen science by dispersing such events across a wider range of locations.

Creative collaborative events can also be held throughout the life-cycle of a citizen science project, when formulating research questions, designing the project, co-designing any tools, launching the project and sharing and celebrating the outcomes.

Creative collaboration events are often known as 'unconferences', a term dating back to the 1998 announcement of the XML Developers Conference in Montreal, Canada (Bosak 1998). Their original purpose was to be more participatory than the classic 'sit-and-listen' formal conference, and to facilitate in-depth conversations and knowledge sharing. Unconferences are participant-driven, often with no set agenda beyond an opening statement, and they are frequently based on the Open Space Technology technique developed by Harrison Owen in the mid-1980s

(Owen 1993). Today, there are several common types of events in this category: Open Space, BarCamps and hack days and hackathons. These are considered in more detail below.

Open Space events

Open Space Technology – oddly named, as it is more properly an approach or technique – brings order to chaos by relying on individual participants' ability to self-organise when a safe and welcoming space is provided for them. In essence, people are brought together around a defined subject and then provided with the space to raise the issues that matter most to them, thus setting the discussion agenda for the rest of the event. When people gather in an Open Space group, the 'law of two feet' applies – any individual not contributing or getting anything out of the break-out group should move to another group.

Open Space is most effectively used within organisations, communities or groups of people who have a strongly shared goal because it relies on participants taking ownership of any actions arising from the sessions. It works best when high levels of complexity, diversity, conflict (real or potential) and urgency are present (Owen 2008). A useful repository of resources for organising Open Spaces can be found on the Open Space World website (http://openspaceworld.org).

BarCamp events

The BarCamp format was inspired by the Friends of O'Reilly Conference, known as FooCamp (Tantek 2006), created by O'Reilly Media founder, Tim O'Reilly, at the turn of the millennium. The defining feature is a whiteboard or brown-papered wall on which participants draw up their own agenda for the event. As Tim O'Reilly recalls,

> We did the very first Foo Camp in 2003. It was in the middle of the dotcom bust, and we had a lot of empty space. It was really for fun, a thank-you to all the people who had given us the gift of their time, attention and ideas over the years. The output is not what we learn but what they learn. It goes back to creating more value than you capture. I love helping people make new connections.
>
> (O'Reilly in Levy 2012)

BarCamps similarly enable the spontaneous creation of the agenda and session content at the event itself, by way of a scheduling wall

where participants post and announce their sessions. 'There are no spectators', the BarCamp philosophy goes, 'there are only participants' (DeVilla 2011). BarCamp gatherings are increasingly widespread globally, including science-themed BarCamps (http://lanyrd.com/2011/scibar camb/) and citizen science–themed BarCamps (https://wikimedia.de/wiki /Wissenschaft/csbarcamp; and http://buergerschaffenwissen.de/bar camp).

These events support self-directed learning and knowledge sharing, and can strengthen a sense of community. They are not usually designed for prototyping or the development of new ideas, and rarely lead to action planning beyond the event. A useful repository of event information and resources for organising BarCamps can be found at the official BarCamp wiki (http://barcamp.org).

Hack day and hackathon events

Finally, hack days and hackathons stem from formalised approaches to collaboration and co-creation that began to move beyond the realm of open innovation and open research and development (R&D) in the early 2000s (Chesbrough 2003), and into the realm of open source communities and technology organisations. The open source community pioneered 'outside-in' creative collaboration events to produce code and develop new functionality and features, and created a space that went beyond idea generation and information sharing. OpenBSD and Sun invented the hackathon event format in 1999 to enable a high-intensity collaborative coding effort around a shared code base (http://www.openbsd.org/hackathons .html). A more free-flowing hack day format was introduced by Yahoo! in 2006 to engage with their external developer community, enhance internal product development and support the creative application of their developer tools and software development kits (Dickerson 2005; Dickerson 2006).

As with BarCamps, hack days and hackathons continue to grow in popularity as a creative outlet for developers and a way for organisations to engage with a wider community of participants than usually possible. They have now expanded beyond their initial software developer orientation into fields such as civic engagement (https://www.bathhacked.org/), science (http://sciencehackday.org/), health (http://nhshackday.com) and museum engagement (https://museumhack.com).

Hack days are usually focused on the technology community and those with technology skills so are particularly well-suited for prototyping new ideas on the fly, testing prototypes for new citizen science mobile

or web applications (Sanders 2008), and inviting the creation of new tools for citizen science based on existing software, technology platforms or devices. An excellent best practice guide to organising hack days can be found in the Hack Day Manifesto (http://hackdaymanifesto.com/).

The ThinkCamp approach to creative collaboration

The ThinkCamp methodology was first developed by the Mobile Collective (Gold 2011) to provide an open and creative environment for developing new products and services at the cross-section of different fields, such as mobile technology and health services. It came from the observation that a new generation of health care professionals were technology savvy and saw opportunities around them, but did not have the developer skills to act on them; at the same time, many in the technology community were passionate about health care provision based on personal experiences, but had no direct channel to make a positive impact.

The event format was born out of the desire to combine the improvisational creativity of the hack day with the self-organising principles of Open Space Technology. The ThinkCamp methodology also incorporates the interdisciplinary approaches to open innovation of the 'Fuzzy Front End' of R&D (Rubinstein 1994; Sanders 2008), which optimises creative problem-solving by taking the process outside the walls of a single organisation (Rochford 1991).

ThinkCamps invite participants from a diverse range of disciplines, skill sets and experiences to collaborate on addressing problems, rising to challenges and taking advantage of new opportunities. A key goal is to lower the bar for non-technical participation so that people without coding skills who might not feel comfortable at a hack day are able to join teams and make a significant contribution. This format evolved further during the EU-funded Citizen Cyberlab project (http://archive .citizencyberlab.org/) to provide a space for offline community-building and creative problem-solving, where scientists and citizens could meet to devise new projects or further develop the Citizen Cyberlab toolkit (Gold 2012). Although participants do not require computer programming or other technology skills, they can still contribute to the development of new technology features and functionality in the role of 'user as co-designer' (Sanders 2008), and provide inputs to prototyping at the event.

The hybrid ThinkCamp event format is uniquely suited to the context of citizen science, where external voices are valued. Supporting the

sharing of knowledge among diverse participants and building bridges to engage a wider audience in the development of new ideas and projects helps to deliver on the principles of citizen science throughout the project lifecycle.

The evolution of the ThinkCamp format

The first iteration of the event format was the MC ThinkCamp mHealth organised by the Mobile Collective in June 2011, to address opportunities and challenges in health care by applying mobile and web technologies in innovative ways. Seventy-five participants attended, primarily mobile developers, technologists and health care professionals. The event opened with two keynote talks to provide context and inspiration for the discussions alongside demonstrations of current mobile app initiatives in health care. The Mobile Collective team then facilitated the creation of the agenda in the Open Space style and provided support for the working groups that emerged organically. Nine working groups formed, eight of which presented outcomes at the end of event and two of which continued after the event (Gold 2011).

The engagement and interest among the participants was high, with many indicating that they wished to stay involved in the further development of the ideas that emerged. However, it was not possible to 'own' the projects as event organisers and few participants were in a position to take on product development outside the scope of their day job. Bringing this format to citizen science, with the aim of supporting grassroots public involvement, therefore means ensuring project ownership is in place to take things forward.

ThinkCamps start with short presentations to set the scene and provide context as inspiration or to present the challenges for the day. If the agenda is to be set by participants, then the event can unfold as described above, which requires little prior planning, but relies on participants pursuing the ideas generated after the event. If the agenda is to feature pre-defined challenges, organisers invite the submission of ideas beforehand, work with challenge 'owners' to present them in a way that invites collaboration, and structure challenges so they can be reasonably tackled within the time allotted. A challenge can be a problem within an existing project or technical platform, a new technology, a new opportunity, an idea for a new project and so on.

Challenges need to be presented by the owner – the person with insight into the problem or opportunity, who is inviting participation but can also take ownership of any ongoing actions beyond the event itself,

either by incorporating them into existing processes, or taking the lead on new initiatives. After the challenge presentations, participants self-select which working groups to take part in, facilitated by the challenge owner. As with any Open Space, the 'law of two feet' applies so participants should always feel free to move among discussions to those they are learning from, contributing to or enjoying. The event culminates in a 'show and tell', where each group presents their challenge and the outcome of their work or discussion, closing with a request for participants to indicate any desire to stay involved.

Challenge-driven ThinkCamps for citizen science

The next two iterations of the ThinkCamp format took place as part of the international Citizen Cyberscience Summit conference series in London in 2012 and 2014 (CCS12 and CCS14). Although billed as a hack day for ease of communication and to attract external participants with technology skills for prototyping, the format followed that of the mHealth ThinkCamp but was more deliberately curated with a range of pre-defined challenges connected to the themes of the conference and presented by challenge owners. The goal was to open the event beyond the traditional conference community of practitioners (primarily citizen science practitioners from research institutions and academic organisations) to harness the knowledge and skill sets of a wider audience for creative problem-solving to the benefit of current and future projects.

This included inviting members of the regional hack day and DIY science communities (see Novak et al. in this volume), inviting volunteer participants from the citizen science projects represented at the conference, posting event information to Meet-Up groups related to the challenges (meetup.com), sharing information with grassroots organisations in related fields, making event registration public on Eventbrite (eventbrite.co.uk) and promoting on the event discovery platform Lanyrd (http://lanyrd.com/2014/citizen-cyberscience-summit/).

The challenges were framed to address problems in the field, define and develop the next step for existing projects, respond to challenges in practice and take advantage of new opportunities. Each challenge represented a different stage of the project cycle, from ideas for new projects to the furthering of existing projects. Both events opened with the challenges being presented in 'elevator pitch' style (a persuasive sales speech that takes no longer than an elevator ride), in front of a wall of posters for each of the challenges (see figure 10.1a). Participants were then
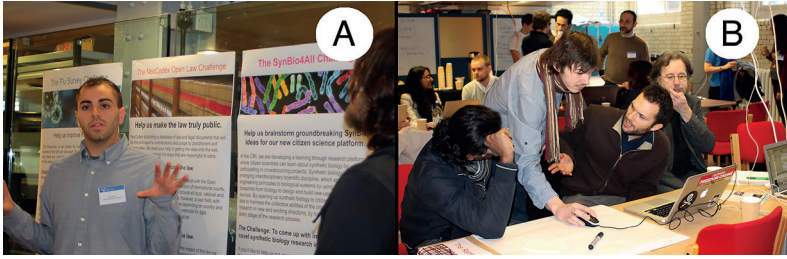
Fig. 10.1 The Citizen Cyberscience Summit ThinkCamp 2014, London England. *Image A* – Ian Marcus of the Centre for Research and Interdisciplinarity, Paris, introducing the SynBio4All Challenge during the 'Elevator Pitches'. *Image B* – Jesse Himmelstein of the Centre for Research and Interdisciplinarity, Paris, working with fellow participants on the RedWire.io Challenge. (Source: Margaret Gold, CCBY)

invited to join relevant working group tables based on their own experience, skills, personal interests or ability to make a contribution (see figure 10.1b).

The CCS12 conference featured 13 challenges and approximately 50 participants, and led to a number of projects moving forward with new ideas and fresh participation. A range of interesting prototypes were demonstrated at the end (see figure 10.2c) and an audience vote was taken on various prizes to be won (see figure 10.2d).

> For me, several highlights of the conference included the impromptu integration of different projects during the summit. Ellie D'Hondt and Matthias Stevens from BrusSense and NoiseTube used the opportunity of the PLOTS balloon mapping demonstration to extend it to noise mapping; Darlene Cavalier from SciStarter discussed with the Open Knowledge Foundation people how to use data about citizen science projects; and the people behind Xtribe at the University of Rome considered how their application can be used for Intelligent Maps – all these are synergies, new connections and new experimentation that the summit enabled. (Haklay 2012)

Building on this success, CCS14 featured a fresh set of 14 challenges and approximately 60 active participants, with five challenge outcomes presented at the end. Not only did the collaborations result in a wide range of projects being moved forward, but a number of new initiatives came out of the connections made.

Fig. 10.2 The Citizen Cyberscience Summit Hack Day 2012, London, UK: *Image C* – Leif Percifield of Newell Brands presenting the outcomes of the Air Quality Egg challenge at the Show & Tell. *Image D* – Louise Francis of Mapping for Change and UCL ExCiteS taking the audience vote, with a noise metre held aloft, for prizes to be won. (Source: Cindy Regulado, CCBY)

> The Cyberscience Summit Hack Day 2014 was a great experience for us at the Lightyear Foundation. We met many people, particularly Rick Hall from Ignite! From this meeting grew an idea for a Lightyear-Ignite! collaboration on Lab_13 Ghana: a pupil-led science space based at a school, based on similar projects in the UK. Following this we raised the funds, recruited volunteers, and in April 2015 launched the pilot at the Agape Academy in the Bosomptwe district in Ghana, which has already worked with 29 local schools and over 600 students. None of this would have happened without the Cyberscience Summit Hack Day!
>
> (Gavin Hesketh, UCL/Lightyear Foundation)

Workshops ran in parallel, which fit well with the hands-on theme and often provided relevant know-how but took time away from the Think-Camp itself. It takes about half a day for participants to embed themselves in a challenge, so where possible, a citizen science ThinkCamp should be a two-day event, with stronger connections between the workshops and the challenges. CCS14 also had a Citizen Science Cafe, based on the World Cafe format for hosting large group dialogue (http://www.theworldcafe .com/). This was introduced the evening before the ThinkCamp and brought 50-plus volunteers from various citizen science projects together with the organisers and scientists behind the projects. This was an important recognition of the value of the volunteer community and a chance to

meet like-minded people, as well as providing project owners with valuable feedback and insights. Unfortunately, almost none of these external attendees participated in the ThinkCamp the next day, perhaps due to the relative ease of attending an evening event over a full-day weekend event.

However, these events demonstrated that participants who had attended the full three days of conference sessions (keynotes, talks and workshops) came to the ThinkCamp with a range of new ideas and were eager to apply them in a new context, enhancing the discussions around the presented challenges. As the conference organiser reflected, after a day of 'listening' and a day of 'talking', the third and final day of the summit was about 'doing' (Haklay 2014).

The citizen science ThinkCamp at ECSA 2016

The most recent iteration of the challenge-driven ThinkCamp format was at the first international European Citizen Science Association (ECSA) conference in Berlin in 2016, as a full-fledged citizen science ThinkCamp to which the local Berlin DIY science, bio-hacker and maker communities were invited (see also Mazumdar et al. in this volume). Organised together with Lucy Patterson, who is co-organiser of Science Hack Day Berlin and the Berlin Science Hacking Community, the event was held on the third and final day of the conference and was structured as a day of collaboration, sharing and the exchanging of ideas (see box 10.1 below). To reduce barriers to attendance, the event was free for non-conference participants, held in a ground-floor space for ease of access and on a Saturday so that taking time off work would not be necessary. Participants were also encouraged to attend any of the mainstream conference sessions happening in parallel with the ThinkCamp for free.

Box 10.1. Citizen science ThinkCamp, ECSA Conference 2016

Why: To engage with local Berlin grassroots science and maker communities as part of the conference, collaborating on opportunities and addressing challenges in citizen science.
When and where: May 21, 2016, Berlin, Germany
Event wiki: https://sites.google.com/a/gold-mobileinnovation.co.uk/ecsa2016—citsci-thinkcamp/About-the-Think-Camp/home

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Who: Over 75 participants, of which 12 attended from outside the conference – participation was encouraged from local Berlin DIY science, bio-hacker and maker communities as well as volunteer participants in the citizen science projects represented at the conference.

What:

1. **The ECSA Inclusiveness Challenge** – How can we ensure that ECSA becomes an inclusive organisation?
2. **The WeCureALZ 'Engaging Diversity' Challenge** – Help us design unique and effective strategies to engage and retain diverse communities.
3. **The CitSci Communities of Europe Challenge** – Mapping the citizen science communities of Europe: How and why should we do this?
4. **The Overleaf Collaborative Writing Challenge** – How can Overleaf support collaborative writing between academics and citizen scientists?
5. **The Museum Data Visualisation Challenge** – How can the visualisation of observation data gathered in the field be made more engaging and dynamic for participants?
6. **The HealthSites.io 'CitSci for Health' Challenge** – What Citizen Science projects become possible with the health facilities geodata being mapped on the HealthSites.io platform?
7. **The Motion-sensing Camera Trap Challenge** – Help us to design and build a DIY camera trap for citizen scientists around the world.
8. **YOUR Citizen Science Challenge** – Two challenges were proposed spontaneously by participants on the day: 1) How can we apply citizen science to the issues faced by refugees? and 2) How can we make sure that citizen science projects are interoperable?

Outcomes: Of the seven pre-defined challenges, four are still actively being worked on at the time of writing, and two may lead to new collaborations. The two spontaneously presented challenges led to fruitful discussions and new connections made between the participants.

A key innovation at the ECSA ThinkCamp was to host a 'Citizen Science Disco' the evening before, which featured a series of talks from the local DIY science, hacker and artistic communities to provide them with an important voice that might otherwise have been missed. This set the scene for the ThinkCamp challenges the next day, where the goal was to collaborate with the broadest local audience possible (Patterson 2016).

Outcomes of the citizen science ThinkCamp challenges

Benefits to the projects and project owners who presented a challenge at the ThinkCamp included making new contacts, the exploration of project goals and audiences, insights into engaging audiences and new practical solutions. Having project leaders present to lead discussion was key to ensuring results and ownership of new actions, and this also worked particularly well for the spontaneous challenges where challenge owners were motivated by the projects presented and opportunities to collaborate.

Participants in the ECSA Inclusiveness Challenge session (see the challenge poster in figure 10.3 image E) agreed that citizen science has the potential to be a transformative approach and make research more inclusive, but that work needs to be done to achieve this. Three main areas of focus were defined during the discussion, with a range of main

Fig. 10.3 The ECSA citizen science ThinkCamp 2016, Berlin Germany: *Image E* – The ECSA Inclusivity Challenge poster. (Photo credit: Margaret Gold, CCBY). *Image F* – The ECSA ThinkCamp participants in working groups alongside the related challenge posters. (Source: Florian Pappert, CCBY)

points for attention and action items being picked up by ECSA head-quarters in partnership with synergistic activities such as the Citizen Science COST Action. These points were worked on further at the Doing-it-Together Science (DITOs) European Stakeholder Round Table on Citizen and DIY Science and Responsible Research and Innovation (RRI) (Göbel 2017).

For the WeCureALZ (now 'EyesOnALZ') Engaging Diversity Challenge, 'the ThinkCamp had a huge beneficial impact . . . across many dimensions – a testament to the preparation, participants, and format' (Pietro Michelucci, Human Computation Institute), including renaming the project and associated game, a new approach to designing game levels, removal of the 'test phase' at the start of the game to lower barriers to entry, and consideration of accessibility factors for an older audience, such as larger fonts, buttons and full-screen video elements (Ramanauskaite 2017b).

The facilitator of the CitSci Communities of Europe Challenge, Jose Luis Fernandez-Marquez of the Citizen Cyberlab and University of Geneva, reported that the ThinkCamp brought new contacts, which will be beneficial to the DITOs project they are participating in, as well as establishing a number of key functional requirements:

> I was especially surprised with the interest of the EC [European Commission] in these kind of maps. Initially the goal of the map was outreach – to increase the visibility of CS [citizen science] projects over Europe, allowing citizens to easily find new CS projects. However, the information we were gathering was very useful for the EC to evaluate CS projects, their impact, to see what happen with the CS projects over the long term (especially those funded by the EU). Also, CS project owners were very interested in the map. They wanted to see the different technologies each of the projects is using. They mentioned as an example, that there are more than 10 CS projects tracking foxes in cities, and they implemented the apps every time from zero.

The owner of the Overleaf Collaborative Writing Challenge was unfortunately unable to attend the event, but another participant at the conference volunteered to lead the discussion. A detailed discussion ensued, which identified the potential for a small research project and generated the enthusiasm to take it forward. However, lack of ownership or further investment might hinder development. The Healthsites.io 'CitSci for

Health' Challenge suffered a similar fate, with the project owner unable to attend at the last minute and no volunteer facilitator available. Consequently, this challenge failed to form a group of participants.

Participants in the Museum Data Visualisation Challenge discussions spent time defining who museum audiences are, and what their motivations and interests might be for museum data, before bringing that back into recommendations for the digital representation of data.

The Motion-sensing Camera Trap Challenge attracted a mix of participants with hardware hacking and DIY science skills, who further defined the challenges to building your own camera trap, and examined three alternative pieces of kit by taking them apart and making notes on the challenge Etherpad (Hsing 2016). Work on this challenge was moved forward beyond the event by posting a challenge to the broader DIY science community on the Hackaday.io platform (Ramanauskaite 2016), and running an open workshop session at the annual Mozilla Festival in London in November 2016.

The importance of encouraging and providing space for external participants to raise issues that matter to them, in order to draw on the wide range of experience and skills in the room, was again evident at the ECSA 2016 ThinkCamp. The two spontaneous challenges (see box 10.1) both led to fruitful conversations. Spontaneous challenge owners are often uniquely placed to act on any outcomes beyond the event because it is inspired by something directly relevant to them, and they gain the support of new contacts.

Best practice recommendations for creative collaboration events

Creative collaborative events can foster co-creation, co-design and collaborative thinking at all points in the citizen science research cycle. Challenges that are well-suited to creative collaboration have represented the full spectrum of the project lifecycle, from ideas for new projects and the beginning phases of newly funded initiatives, through mid-project improvements and impetus for new directions, to the creative application of existing tools and platforms in new ways, and finally to the representation of data upon research conclusion.

Additionally, by taking the time to reach out to a wider group of potential participants, particularly those connected to the subject matter of the challenges as well as those traditionally under-represented in citi-

zen science research, means that more diverse experiences and viewpoints are brought to the table.

To meet their potential to support inclusive, co-creational approaches to citizen science, the following steps are recommended for project initiators and event organisers.

Before the event

1. Resource:
    a. Budget for a part- or full-time community manager, and the support of grassroots community spaces in funding applications for your events;
    b. Consider accessibility, travel and dietary requirements of participants in advance and budget for these costs.
2. Ownership: Invite pre-event challenge submissions and encourage attendance by the challenge owner. This is key to attracting participants and to following up on actions post-event. Consider how contributions will be recognised and accredited by the project owners.
3. Outreach: Actively reach out to a diverse range of participants and be sensitive to removing barriers to attendance, including time of day and physical location. Explore ways to give local people a platform and a voice, particularly those who would not call themselves citizen scientists.

During the event

4. Context: Set the context and find ways to make it relevant to what people already know.
5. Equity: Create the space to value and share knowledge and experience between all participants on an equal footing for mutual benefit. This might require self-regulation from some participants to ensure everyone's contributions are valued.
6. Representation: Build elements into the event programme that actively allow other voices to be heard such as World Cafe–style dialogue or guest talks.
7. Spontaneity: Invite, encourage and support spontaneous contributions from participants.
8. Innovate: Embrace serendipity, failure and unexpected outcomes to enable innovation.

9. Openly evolve: Document, evaluate and reflect on your events to share and help evolve creative collaboration approaches further. Prototypes, videos, reports and code can all be posted online. Be sure to credit everyone and get prior informed consent.

After the event

10. Connect: Provide forums or facilitate connections through which people can stay in touch and updated on progress (but which they can also opt out of).

Event organisers need to consider the fact that many people outside the existing community of citizen science practitioners do not necessarily identify with the label 'citizen scientist' (Eitzel et al. 2017; Lewandowski et al. 2017), even when they may be participating in activities that fit the academic definition.

> Problems include: The fact that not all communities are included in the conversation: not everybody identifies themselves with the same labels we use. That means we have the responsibility to be aware of these communities and reach out with them.
>
> (Ramanauskaite 2016)

A diverse range of voices contributing to the ThinkCamp process is possibly as important as the outcomes of the event itself: 'Citizen science does not replace this definition of "best available science" but adds a new dimension. The broader definition includes wider participation, broader impacts to society, and chances for many perspectives to add their voices to the final analysis' (Freitag 2013, 2).

Serendipity must be embraced when designing and running any variation of creative collaboration event, where participants are being invited to shape or entirely drive the agenda. Although the organiser can structure ThinkCamp events to support a certain desired outcome, once the event begins, control is handed over to those who are in the room – it is their event now, and they will take it in the direction that meets their needs, satisfies their curiosity or resolves their desire to seek a particular solution.

Harrison Owen advises strongly on the importance of letting go all control of Open Space, and defines the four principles as '1) Whoever comes is the right people. 2) Whatever happens is the only thing that could have. 3) Whenever it starts is the right time. 4) When it is over it is over'

(Owen 1993, 31). ThinkCamps should therefore not be resourced and funded with strict 'performance criteria' in mind, such as defined outputs or attendance numbers.

In fact, challenges spontaneously proposed by participants at the event itself should be actively encouraged and supported. Successful creative collaboration events can bring the virtuous circle of 'informal, unstructured and social' learning (Jennett et al. 2016, 15) to life in face-to-face interactions between participants and scientists:

> It is important to provide enough creative space where grassroots initiatives can flourish side-by-side with more established forms of scientific knowledge production and a platform where the community can meet and exchange ideas so as to establish fertile grounds for the broader dissemination and uptake of this collaboration between citizens and scientists.   (Schäfer 2016, 10)

Further, with the advent of the DIY science, open science and maker movements, it is important to consider how to foster and build capacity, support the crossover of knowledge and know-how, and share with creative citizens participating in these spaces, as there is much to be learned from different groups (Patterson 2017). Holding project-funded events in grassroots community locations such as Fab Labs and Hackerspaces is one tangible way to provide these communities with much-needed financial support. (Patterson 2017; Ramanauskaite 2017a)

Indeed, the recent Arizona State University Maker Summit brought the maker and citizen science communities together to share insights, tools and best practices (Prange, Lande & Cavalier 2018). The Learning Outcomes and Next Steps report from this event can be found online at https://makersummit.asu.edu/. All such approaches to generate insights and foster cross-pollination by bringing these communities together through creative collaboration are welcomed.

Theoretically, creative collaboration events for citizen science can be situated alongside other creative research methods. For example, within media and communication studies, Gauntlett (2011, 4) considers 'making' as a way of connecting ideas, to other people and to the social and physical environment:

> This rarely seems to be a matter of 'making what I thought at the start,' but rather a process of discovery and having ideas through the process of making. In particular, taking time to make something, using the hands, gave people the opportunity to clarify thoughts or

feelings, and to see the subject matter in a new light. And having an image or physical object to present and discuss enabled them to communicate and connect with other people more directly.

It is here that creative collaborative events involving diverse participants might add considerable value to what citizen science offers, in terms of making sense of the world around us, our relationships to it and to one another.

Conclusion: Towards participatory democracy

The evidence and outcomes of ThinkCamps, which were designed to open up formal academic conferences to participation from a wider community, point to the value of embedding such events more deeply within citizen science projects. They are a valuable tool with which to foster co-creation, co-design and collaborative thinking during the citizen science research cycle.

Experience evolving these creative collaboration event formats to embed them within citizen science demonstrates the potential to deliver on the promise of science capital, and the principles for diversity and inclusion within citizen science as set out within the ECSA Ten Principles (see Robinson in this volume). More in-depth evidence and further research is required but it is important to consider how these approaches might be of value to supporting democratic participation in science policy by bridging the science-society gap.

The citizen-led approach to a shared understanding of both the problem and the solution, with event-based support for co-creation throughout, has clear implications for how policy could be formed in areas where science has a vital role to play, such as biodiversity management, air and water pollution, and fracking. For example, the pan-European DITOs project sets out to involve citizens in both bio-design and, critically, to contribute to policy on environmental monitoring.

Furthermore, as more communities become active in devising and leading their own citizen science projects, there is an opportunity for policymakers to not only play a key stakeholder role in the project life-cycle, but also to support such grassroots efforts by ensuring that there is a pathway to action and funding:

Strategic policy-making needs to consider inclusive programme designs and funding mechanisms. . . . When we talk about funding,

agencies should consider a funding programme for citizen science projects that aims to collect the manifold experiences from the different project typologies of this ever evolving research methodology and that creates visibility for the potentials of citizen science for researchers and the public. (Schäfer 2016)

Sociologists have outlined both the possibilities and practical and ethical challenges of deliberative democratic methods to engage citizens in public policy-making (Irwin 2001; Árnason 2012; Saunders & Mulgan 2017). The field of participatory democracy and the concept of the 'participatory turn' (Bherer et al. 2016) provides guidance as to how creative collaboration events could further bridge the gap between science and society, by scaling this approach to engage citizens, scientists and policymakers together. This has implications for funding bodies and how they select the initiatives which they support:

A clear challenge to design a programme that allows participation of "grassroots" initiatives, which are driven by civil society organisations or by independent citizen scientists, therefore presents itself. . . . In the long run, citizen science should not be seen as separate from other research areas but as an integral part of existing scientific activities comparable to science communication. Thus the involvement of citizens could become one of the selection and evaluation criteria in existing funding schemes. (Schäfer 2016)

Those planning their own future citizen science projects, or practitioners seeking to support grassroots initiatives for scientific enquiry, should therefore consider not only introducing such events as a tool for inclusion and co-creation, but also deliberately engaging with policymakers to bring community-based citizen science initiatives into the fold of existing scientific activities that inform policy and civic action. Policymakers should also be encouraged to consider the recommendations for running creative collaborative events as a process to facilitate a range of expertise contributing to and influencing decision-making.

Finally, given that citizen science projects often use the internet, and that participative democracy needs to draw on wider contributions, it will be important to consider and evaluate effective, equitable and accessible ways and tools to foster contributions to the co-design, analysis and reporting of citizen science projects. This might also help with tracking follow-up actions and contributions, sharing methods, innovations and progress more widely.