

Chapter 13

Participants in Citizen Science



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Abstract The most important factor that defines citizen science is that non-professional scientists contribute to scientific research. Therefore, it is important to recognise the perspectives and experiences of these participants. Projects may provide ways for participants to contribute to scientific research at different stages of the scientific process according to different levels of engagement. Understanding what motivates citizen scientists to engage in a project, and subsequently matching the project to these motivations, will help project leaders to recruit and retain participants. In addition, it is important to understand what benefits participants gain from engagement in citizen science projects. For individual projects, this will help ensure that scientists as well as participants benefit. For the wider field of citizen science, this will provide evidence of the potential impact of citizen science on participants. However, participants may also encounter challenges during their engagement with citizen science projects. Project leaders and scientists should plan in advance to address these challenges and ensure that relevant expertise is present in the project team.

Keywords Citizen engagement · Participant motivation · Participant experiences · Learning outcomes · Participant benefits · Recruitment

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Introduction

The feature that most distinguishes *citizen science* from other forms of science is that non-professional scientists are involved in the scientific process. These non-scientists, the ‘citizens’ in citizen science, can collaborate with scientists in all stages and aspects of the scientific process, but, in most projects, they contribute to data collection and data analysis. The terminology used to describe participants in citizen science varies across the field, like the definition of citizen science in general (Haklay et al., this volume, Chap. 2). Eitzel et al. (2017) explored terminology in citizen science and found a range of terms, including hobbyist, amateur, citizen scientist, collaborator, human sensor, and participant. Many of these terms have a negative connotation, and some do not cover what participants in citizen science projects actually do. For example, *citizen* may have a negative connotation for people who do not have citizenship in the country they live in. The term *volunteer* may be too general and does not encompass the fact that most citizen science projects strive to provide benefits to the non-scientists involved. Eitzel et al. (2017) propose that scholars and practitioners in citizen science choose their terminology deliberately and explain their definitions of the terms chosen. In this chapter, we will use the terms participant and citizen scientist to incorporate anyone within a citizen science project who is not part of the project coordination team.

The field of research about participants’ experiences in citizen science is new and borrows from many other fields. For example, although the use of the term volunteer for participants in citizen science can be problematic, much of the research regarding participants borrows from the field of volunteer research in social science and health. Motivations for volunteering in general are similar to motivations for participation in citizen science. Research and theory from other fields such as education, psychology, and social science are also applied to the study of citizen science participation.

In this chapter, we will discuss several aspects that are important to consider when analysing the perspective of participants. First, we will describe how scrutiny of the role of participants and their perspective has grown. Then we will discuss participants’ motivations to engage with citizen science. Understanding why citizen scientists engage with a project can help project leaders with retention of participants. Next, we will discuss the benefits participants gain from their engagement with citizen science. These outcomes are ideally aligned with participant motivations and with the goals of project leaders. Lastly, we will discuss the challenges both participants and project organisers face in citizen science projects in relation to participation and recommendations for resolving these challenges in practice.

Increased Scrutiny of Participants

The field of citizen science has been professionalising over the last few decades (see also Haklay et al., this volume, Chap. 2; Vohland et al., this volume, Chap. 3). As part of that process, there has been an increased scrutiny of the viewpoint of the citizen scientist. Kullenberg and Kasperowski (2016) determined that there is a growing trend in the number of scientific papers about citizen science. One of the clusters of publications they found was on the social science of citizen science in journals such as *Public Understanding of Science*. These papers include the experiences of citizen scientists. In addition, the *ECSA 10 Principles of Citizen Science* (ECSA 2015) includes no less than five principles explicitly addressing the citizen scientist's perspective.

Taking the knowledge, skills, and expertise of citizens as collaborators in scientific research seriously fits into a larger trend towards public participation in several other areas. For example, within the field of science communication, there has been a shift from one-way communication towards more interaction between science and society (Smallman 2018). In addition, many local governments organise public dialogues and public consultations for decision-making processes. Similarly, the field of health care has also increasingly included the voice of the patients and the public (Ceccaroni et al., this volume, Chap. 12; Tritter 2009). In all these fields, the assumption is that involving the public in science, policy, and health will make for better outcomes and decisions and that by making use of the public's knowledge and ideas, these decisions will also be supported by a broader audience.

In citizen science, scrutiny of the role and viewpoint of participants has increased because, in addition to developing and providing clear procedures and protocols to ensure data quality (see Balázs et al., this volume, Chap. 8; Hidalgo et al., this volume, Chap. 11), making sure that participants' expectations and needs are satisfied also influences the quality of scientific outcomes. Since most citizen science projects have project goals regarding benefits for participants, it is also necessary to understand their experiences in order to measure outcomes. Further, increased understanding of participants' experiences is necessary to make claims about the overall benefits of citizen science for participants and society.

Involvement of Citizens

Levels of Engagement

In general, citizens can engage in different levels of the scientific process: development of research questions and hypotheses, data collection, data analysis, drawing conclusions, and disseminating data. In all of these stages, engagement can be top-down (directed by the project leaders) or bottom-up (directed by participants themselves). Bonney et al. (2009) developed an often-used categorisation of citizen

science projects. Their framework defines *contributory* projects as projects where scientists design the project and participants are involved in collecting and analysing data according to predefined protocols. In *collaborative* projects, participants may also be involved in adjusting protocols, drawing conclusions, and proposing new directions for research. Finally, *co-created* projects include citizens in all stages of the scientific process; scientists and citizens collectively design and develop the project. Another categorisation that is often used in the field of citizen science is the levels of participation coined by Haklay (2013): *crowdsourcing*, *distributed intelligence*, *participatory science*, and *extreme citizen science*. Here, levels range from ‘citizens as sensors’ (crowdsourcing) and ‘citizens as interpreters’ (distributed intelligence) to levels where participants are more involved in problem definition and collection protocols (participatory science) or are even part of the entire development of the scientific process (extreme citizen science).

In both of these categorisations, participant engagement will look different according to the type of project involved. Most citizen science projects are contributory or crowdsourced/distributed intelligence projects. In these projects, participants are recruited to contribute to a certain scientific cause, and they then register with a project that fits their motivations and interests and start contributing according to a fixed protocol. Most of the projects listed on platforms such as Zooniverse and SciStarter are contributory projects, and many participants are excited to be able to contribute to science in this way. The development and growth of the Internet and mobile technologies have enabled many people to contribute to science from the field or from their own homes (Silvertown 2009). One disadvantage of these large online contributory projects is that often a large portion of participants only contribute once and then leave the project; the majority of the work is done by only a small number of participants (Sauermaann and Franzoni 2015).

In collaborative and co-created projects (Bonney et al. 2009) and participatory science and extreme citizen science projects (Haklay 2013), participants have a more active role in the development of the project itself. They can be involved in sessions where the results of the project are being discussed and interpreted. They can also contribute to the dissemination of the results to other stakeholders, such as local municipalities. For example, in the *Co-click’eau* project in France, farmers, water policymakers, and other stakeholders collaborated to determine and assess the consequences of different scenarios to comply with EU freshwater regulations. In some regions, using this approach to citizen science results in co-designed action plans and collaborative learning (for a case study, see Bio Innovation Service 2018).

Although many participants may be satisfied with a minimum level of engagement in a citizen science project, in general it is better to provide opportunities for participants to become more involved in a citizen science project if they want to be (see, e.g. ECSA 2015). Many projects have opportunities available to become more engaged, for example, through interaction in an online forum, by becoming a moderator or trainer, or in small-scale workshops on data interpretation or policy involvement. Sometimes these opportunities evolve within a project because participants request them. An example is the Dutch project *Schone Rivieren* (Clean Rivers). In this project, participants were trained to monitor waste along the

riverbanks of two large rivers in the Netherlands. After several participants offered to do more, the project started to organise *hackathons* and *maker days*, allowing engaged participants to help with other aspects of the project, such as a national conference, improving training material, and community building. As a result of the initiative of these active participants, the project itself is now working on a more embedded way for others to also increase engagement. The preference of participants for a certain level of engagement depends largely on their motivation to participate.

Motivation to Participate

Motivations for participating in citizen science projects vary between individuals. In order to attract participants and keep them engaged in a project, it is important to understand what drives them to participate and why they stick with a project or leave it. The frameworks for studying motivation in citizen science participation come from research conducted on volunteerism in the social service sector, aimed at understanding the psychological and social processes that initiate and sustain volunteerism (Clary et al. 1998; Finkelstein 2008). Clary et al. (1998) proposed the Volunteer Function Inventory (VFI), a measure of six motivational functions for volunteering (*values, understanding, social, career, ego protection, ego enhancement*) based on the psychological theory of functionalism (Katz 1960) – according to which people display similar attitudes in response to psychological functions that serve individuals’ needs.

Studies about motivation in citizen science often use social science research methods such as *surveys* and *interviews* (see Schaefer et al., this volume, Chap. 25). In surveys, participants generally indicate how strongly they agree with a list of statements about their motivation (e.g. ‘I participate in this project because I like to contribute to scientific research’) or they indicate the motivations that are most important to them. Often several of these questions are then combined within categories of motivation such as *contribution, intrinsic motivation, extrinsic motivation* (e.g. West and Pateman 2016); others divide motivations into how much they serve a person’s own interests or the interests of others (e.g. Rotman et al. 2012). Several studies have been conducted to unpick citizen scientists’ motivations (Curtis 2015; Land-Zandstra et al. 2016a; Raddick et al. 2013; Rotman et al. 2012; Wright et al. 2015; Agnello et al. 2020). In many of these studies, participants are motivated by the fact that they are contributing to ‘real science’, or to the overarching goal of the project (e.g. the environment, health, biodiversity, astronomy). For example, in the *Galaxy Zoo* project, almost 40% of the people that took part in a survey about their motivation picked the statement ‘I am excited to contribute to original scientific research’ as their primary motivation for participation, making it by far the most important motivation (Raddick et al. 2013).

Another important motivation is often an intrinsic interest in the particular topic of the project, such as birds, galaxies, plants, language, etc. For example, many bird

monitoring projects attract people who already are interested in spotting birds or who are interested in nature (Wright et al. 2015; Sullivan et al. 2009). Health-related citizen science is often strongly linked to a personal interest as it may provide people with a certain disease or illness a way to contribute to research towards a treatment or a cure (Wiggins and Wilbanks 2019). For example, in the Dutch air quality project, *iSPEX*, many people stated that they contributed because they themselves or a family member had asthma (Land-Zandstra et al. 2016a).

Other common motivations are related to enjoyment, recreation, and social interaction; participants often look for enjoyable activities or a way to become part of a community of like-minded people. For example, *BioBlitzes* (see Rüfenacht et al., this volume, Chap. 24) provide an opportunity to collect biodiversity data in the field, working in groups where people meet each other face to face. Asah and Blahna (2012) found that people who want to converse and interact with like-minded people are more likely to participate in citizen science projects. Other studies have shown that face-to-face interactions with leading scientists can positively influence the level of participation in a project (Havens et al. 2012). The motivations to socialise and for recreation drive outcomes such as the level of personal investment and the willingness to advocate for the programme (Agnello et al. 2020). Other projects offer communication channels on their website, such as a forum, or organise separate events where participants can meet each other and project leaders offline and share their experiences. For example, in the citizen science game *Foldit*, players use their problem-solving skills to come up with ways proteins can be folded. In this project, participants revealed in interviews that the fact that they could collaborate in the game with a diverse community who shared a common goal was one of the things they enjoyed most (Curtis 2015). In cases where citizen science has been ‘gamified’ (i.e. turned into an online game), competition also sometimes serves as a motivating factor.

Although research on motivation in citizen science is increasing, much of it involves case studies which makes it hard to compare across projects. In order to work towards a more universal framework for assessing motivation for citizen science, Jeanmougin et al. (2017) conducted a systematic literature review¹ of articles that studied citizen scientists’ motivations. They proposed a framework based on existing theory of basic human values (Schwartz et al. 2012). Levontin et al. (2018) used Schwartz’s universal human values to develop such a framework, supplemented with motivations that are unique to citizen science (based on the literature review). They then developed an extensive questionnaire to measure these motivations in citizen scientists. Table 13.1 shows the motivation categories, the definition of each category, and an example in each category. The assumption is that if an assessment of motivation to participate in citizen science is based on this overarching theoretical framework of basic human values, using the questionnaire, then it will become easier and more reliable to compare different projects

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Table 13.1 Categories of motivation, based on Levontin et al. (2018)

Motivation category	Definition in terms of motivational goals	Example
Self-direction	Independent thought and action – choosing, creating, exploring	‘I want to learn’
Stimulation	Excitement, novelty, and change	‘I strive to challenge myself’
Hedonism	Pleasure and sensuous gratification	‘I want to have fun’
Achievement	Personal success through demonstrating competence according to social standards	‘I am seeking fame’
Power	Power through exercising control over people and material and social resources	‘I want to gain recognition and status’
Face	Security and power through maintaining one’s public image and avoiding humiliation	‘I want to enhance my reputation’
Security	Safety, harmony, and stability of society, of relationships, and of self	‘I want to live in secure surroundings’
Conformity	Restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms	‘Other people I know are participating’
Benevolence	Preservation and enhancement of the welfare of people with whom one is in frequent personal contact	‘I am happy to help’
Universalism – social	Commitment to equality, justice, and protection for all people	‘I want to improve our society’
Universalism – nature	Preservation of the natural environment	‘I want to help wildlife’
Routine	Everyday, ordinary, and regular	‘I was doing this activity anyway’
Belongingness	One’s feeling of being secure, accepted, included, valued, and respected	‘I want to socialise with other people’
Help with research	Contribution to science	‘I want to contribute to science’
Teaching	Providing an educational opportunity to others	‘I want to share my knowledge and experience’

(e.g. biological versus astronomical; online versus offline) and different participant groups (e.g. children versus adults).

In addition to learning more about motivations to participate in citizen science projects, it is also important to understand how motivations change over the course of a project. Several studies have focused on changing motivation over time and different levels of engagement (Crowston and Fagnot 2008; Eveleigh et al. 2014; Land-Zandstra et al. 2016b; Rotman et al. 2012). Crowston and Fagnot (2008), for example, suggest that, initially, participants are mainly motivated by curiosity about a project, while long-term participants also include social obligation, a shared ideology, and a feeling of satisfaction as motivating factors. Rotman et al. (2012) found that, in their sample, new participants were generally guided by egocentric

motivations, while long-term participants were more motivated by helping others. Similarly, Land-Zandstra et al. (2016b) found that participants who had been involved with the flu-tracking project *The Great Influenza Survey* for a while identified with contribution to science as a motivator in greater numbers than newer participants. However, comparing new and long-term participants is not the same as measuring a change of motivation over time within the same cohort. This kind of longitudinal research on participants' motivation, which is rarely conducted in citizen science projects, should be encouraged.

Benefits and Outcomes for Participants

Participants in citizen science derive a variety of benefits and outcomes. From the individual participant's perspective, these benefits are related to, for example, scientific literacy, health benefits, opportunity to socialise, and empowerment (Blaney et al. 2016, Haywood 2014, King et al. 2016). For example, Moore et al. (2006), researching community involvement in conservation groups, looked at the benefits of participation and found higher health and well-being in participants engaged in land management. A correlation between participation in environmental work and benefits relating to physical, spiritual, and social health was also found in a study involving people suffering depression (Townsend 2006). Another study categorised the benefits perceived by participants as *altruistic*, *individual*, and *organisational* (Agnello et al. 2020).

In addition to the scientific impact of citizen science, projects can and should seek to ensure benefits for participants which, in turn, can be drivers of outputs and outcomes, such as the level of personal investment and willingness to advocate for the programme. For example, a study surveying different citizen science projects in the south-east of England found that participants who perceived individual benefits dedicated more time to the programme, got involved in additional activities within the same organisation, visited more sites, and attended more training sessions. Moreover, both altruistic and individual perceived benefits predicted participants' willingness to advocate for the programme (Agnello et al. 2020).

Benefits are often connected to the motivations that participants have when contributing to a project. For example, when someone takes part in a project to learn more about butterflies, then increased knowledge and understanding would be an expected benefit. Or, if someone engages in a citizen science project because he or she is concerned about an environmental issue in his or her neighbourhood, the outcome for the participant might be empowerment to be able to address the issue with the local municipality or other stakeholders.

In addition, project leaders may have certain goals in mind with regard to outcomes for participants, often in terms of learning outcomes, increased awareness about an issue, and behaviour change. Alongside the lack of coherent research about motivation of participants, participant outcomes are not often studied or, if they are, it is hard to draw overarching conclusions for citizen science projects in general.

Phillips et al. (2018) reviewed intended outcomes of citizen science projects in the USA and Canada and found that the goals that were most often identified by project leaders were improving research skills, increasing content knowledge, and increasing environmental stewardship (e.g. protecting water quality). In a follow-up online survey of project leaders, Phillips et al. (2018) found that around half of the respondents measured the outcomes of their project. The most reported outcomes were *interest or engagement in science* (46%), *knowledge* (43%), *behaviour change* (36%), *attitude change* (33%), and *research skills* (28%). Interestingly, there was a discrepancy between the most commonly stated goals of the project and the outcomes that were measured.

Subsequently, Phillips et al. (2018) proposed a framework of common citizen science outcomes to be used for the formulation of clear project goals and for the evaluation of a project's impact based on those outcomes. They supplemented the aforementioned outcomes with *self-efficacy* (confidence in one's ability to participate in science), *behaviour and stewardship* (new actions as a result of the participation), and *motivation* ('goal-driven inclination to achieve a science behavior or activity'). We will discuss each of these outcomes with examples.

Often the most obvious outcome that project leaders aim for is increased knowledge and understanding among participants about a specific topic or science literacy in general. Even though this is often not the most important motivation for participants, they can still achieve knowledge gains (either measured or self-reported). For example, in a citizen science project conducted by the US National Institute of Invasive Species Science (NISS), participants showed an increased level of knowledge about invasive species (Crall et al. 2012). However, their knowledge about the scientific method did not increase; this type of general science literacy may be harder to impact.

Related to an increase in scientific knowledge, citizen science projects can have an impact on participants' research skills. In particular, participants may learn to conduct certain data collection protocols such as identifying species of bees or birds, or measuring variables such as air pollution or water quality. These increased skills are beneficial for the participants but also for project leaders, since increased research skills also generally increase project data quality.

Many citizen scientists start contributing to a project because they have a pre-existing interest in the project's topic. People can also become even more interested in the topic once they engage with it further. For example, in an online transcription project where participants had to transcribe sixteenth- and seventeenth-century handwriting, a small group of participants chose the more difficult task of deciphering sixteenth-century handwriting in preference to the easier task of deciphering the seventeenth-century handwriting (De Moor et al. 2019). Although prior interest is more often assessed as a prerequisite for participation in citizen science, more research on increased interest as a result of participation would be interesting.

Self-efficacy, the confidence about one's ability for a certain task or behaviour, is not often measured as an outcome of citizen science, even though Phillips et al. (2018) reported that it was mentioned by project leaders as an intended outcome.

However, participation in a citizen science project may show participants that they are able to perform science, even if they did not previously think of themselves as scientists.

In many environmental and health-based citizen science projects, the motivation of organisers as well as participants may be to produce scientific knowledge and have an impact on issues such as water quality, air quality, and health. Changing behaviour of participants, and, indirectly, of other stakeholders, may be one of the goals. For example, in the *Clean Rivers* project, participants reported having changed their behaviour in terms of their plastic use and their waste disposal behaviour. In projects that are initiated by citizens, for example, because they want to improve their environment with regard to air pollution, the results that they obtain with citizen science may empower them to challenge local government. However, real evidence of these types of impacts is hard to quantify and the results are often mixed (Phillips et al. 2018). More research is needed to determine how citizen science can change participants' behaviour.

The last outcome that Phillips et al. (2018) identify, motivation, can be seen as a factor that influences a person's decision to participate in a project as well as an outcome of the project, similar to interest. We have already described motivation as input for engagement in a project. Motivation as an outcome includes the motivation to continue engaging with a project, to become more active in a project, and to become engaged in other, related, activities.

Participants' Challenges and Recommendations for Project Leaders

As may have become clear from the discussion of participant experiences, motivations, and outcomes, complying with the individual personality traits, values, emotions, and interests of participants in citizen science is a complex task. These aspects determine the motivations, expectations, and barriers of the target audience, which can differ at each phase of the project and the participant experience. In this section, we will focus on some of the challenges that limit participant engagement throughout the project life cycle along with practical recommendations for resolving these – see Table 13.2 for an overview (based on Agnello 2014).

The way project goals, tasks, and recruitment messages are communicated represents a key factor. Initially, willingness to engage with citizen science can be affected by the extent to which the *communication strategy* (the message, wording, and media) is inclusive and matches the motivation of participants. For example, 'skill level' may not be the correct phrasing to use during recruitment as the distinction between 'skilled' and 'unskilled' participants can discourage participation. Potential participants without the required skills in terms of qualifications or with no prior experience, but whose enthusiasm and knowledge can be built over time, may feel excluded. Moreover, certain aspects of project design, such as data

Table 13.2 Challenges to participation in each phase of citizen science projects and recommendations for project leaders

Phase of project management	Phase of the participant experience	Challenge or barrier to participation	Recommendations for project leaders
Recruitment	Motivation to join a project	Communication is not inclusive	Develop communication strategies based on your target audience
		Project goals are not clearly communicated to tap into motivations	Understand what motivates participants in citizen science
	Early stages of engagement	Finding the right task that fits participants' interests, skills, and time availability	Conduct a preliminary assessment of motivations, expectations, availability, and barriers of participants
		Understanding how one can contribute to the project	Communicate clearly tasks for participants, explain aims of the project and the meaning of participants' work
		Not feeling integrated in a well-established group	Plan for welcome of incomers
	Retention	Perceiving benefits and satisfaction	Motivations are not met
Costs of participation			Identify participants' perceived benefits, assess satisfaction, and ensure benefits exceed the costs
Continued engagement		Lack of efficiency in data flow	Data collected by citizens must be shared and used
		Not feeling accomplished	Communicate results and impact of contribution
		Not feeling appreciated	Understand how to reward different types of people (training, give responsibility, reward, recognition, feedback)
		Not feeling acknowledged	Acknowledge contribution, giving adequate recognition of achievements on the website
Evaluation and wrapping up		Overall experience and role in the wrap up	Feeling that expectations have not been met
	The project is archived		Give open access to the documentation produced during the project
	Accessibility of data		Provide access to data to the wider audience
	What's next?		Guide participants to new projects

collection and submission, are potential barriers to participants; project design should take into account different abilities and age groups.

From the early stages of engagement, it is important to communicate clearly the different ways participants can contribute to a project. Project leaders need to make sure participants are aware of how they can make a difference through citizen science by doing something interesting, feasible, and achievable for them. If participants are expected to do a complex and effort-intensive task without being reimbursed for their time, project leaders need to clearly define the tasks involved to complete the project and justify why they are seeking public help; otherwise participants may feel it is the government's or the scientists' responsibility to pay participants. Communication strategies (see Rüfenacht et al., this volume, Chap. 24) and inclusiveness (see Paleco et al., this volume, Chap. 14) must be carefully addressed when planning citizen science projects to make sure that diverse groups of participants are engaged, regardless of their skill level, education level, age, gender, ethnicity, and socio-economic status. Also, it must be acknowledged that participants' availability is a potential limiting factor; therefore, project planning should tackle this issue by giving participants the opportunity to contribute when they are able, for example, on the weekends.

Participants dropping out of projects after a short time are often a big challenge. Some of the causes are linked to the dynamics of participation in a community which are determined, for example, by culture, age, and similar factors that can make it difficult for people to feel integrated or involved in a project. For example, a homogeneous group (e.g. made up of all retirees or of a particular ethnic group) can be intimidating and also a barrier to new participants feeling integrated. Therefore, welcoming new participants when they become part of a citizen science community is essential and must be planned for, including offering orientation, explaining how the project functions and key roles in the team, as well as offering opportunities to be introduced to the project community. For example, informal conversation can help to create a positive experience that helps participants to feel welcome and become aware of the ways to ask for help or how to improve their skills; this also enables the project leaders to find out more about their interests and barriers. In order to build an inclusive and effectively engaged community, the project team must ensure a common understanding of data quality among participants and provide constructive feedback, being careful about correcting participants without demotivating them.

Another factor that influences the decision whether or not to continue engagement is how well a project matches participants' motivations and expectations. When there is a mismatch, participants may become very frustrated. For instance, participants whose motivation to join a project is to feel like they are contributing to something important generally expect that information they provide is useful and that data are being utilised in a conscientious and effective way. If there is a lack of efficiency in the data flow – when data collected are not shared or are delayed – this can demotivate participants. Research conducted on the social and psychological traits of participants in citizen science, focusing on the importance of assessing motivations for participation, has developed frameworks for use by project leaders.

By understanding what motivates participants, the project team can work towards meeting expectations and increase the possibility of sustaining commitment in the long term (Bruyere and Rappe 2007; Measham and Barnett 2008; Wright et al. 2015; Agnello et al. 2020).

Assessing what determines participants' satisfaction is crucial to retention (i.e. keeping participants in the project). How satisfied or dissatisfied a participant is depends on factors such as feeling appreciated, feeling rewarded, and the perception of the benefits generated through participation in citizen science. Understanding how to reward and encourage different types of people and how to give adequate recognition can help project leaders to increase project engagement satisfaction. Identifying the benefits people perceive as a consequence of their experience can be useful in order to cultivate them. It is also important to keep in mind that citizen science activities require time and effort from participants. Travelling to the project venue, or simply having to juggle work and family life, inevitably leads people to weigh up the opportunity costs – the potential benefits missed when choosing to dedicate time to a project. Hence, it is important to ensure that the overall benefits people derive from participation exceed any costs they may incur.

The time of project closure and handover is usually a stressful one for project leaders. Among the many tasks that have to be completed, they must pay attention to not overlook the needs of the participants, ensuring that their role is taken into account even in the wrapping up phase. This is the final opportunity to impress a positive memory on the participants about their experience with citizen science and the project. The latter is very important when reporting to donors and if a follow-up project has to recruit new participants or re-engage with previous ones. Participation in citizen science has the potential to start a ripple of positive impact whereby action that successfully gives back to the community encourages others to also get involved. Transparency about the outputs is a right of the participants, and project leaders must ensure clarity whether or not the project's main goal has been achieved. It is of crucial importance to discuss unsuccessful aspects of a project from both the participants' and project leaders' perspectives in order to facilitate future improvements. Finally, having developed a good understanding of the participant cohort, project leaders can provide recommendations to participants on how to continue their involvement in citizen science, for example, by directing them to similar projects that fit their motivations or by discussing the possibility of co-creating a follow-up project.

Conclusion

In this chapter we have discussed the role that participants play in citizen science and different aspects of their experience that are important to take into account, such as providing different levels of engagement, the motivations that bring people to a project and keep them engaged, and the outcomes and benefits for participants. In

each phase of a citizen science project's life cycle, these aspects provide certain challenges for both participants and project leaders.

Of course, there is not one typical citizen scientist, so project leaders should investigate the motivations, benefits, and barriers of the participants of their specific projects. In addition, they should plan in advance to address these issues. Often providing different ways to get engaged in a project can help to cater for diverse participants. For example, some participants may be satisfied contributing to a project individually without any interaction with fellow participants, while others are looking for ways to get in touch with a community. Learning more about citizen scientists often means borrowing insights and methods from fields such as social science, psychology, and education. Project teams should make sure that they have the expertise within the team and the funds allocated to address and assess participants' motivation, benefits, and challenges. We recommend building a multidisciplinary team, for example, including a science educator or communicator and a social scientist or a community manager, and providing training to scientists to enhance their skills for interacting with participants.

Throughout the chapter we have discussed research on the motivations and experiences of citizen scientists. Increasingly, project leaders include evaluation and participant research in their projects. On the one hand, this helps individual projects to understand and address their specific group of participants. When project leaders understand the most significant motivations of their participants, they can ensure that communication about the project or activities offered within the project matches those motivations. Additionally, when a project has defined certain goals with regard to participant outcomes (e.g. increased scientific literacy, empowerment, behaviour change), project leaders should include measures to assess these goals. On the other hand, ideally, combining research across many different projects will help the field to understand how motivation for citizen science works in general and how participation in citizen science may impact participants and society. However, in order to reliably combine research outcomes, it is important that results from different projects are comparable. Using overarching frameworks such as the motivation framework, provided by Levontin et al. (2018), or the participant outcomes framework, developed by Phillips et al. (2018), can help compare results across projects. The chapter on evaluation in this volume will discuss further details on how to conduct evaluation and research on citizen science (Schaefer et al., this volume, Chap. 25).

In conclusion, within the field of citizen science, scrutiny of citizen scientists and their experiences is growing. There is an increased understanding of what motivates them, what benefits they may get out of their participation, and what challenges they face. The area of participant experiences will benefit from sustained scrutiny and more overarching conclusions.

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