Motivations Affecting Initial and Long-Term Participation in Citizen Science Projects in Three Countries

Dana Rotman[1], Jen Hammock[2], Jenny Preece[1], Derek Hansen[4], Carol Boston[1], Anne Bowser[1] and Yurong He[1]

[1] College of Information Studies, University of Maryland, College Park, MD

[2] National Museum of Natural History, Smithsonian Institution, Washington, DC

[3] Information Technology, Brigham Young University, Provo, UT

Abstract

Reliance on volunteer participation for citizen science has become extremely popular. Cutting across disciplines, locations, and participation practices, hundreds of thousands of volunteers throughout the world are helping scientists accomplish tasks they could not otherwise perform. Although existing projects have demonstrated the value of involving volunteers in data collection, relatively few projects have been successful in maintaining volunteers' continued involvement over long periods of time. Therefore, it is important to understand the temporal nature of volunteers' motivations and their effect on participation practices, so that effective partnerships between volunteers and scientists can be established. This paper presents case studies of longitudinal participation practices in citizen science in three countries—the United States, India, and Costa Rica. The findings reveal a temporal process of participation, in which initial participation stems in most cases from self-directed motivations, such as personal interest. In contrast, long-term participation is more complex and includes both self-directed motivations and collaborative motivations.

Keywords: citizen science, motivation, volunteers, case studies

Citation: Rotman, D., Hammock, J., Preece, J., Hansen, D., Boston, C., Bowser, A., & He, Y. (2014). Motivations Affecting Initial and Long-Term Participation in Citizen Science Projects in Three Countries. In *iConference 2014 Proceedings* (p. 110–124). doi:10.9776/14054

Acknowledgements: We thank our interviewees and reviewers. Funding provided by NSF grants 10-0352 and 11019993.

Contact: hammockj@si.edu, preece@umd.edu (Dana Rotman c/o preece@umd.edu), dlhansen@byu.edu, cboston@umd.edu, abowser1@umd.edu, yrhe@umd.edu

1 Introduction

Around the world, the number and impact of biodiversity- and ecology-related citizen science projects is greater than ever before. Hundreds, and sometimes thousands, of people of all ages, professions, occupations, and locations, take part in these endeavors. The projects themselves range from those that can be done at home or in the backyard, such as sorting photographs of animals in order to document migration habits or counting the number and species of birds feeding from a birdfeeder, to remote and more complex fieldwork, including field observations, specimen collection, and long-term monitoring (see www.citizenscience.org and www.scistarter.org for a list of citizen science projects in the United States). Projects also vary according to their scope and target audience and can range from families and young students engaged in specific, short-term, local projects (such as "bioblitzes," which are compressed forms of biological surveys aimed at capturing a snapshot of current ecological conditions), to long-term involvement in continuous projects that encompass global phenomena (Bonney et al., 2009; Rotman et al., 2013; Wiggins & Crowston, 2011). Volunteer involvement in scientific projects is also supported by new advances in technology, namely Internet-based and mobile connectivity, which brings scientists, scientific research projects, and volunteers closer than ever before.

Volunteers and scientists derive different benefits from participation in scientific research. Volunteer motivations, especially, are complex, related to both individual and social differences, and they change over time (Boezeman & Ellemers, 2007; Clary et al., 1998; Locke, Ellis, & Smith, 2003). The main thrust of this study is to understand the underlying motivations affecting long-term participation of volunteers in citizen science projects. This is achieved by analyzing interview data from participants in citizen science projects in the United States, India, and Costa Rica. The research question that this paper addresses is: What are the motivations that affect volunteers' initial and long-term participation in citizen science?

The remainder of the paper will frame this research within previous contributions, introduce the methods used and the case selection, discuss findings from interviews with volunteers in three different countries, and explore differences between initial and long-term motivating factors in the three countries. The paper ends with a brief discussion of the implications of this study for future research in citizen science.

2 Background

Citizen science enables research based upon the work of volunteers, some of whom may be knowledgeable in the domain, yet who typically lack formal training (Bonney et al., 2009; Cooper et al., 2009). In addition to direct scientific collaboration, citizen science supports the "engagement of nonscientists in true decision-making about policy issues that have technical or scientific components" (Lewenstein, 2004), and can increase scientific literacy and interest (Miller-Rushing, Primack, & Bonney, 2012).

Today, there is a growing reliance on volunteers' contributions to science for various budgetary and practical reasons: scientists can no longer afford long excursions into the field, yet the potential for collecting data is greater than ever before, particularly if technology can be appropriately harnessed while still keeping humans in the loop. This deluge of data, coming from sensors, probes, observations, and computerized assessments, makes it difficult for even large teams of professional scientists to methodically collect and analyze the data without the help of volunteers. Over the past decade, citizen science has changed gradually and become more and more dependent on technology that reaches larger numbers of volunteers, often located remotely from professional scientists and from each other. To support the growing role of volunteers in scientific research, we must better understand what initially attracts volunteers and, perhaps most importantly, what motivates them to continue to participate for extended periods of time—an issue that has only recently begun to be explored (Rotman et al., 2013).

Volunteers participate in collaborative activities for a wide variety of reasons at both individual and group levels. These general motivations include commitment to a larger cause, reputation gains, reciprocity, learning benefits, expression of self-efficacy, personal motivation types, and empathy (Batson, Ahmad, & Tsang, 2002; Lakhani & von Hippel, 2003; Preece & Shneiderman, 2009). Researchers have also examined how patterns of U.S. volunteerism change over a lifetime. Pearce (2003) reports a complex, cyclical pattern where volunteerism increases until age 18, decreases drastically in the early 20s, and rises again to reach a peak between 40 and 45. Bussell & Forbes (2003) have also studied volunteerism over time in the context of recruitment and retention cycles. However, while work within citizen science has touched on motivational concepts in different contexts (Nov, Arazy, & Anderson, 2011; Raddick et al., 2010), citizen science motivation has been studied in countries outside the United States to a lesser extent, with notable exceptions such as Bell et al. (2008). And while there is likely some overlap with temporal motivation in domains such as volunteerism (Bussell & Forbes, 2003), online social structures (Butler, 2001), and communities (Preece & Shneiderman, 2009), some factors unique to citizen science—such as the tendency of scientists to embrace volunteer contributions early on in a research project, but not at later stages (Kim, Robson, Zimmerman, Pierce, & Haber, 2011), and the unique role of expertise—suggest that domain-specific research is crucial to understanding motivations over time.

Volunteers are people who give an asset such as time, resources, or attention freely and without the expectation of monetary or other reward (Dekker & Halman, 2003). Within the United States, many formal volunteer opportunities fall within existing establishments such as local organizations and religious communities (Putnam, 2001). These communities provide an infrastructure able to utilize key factors, such as social support (Bussell & Forbes, 2003), that help sustain contribution over time. Without this infrastructure, it can be difficult for volunteers to move beyond brief or intermittent contributions (Penner, 2004; Putnam, 2001). Researchers studying citizen science projects have identified certain types of projects, such as action projects, that are similarly rooted in place and thus interwoven with a community and its concerns (Wiggins & Crowston, 2011).

The decision to volunteer is a factor influenced by individual differences such as gender, access to technology, age, income, family structure, level of education, and independence (Pearce, 1993; Terry, Harder, & Pracht, 2012). It is also a factor of the culture in which volunteers and projects are situated (e.g., relative emphasis on individualism vs. collectivism as described in Hofstede's work (1980, 2001). These factors, along with evidence about cultural attitudes toward nature and ecology, were used to identify the three countries chosen for this study—the United States, India, and Costa Rica.

This paper examines the motivations of citizen science volunteers in three countries and is based on a larger work (Rotman, 2013). While an in-depth comparison of these cultures is beyond the scope of this paper, an awareness that the motivations of citizen science volunteers are a factor of individual and group differences helps paint a holistic picture of motivation and an understanding that motivations change over time.

3 Methods

This research focuses on the motivational factors affecting short- and long-term participation practices of volunteers in ecology-related citizen science projects. Three independent cases were selected, based broadly on Yin's description of a case as "investigat[ing] a contemporary phenomenon in-depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (2009, p. 18). The cases differ in the dominant demographics and in the professions, backgrounds, and education of their participants. The countries, which differ in their placement on various cultural dimensions proposed by Hofstede (1980, 2001), were chosen primarily because they offer different histories of citizen science, variation in the ways in which citizen science is practiced, and differing levels of formal and institutional support for citizen science projects (see Table 1). Sampling the different countries provided an opportunity to better understand the range of motivations and gain a more global perspective. This paper is not focused specifically on the differences across countries, though future work will consider that more directly.

3.1 Three Exploratory Case Studies: The United States, India, and Costa Rica

The website scistarter.com lists more than 400 citizen science projects in the United States alone. It is estimated that hundreds of thousands of people engage annually in these projects (National Science Foundation, 2012). Some ecology-related projects cut across local boundaries and are national in nature; but many are local, focusing on the immediate community or locality of volunteers. Most citizen science projects are supported through research programs in academic institutions, government agencies, and non-governmental organizations (NGOs), but a few are supported locally.

India has numerous protected areas and natural sanctuaries that were developed in recent decades, but involvement of volunteers in science is relatively uncommon. The distinction between castes, and the differences in linguistic, religious, regional, social, and economic groups, have trickled down and made collaboration among the different groups difficult (Kannan, 1990). Countrywide collaborative scientific projects began to evolve in the mid-1990s with the People's Biodiversity Register (PBR) as one of the first projects implemented across India (Gadgil, 2006). It aimed to support rural communities' and individuals' understanding of their ecological setting, document local ecological changes, and lead to local resource management and countrywide documentation of these actions. Following PBR, the Indian government formed "Biodiversity Management Committees" that created biodiversity registers in consultation with the local people, which led the way to broader collaborative scientific projects that involved local "people's knowledge" to enhance "official knowledge" (Gadgil, 2006).

Costa Rica has the highest biodiversity density of any country in the world, with one of the highest proportions of protected land. Biodiversity is considered a national resource that can lead to economic prosperity: the monetary and economic value of conservation is emphasized by educational institutions and governmental organizations alike (Wallace, 1992). The country supports the use of private lands as natural preserves and environmental education centers through subsidies and direct payment (Langholz, Lassoie, & Schelhas, 2000). This deep commitment of both government and private organizations to conservation encourages citizen science projects focused on biodiversity. Funding for the projects comes from various governmental agencies, NGOs, and international and private organizations (Rotman, 2013). Key features of the countries chosen as case studies are listed in Table 1.

3.2 Interviews and Analysis

Interviews facilitate an understanding of the world from the participants' perspective and aid in uncovering the meaning of people's experiences by allowing for the development of rich descriptions and the integration of multiple points of view (Kvale, 1996, 2009).

The selection of potential interviewees was based on "purposeful sampling" (Patton, 2002) in which a general framework for analysis provides an information-rich data set (Kozinets, 2002) as it cuts across participant variations in a way that portrays different demographics, interests, participation types, and engagement levels, but does not aim to create a representative sample. In addition, snowball sampling (Babbie, 2010; Biernacki & Waldorf, 1981) was used, in which interviewees pointed to others who could potentially provide rich information and/or were relevant to understanding pertinent issues of collaboration and motivation. Where snowballing sampling was used, the chain of referral was followed until "conceptual saturation" (Patton, 2002) was obtained. This resulted in 13 interviews in the United States, 22 in India and 9 in Costa Rica. Table 2 provides demographic information about the participants.

Country	Size and population (compared to other countries)	History of collaborative scientific projects	Institutional support and funding
United States	3rd largest in size, 3rd in population	Since the 19th century	Government, NGOs, educational institutions
India	7th largest in size, 2nd in population	Since the 1990s	NGOs, few educational institutions
Costa Rica	127th largest in size, 121st in populations	Since 1970	Government, local and global NGOs, local communities, educational institutions

Table 1: A comparison of various properties of collaborative scientific projects in the United States, India, and Costa Rica

In all cases, the interviews were semi-structured, based on a general list of predefined concepts and probes (Rubin & Rubin, 1995) used by the interviewer to maintain control of the direction of the interview. In some cases, the interview protocol was modified slightly to address cultural sensitivities. The core concepts of the interviews were iterated upon and continuously developed throughout the interviews. Important concepts that were introduced by participants in the first interviews were included in later interviews, and in order to maintain similarity across populations, the same experiences and meanings were sought in the different cultures.

Country	**Number of interviews**	**Roles**	**Other demographic information**
United States	13	Professional scientists (3), volunteers (10)	6 males, 7 females
India	22	Professional scientists (6), volunteers (16)	20 males, 2 females (more females were invited to participate but they declined)
Costa Rica	9	Professional scientists (2), volunteers (7)	5 males, 4 females

Table 2: Demographics of interview participants

The interviews in the United States were conducted in April and May 2010; in India in December 2011; and in Costa Rica in August-November 2012. Due to the geographic distance, many of the interviews were conducted over Skype. Three of the Costa Rican interviews were conducted in Costa Rican Spanish and translated into English.

The interviews were analyzed using grounded theory (Strauss & Corbin, 1990). Interviews from each of the three countries were coded separately; within each country, interviews were first coded independently of each other to reflect major concepts (e.g., "motivational factors," "initiating collaboration," "work patterns," etc.), and then synthesized according to emergent themes (e.g., "cycle of collaboration"). Themes from all three countries were then grouped into a codebook, which was modified and refined throughout the coding process to reflect emergent concepts. Once the codebook was finalized, the interviews were re-evaluated and coded according to the identified themes. The themes were then compared in and across cases. To aid in the analysis process, notes, citations drawn from the interviews, and drawings and visualizations of the relationships between codes and themes were used. The interviews were analyzed until conceptual saturation was achieved and no new concepts were identified (Morse, 1991). Additional data, such as content retrieved from relevant mailing lists, images, and artifacts, were also collected and analyzed. The names and personal details of all interviewees were changed to protect their anonymity.

4 Findings

The themes that came up from the data addressed initial participation, long-term participation, and de-motivating factors, which are discussed below

4.1 Initial Participation

As the data unfolded, it became apparent that participation was highly dependent on personal interest, but there was also a gap between intent and actual participation. While most interviewees expressed a favorable attitude toward citizen science, they did not participate unless a project had a personal value or benefit for them. Four factors were found to encourage initial participation:

4.1.1 Personal interests

Jill's comment typifies the role of personal interest as an initial motivator: "I think personal interest comes first. Personal interest and personal gain, with information." (Jill, USA). Some volunteers (especially in the United States and, to some extent, in Costa Rica) were actively looking for opportunities to extend their knowledge through participation in citizen science projects. Others (mostly in the United States and Costa Rica) stumbled upon such projects by chance.

A slightly different case was that of an existing hobby which related to citizen science, like photography, art, travel, and sports (this was observed mostly in the United States). In these cases the main motivational factor was the ability to use the citizen science project as a platform to promote their hobbies as illustrated by Danny: "I started looking for a way to share pictures so that I could learn more about butterflies… and what started four or five years back is that some of the scientists said 'OK … please go here and there.' I do that when I can but only if I can also get the pictures that I want or at the time that the light is good. " (Danny, USA)

Similarly, some volunteers found citizen science gave them an enjoyable opportunity to spend time with their friends and families and enhance their relationships through joint activities. In these cases, collaborative scientific projects had to be fun and engaging and speak directly to the interests and skill sets of potential volunteers.

4.1.2 Self-promotion

Self-promotion and furthering one's own opportunities was also motivating, as these quotes illustrate: "…it will benefit me to increase my knowledge and … for my experience for my future prospects or any other." (Abhinav, India) "[My motivation is] gaining the experience and seeing what it is, maybe having something for my resume." (Joe, USA)

4.1.3 Self-efficacy

The depth and level of involvement offered to volunteers within each project also became a strong motivator, speaking to volunteers' sense of self-efficacy and feelings of equality and control over the scientific process. This was best exemplified in Costa Rica, where many citizen science projects offered volunteers control of the data they contributed and open access to their data and the data of others for secondary studies, as indicated by Laura's comment: "A volunteer can participate at any level of research in my opinion. From a person who has no experience and needs to be trained to participate, to someone who has the same academic qualifications as the scientists and who just isn't being paid." (Laura, Costa Rica)

However, most citizen science projects, specifically in India and to a lesser extent in the United States, did not actively encourage volunteers to participate in analysis or conduct secondary studies. Some even rejected the idea of volunteer involvement in the post-data collection altogether.

4.1.4 Social responsibility

Interestingly, collectivistic motivations as antecedents to participation surfaced at the initial stage of the projects only in one case – that of Costa Rica. Costa Rican collectivistic culture, supported by education and practice, emphasized the principles of social responsibility toward natural resources and drew many people to explore the opportunities citizen science offered, with the intention of joining these projects in order to advance the greater good of society as Jose's comment illustrates: "I think if you visit Costa Rica and you talk to a cop, driver, or maybe a bus driver or people that work in a restaurant, they will make you a conversation about the topics of environment and their importance, there's a true moral thing." (Jose, Costa Rica)

The role of the education system in the support of local institutions cannot be underestimated; but even more than that, the collectivistic motives were the product of national pride in nature and grassroots understandings of the role biodiversity has in maintaining and supporting the community. This introduces an alternative view of initial motivation to participate, one not directly related to the person volunteering, which was also associated with communities to which they belong.

4.2 Long-term Participation

Whereas the previous section detailed the first step toward participation, i.e., the move from a favorable view of citizen science to actual participation, here the focus is on continuous participation for extended periods of time. Unlike initial motivations, which focused mainly on one's self and related to the benefits one expected as a result of participation, long-term participation was motivated through a range of relationships. These relationships were negotiated between individual volunteers and those within and outside of the projects. Within-project relationships were initiated and cultivated between participants of the same project— predominantly among the volunteers themselves and between volunteers and scientists; external relationships were those created between volunteers and others who didn't take part in citizen science projects, such as members of their communities, friends and families. Five factors were found to encourage long-term participation.

4.2.1 Trust

Scientists often saw volunteers as well-intentioned individuals with a limited ability to fulfill substantial scientific tasks that needed to be monitored as the comment from Madhu indicates: "… cross checking, cross study is always advisable." (Madhu, India). While the scientists acknowledged the need for volunteers' help in their work, they were hesitant to trust them with tasks that were more complex than simple data collection for fear of "data contamination," low quality or complete lack of quality control, and potential deviance that would hinder their work. Volunteers, on the other hand, were shy of scientists, often seeing them as aloof and intimidating, speaking a particular jargon that was foreign to them. In quite a few cases, they did not even meet with the scientists throughout the project. Under these conditions, creating trust was difficult. However, some projects succeeded, and this success was often related to the governance structure of the project—the more centralized and pyramid-like the project was (where the leading scientists were removed from the volunteers), the less it resulted in trust between the groups, while relatively flat projects that enabled interaction between scientists and volunteers led to a slow build-up of personal relationships that facilitated trust.

4.2.2 Setting common goals

Setting the goals up front was used to create a common baseline of expectations among the various participants, and particularly between scientists and volunteers, as a scientist, Antonio, pointed out: "Communication must be constant and clear. A scientist has to be well-prepared to speak the language of citizens in order to clearly transmit their project and to inspire interest in people." (Antonio, Costa Rica) Potentially contentious issues, such as roles, responsibilities, expected outcomes, and standards, were easier to address when they were openly communicated and discussed, or at least set out in a formal manner by the project's leaders. Periodic discussion of these goals, which included volunteers as partners (or at the very least alerted them to the existence of such goals) helped in facilitating a positive rapport that maintained volunteers' sense of competency. Routine messages about the project's status, goals, and procedures helped remind volunteers of upcoming events or the continuity of the project, which was useful to those who were not deeply involved in it, and encouraged their participation for longer periods of time.

4.2.3 Acknowledgement and attribution

While acknowledgement could take various forms, and the view of what constituted sufficient acknowledgment varied greatly, a minimal level of recognition was essential for facilitating long-lasting participation, as Suzan's comment illustrates : "Just a name and this X and that Y was contributed by this or that person. Something simple… is like a big thing for a normal person, this kind of thing make it very personal thing, and that way we encourage all to do it more …" (Suzan, USA)

The data revealed several aspects of acknowledgement that were either independent or interrelated, depending on the specific project and its settings. For example, some projects in the United States offered structured modes of acknowledgement that were open to all participants (periodic meetings in which volunteers' work was showcased, or singling out individual volunteers for their contributions). Other projects offered lab meetings or meetings in the field, in which active volunteers and scientists interacted. In both cases these were pre-planned events that were meant to bring volunteers closer to the leaders of the projects and highlight the work that they do. Most volunteers were not particular about the form acknowledgement took, as long as some was made, and it was made public. However the more "scientifically valid" the acknowledgement, the more it was appreciated. In other cases, mostly in the United Sates and Costa Rica, acknowledgement was provisory and impromptu, and came up though chance meetings among project participants.

Like acknowledgement, attribution could be given in many ways—from a general acknowledgement that the data was obtained through collaboration with volunteers (without specifically naming volunteers or volunteer groups), to individual credit given to specific contributors. This was especially important where the data was used for outside publications (e.g., journal and conference papers, books, and online publications). Volunteers reported finding out that they were not acknowledged in publications which disappointed them. This was observed across all types of projects, and in all three cases.

4.2.4 Mentorship

As with the other themes related to within-project relationships, education and mentorship was based on several separate but interrelated concepts: training, closeness, and empowerment. As Oscar notes, "I get the sense that a lot of people do recognize our motivation to do citizen science because of the educational aspect." (Oscar, Costa Rica)

Many of the volunteers who joined citizen science projects in order to advance their scientific understanding and sense of self-efficacy actively sought an ongoing relationship with scientists. In some cases this translated into mentorship of various forms: from close contact between scientists and volunteers to ensure that the research was done correctly, to close personal relationships between scientists and volunteers. Many volunteers appreciated every opportunity they were given to meet with scientists and were willing to give up time and resources (e.g., pay for travel) to accomplish that. However, not many senior scientists were interested in engaging with volunteers, unlike junior scientists, who saw great value in mentorship activities (perhaps because they were close enough to the apprenticeship process required of beginning scientists).

Another form of mentorship came from the need to train volunteers: some projects offered or required initial or repeated training in order for volunteers to actively participate. Training varied according to the specific project needs, and could be as short as a few hours or as long as several days. Further, it could be free or require payment; and it could be done online (birdsong recognition audio tracks in the United States and Costa Rica) or in the field (scat and track identification outings in India and Costa Rica). In all cases, volunteers were appreciative of the opportunity to extend their knowledge and competencies. Although training of volunteers could offer scientists numerous advantages, including a higher level of data quality and deeper commitment among volunteers, not many embraced this opportunity to include training in their research protocol.

4.2.5 External relationships

Most volunteers did not become engaged in citizen science to create change but rather, due to personal interests. However, through their participation they became exposed to the effects citizen science can have on their immediate environment and beyond it, and for some volunteers, this became a major cause. In turn, this cause motivated them to extend their participation outside the project, as Linda aspired: "[I] want to be kind of a liaison between the scientific field … and the common person who has the questions and doesn't know how to ask." (Linda, USA)

The shift from self-related motivation to a collectivistic one was not trivial. Volunteers have fewer avenues to extend their knowledge to others, and their status is not as highly regarded as that of professional scientists. Yet, in many cases they saw their role as mediators between local communities and scientists.

Education as a motivational factor was especially salient where volunteers encountered remote communities whose exposure to conservation-related education was lacking. Beyond awareness, education was seen as a tool to empower the local population and enable it to combine ecologically minded and sustainable practices with its economic and social needs.

4.2.6 De-motivating Factors

As described in the previous sections, favorable inclination toward citizen science has to be complemented by various motivational factors to drive volunteers to participate in a project. At the same time, de-motivating factors also affect participation, and particularly long-term participation, as Chris comments: “Initially everybody’s enthusiastic and with time participation level keeps dropping down. It’s a very small percentage that continues giving information.” (Chris, USA)

Attrition rates among volunteers in citizen science projects were discussed in all three cases, and were estimated to range between 80 to 95 percent. This could be due to several issues: the lack of positive motivational factors mentioned above, or alternatively, the existence of de-motivating factors. De-motivating factors typically spoke to internal negotiations between the demands of the project and the volunteer. Constraints involving time and problems associated with technology were the most prominent de-motivating factors.

4.2.7 Time

The following quote from Apurva sums up the time dilemma that some volunteers experience: “It depends on how much time I have to contribute to this project. The best thing is where I can just log in a few seconds or minutes the information that I want to pass on and I’m very happy to do that, but if I spend about hour or two to even send a particular record and all the details, maybe I want to take a rain check…[I want to spend] as little time as I can. [If] it’s going to impinge on my own work time, that’s something I don’t want to do.” (Apurva, India)

Interest, enjoyment, challenge or other initial or continuous motivations were often not enough to overcome excessive time demands. Some volunteers complained that scientists had no appreciation of their time, and demanded that they engage in overly complex and time-intensive tasks. This was a common theme across all cases. While some volunteers appreciated intensive projects that made them feel more committed to the scientific goals, most volunteers balked at the thought of spending too much time (a subjective term that could stretch from a morning every week to continuous immersion in the field) on a given project. Similarly, projects that required extensive travel to remote areas (especially in India) were seen less favorably than local projects that could be interlaced with volunteers’ routines.

4.2.8 Technology

Projects that were (or could potentially be) made easy through the use of technology, but failed to deliver on that aspect frustrated volunteers and discouraged them, as Nina pointed out: “A lot of the schools I worked with were like one-room schoolhouses, maybe they had a computer, but probably they didn’t. They probably didn’t have an Internet connection even if they had a computer, so that was a big challenge.” (Nina, Costa Rica).

This problem was particularly apparent in India and Costa Rica, where the technological infrastructure is poor in some rural areas, and is somewhat limited even in urban areas (this was especially relevant to mobile and web connectivity—one interviewee reported that between 60 and 90% of the Indian population does not have Internet connectivity or literacy). Even in the so-called technologically advanced United States, interviewees reported accessibility and usability problems.

Problems involving lack of technology or inadequate or poorly designed technology frustrated volunteers and made them disenchanted with the projects. Projects that took into account the technological barriers and understood the local infrastructural limitations and made the relevant adjustments to enable participation and task completion were the ones whose volunteers were engaged for longer periods of time.

5 Discussion

The findings reported above suggest that short-term and long-term participation tend to stem from different motivations, although there is some overlap. Without some initial self-directed motivation, such as a strong personal interest, participation will not happen, but without a broader motivation that goes beyond the self, such as commitment to conservation, long-term participation will not occur.

Long-term participation is affected by myriad aspects, ranging from project-specific ones (e.g., type of project and local arrangements) to external relationships that extend beyond the project and affect individuals and communities outside it (e.g., national policies and culture). At the same time, de-motivating factors, such as poor communication or inadequate technical infrastructure, affect participation negatively and may cause attrition throughout the project lifecycle. By taking these findings into account and exploring how they relate to citizen science projects in different cultures, project managers and technology designers may gain insights about how to encourage long-term volunteer participation. How this is achieved will be influenced by the cultural setting in which the project is embedded, the type of project, the volunteer population, and how it relates to the scientists managing the project.

Although some citizen science projects lend themselves well to singular contribution (e.g., single-day bioblitzes), most projects, such as those dealing with conservation, investigation, or education are long term and necessitate the ongoing involvement of volunteers (Wiggins & Crowston, 2011). However, long-term engagement is tricky to achieve, as was evident in all three cases. Facilitating long-term participation was highly dependent on the existence of—or at the very least, an awareness of— initial self-directed motivations such as personal interests, self-promotion, self-efficacy, and social responsibility. Where these were present, long-term motivations that reflected within- and across- group relationships became relevant. The most salient of those were the relationships between volunteers and scientists, and between volunteers and their communities. Projects that did not support or actively facilitate these relationships suffered from high attrition. Paying attention to factors that motivate participants' involvement is of particular importance when one considers that they are volunteering their time to a larger endeavor (see Terranova, 2000 for a critique of free labor in the digital economy).

The two most significant de-motivating factors mentioned by interviewees as affecting long-term participation were time commitments and technology availability and usability, which were often highly intertwined. According to many interviewees, their need for training and feedback was not given much attention; instead, technological tools were thought of as "cover-all" solutions. In all three cases, pen and paper often proved not only to be more effective than highly complex computerized systems, but were also critical where no communications infrastructure actually existed. The gap between expectation and actuality in terms of technology was prevalent not only in the developing countries (India and Costa Rica), but also in the United States, where many volunteers found complex online reporting systems too burdensome and taxing to learn or use, and preferred simple interfaces or offline reporting tools.

Projects that did not offer straightforward communication suffered from higher attrition rates and lower long-term engagement rates. Where volunteers could easily contribute data, and also retrieve it or follow the path of use of the data they contribute—and specifically when they could see its broader impact on scientific advancements and their own communities—they were motivated toward deeper engagement for longer periods of time, and more complex missions. Projects that enabled this interaction, and also emphasized the human perspective (e.g., communication, feedback, training, etc.), got an even more positive response. Feedback, for example, is crucial, but so is the way it is delivered. Most projects in all three countries studied suffered in that aspect.

Table 3 summarizes the motivating factors that affect short- and long-term participation within the context of each of the cases that were studied.

6 Conclusion

Many citizen science projects struggle with recruitment and attrition issues. Long-term volunteer participation is key to the success of such projects, but few projects succeed in supporting it well. This research suggests that approaches to engage citizen scientists must recognize the different reasons volunteers join versus the reasons they continue participating, as well as the role of cultural differences. Initial motivation for participation stems from self-related themes, in which volunteers are

Theme	Related concepts	Potential participants	Countries
INITIAL PARTICIPATION			
Personal interest	Enjoyment, interest, ancillary hobbies, leisure, interest in nature	Individuals with ample time to spare or a very specific interest in nature; families, all ages	United States, India, Costa Rica
Self-promotion	Reputation building, social advancement, future employment	Individuals wanting to advance themselves (e.g., students, young adults)	United States, India, Costa Rica
Self-efficacy	Affecting scientific work, belonging to the scientific community	Educated individuals; relatively older adults	United States, Costa Rica
Social responsibility	Conservation, pride, national and local dependency	Individuals affected by the local culture and education system; relatively young adults	Costa Rica
LONG-TERM PARTICIPATION			
Within-project relationships			
Trust	Data quality, skills, value, time, leadership roles	Experienced volunteers looking for close relationships with scientists	United States, Costa Rica
Common goals	Communication, updates, structured protocols	Volunteers looking to deepen their relationships with scientists	Costa Rica
Acknowledgement	Recognition, attribution, value	All volunteers	United States, India, Costa Rica
Mentorship	Training, closeness, empowerment	Volunteers who wanted to become deeply involved in the project	United States, India
External relationships			
Education and outreach	Mediation, empowerment, local populations, knowledge	Long-standing volunteers who interact with locals	United States, India, Costa Rica

Theme	Related concepts	Potential participants	Countries
Policy and activism	Accountability, government, institutions, community	Long-standing volunteers who interact with locals	United States, Costa Rica

Table 3: Breakdown of initial and continuous motivations according to the thematic concepts, and their manifestation in each of the three cases

inclined to participate in projects that address their interests and offer them self-advancement and enjoyment. This correlates well with the existing literature that discusses initial motivation in this context (Bussell & Forbes, 2003; Butler, 2001; Preece & Shneiderman, 2009; Rotman et al., 2012). At a later stage, the motivational process becomes more complex and includes both self-related motivations and collaborative motivations that include within-project relationships and external relationships: a project has to show some value outside the actual tasks volunteers undertake in order to be deemed important enough to warrant continuous participation.

The findings from the case studies discussed in this paper suggest several areas for future research. The role of feedback in motivating participation is recognized as important in many types of volunteerism (e.g., Zhu, Zhang, He, Kraut, & Kittur, 2013), including citizen science (He et al., 2013), and so is gamification (Bowser et al., 2012; Crowston & Prestopnik, 2013). The issues summarized in Table 3 above also offer suggestions for future research. In addition, although it is tempting to view citizen science projects as an opportunity for scaling up data collection at a relatively low cost, specifically in biodiversity and ecology research, this study shows that in three different countries, with diverse projects and volunteers, human interaction is a strong motivational factor. Following promising beginnings (e.g., Wiggins, 2013), considerable additional research is needed to understand how to scale up using technology while still ensuring human-to-human interaction both on- and offline, particularly between scientists and volunteers. In addition, future research is also needed to ensure appropriate checks on data quality, data standards, and policies across the world.

The complexity of factors affecting long-term motivation and participation practices in each of the three countries indicates the need to tailor the design and implementation of each citizen science project according to the specifics of its purpose, location, available infrastructure, participation practices, and the expectations of potential volunteers, with attention to cultural context and sensitivities and realistic use of technology. This is an important area of research for citizen science and indeed, for any qualitative research requiring extended engagement by participants.

7 References

Babbie, E. R. (2010). *The practice of social research.* Belmont, Calif: Wadsworth Cengage.

Batson, C. D., Ahmad, N., & Tsang, J. A. (2002). Four motives for community involvement. *Journal of Social Issues, 58*, 3, 429-445.

Bell, S., Marzano, M., Cent, J., Kobierska, H., Podjed, D., Vandzinskaite, D., Reinert, H., ... MurÅiÄ, R. (2008). What counts? Volunteers and their organisations in the recording and monitoring of biodiversity. *Biodiversity and Conservation, 17*, 14, 3443-3454.

Biernacki, P., & Waldorf, D. (1981). Snowball sampling: Problems and techniques of chain referral sampling. *Sociological Methods Research, 10*, 141-163.

Boezeman, E. J., & Ellemers, N. (2007). Volunteering for charity: Pride, respect, and the commitment of volunteers. *The Journal of Applied Psychology, 92*, 3, 771-85.

Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., & Wilderman, C. C. (2009). *Public participation in scientific research: Defining the field and assessing its potential for* *informal science education.* Washington, D.C.: Center for Advancement of Informal Science Education (CAISE). http://files.eric.ed.gov/fulltext/ED519688.pdf

Bowser, A., He, Y., Rotman, D., Preece, J., Hansen, D., Raphael, J., Reid, M., ... 31st Annual CHI Conference on Human Factors in Computing Systems: Changing Perspectives, CHI 2013. (2013, May). Prototyping in PLACE: A scalable approach to developing location-based apps and games. *Conference on Human Factors in Computing Systems - Proceedings*, 1519-1528.

Bussell, H., & Forbes, D. (2003). The volunteer life cycle: a marketing model for volunteering. *Voluntary Action,* 5, 61-80.

Butler, B. S. (2001). Membership size, communication activity, and sustainability: A resource-based model of online social structures. *Information Systems Research*, *12*, 4, 346-362

Clary, E. G., Snyder, M., Ridge, R. D., Copeland, J., Stukas, A. A., Haugen, J., & Miene, P. (1998). Understanding and assessing the motivations of volunteers: A functional approach. *Journal of Personality and Social Psychology, 74*, 6, 1516-1530.

Bonney, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *Bioscience, 59*, 11, 977-984.

Crowston, K., & Prestopnik, N. R. 46th Annual Hawaii International Conference on System Sciences, HICSS 2013. (2013, April). Motivation and data quality in a citizen science game: A design science evaluation. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 450-459.

Wallace, D. R. (1992). *The Quetzal and the Macaw: The story of Costa Rica's national parks.* San Francisco: Sierra Club Books.

Dekker, P., & Halman, L. (2003). Volunteering and the values. In P. Dekker & L. Halman (Eds.), *The values of volunteering: cross cultural perspectives* (pp. 1-18). New York: Kluwer Academic/Plenum Publishers.

Denzin, N. K. (1978). *The research act: A theoretical introduction to sociological methods.* New York: McGraw-Hill.

Gadgil, M. (2006). Science and the right to information. *Economic and Political Weekly, 41*, 19, 1895-1902.

He, Y., Preece., J., Boston., C., Bowser, A., Hansen, D., Hammock, J., & Rotman, D. (2013). Effects of feedback and working preference on novice citizen scientists' motivation and contribution. Manuscript in preparation.

Hofstede, G. H. (1980). *Culture's consequences: International differences in work-related values.* Beverly Hills, Calif: Sage Publications.

Hofstede, G. H. (2001). *Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations.* Thousand Oaks, Calif: Sage Publications.

Kannan, K. P. (1990). Secularism and People's Science Movement in India. *Economic and Political Weekly, 25*, 6, 311-313.

Kim, S., Robson, C., Zimmerman, T., Pierce, J., Haber, E. M. 29th Annual CHI Conference on Human Factors in Computing Systems, CHI 2011. (2011, June). Creek Watch: Pairing usefulness and usability for successful citizen science. *Conference on Human Factors in Computing Systems - Proceedings*, 2125-2134.

Kozinets, R. V. (2002). The field behind the screen: Using netnography for marketing research in online communities. *Journal of Marketing Research, 39*, 1, 61-72.

Kvale, S. (1996). *Interviews: An introduction to qualitative research interviewing.* Thousand Oaks, Calif: Sage Publications.

Kvale, S., & Brinkmann, S. (2009). *InterViews: Learning the craft of qualitative research interviewing.* Los Angeles: Sage Publications.

Lakhani, K. R., & von Hippel, E. (2003). How open source software works: "free" user-to-user assistance. *Research Policy, 32*, 6, 923-943.

Langholz, J., Lassoie, J., & Schelhas, J. (2000). Incentives for biological conservation: Costa Rica's private wildlife refuge program. *Conservation Biology*, *14*, 6, 1735-1743.

Lewenstein, B. V. (2004, June). What does citizen science accomplish?" Paper read at the CNRS Colloquium, Paris.

Locke, M., Ellis, A., & Smith, J. D. (2003). 'Hold on to what you've got': The volunteer retention literature. *Voluntary Action, 5*, 3, 81-99.

Miller-Rushing, A., Primack, R., & Bonney, R. (2012). The history of public participation in ecological research. *Frontiers in Ecology and the Environment, 10*, 6, 285-290.

Morse, J.M. (1991). Strategies for sampling. In J. M. Morse (Ed.), Qualitative nursing research: A contemporary dialogue (pp. 126-145). London: Sage Publications, Inc.

Nov, O., Arazy, O., Anderson, D. 6th Annual Conference iConference: Inspiration, Integrity, and Intrepidity, iConference 2011. (2011, March). Dusting for science: Motivation and participation of digital citizen science volunteers. *ACM International Conference Proceeding Series*, 68-74.

National Science Foundation. (2012). Two "firsts" give citizen science new prominence in addressing societal problems [Webcast briefing]. Retrieved from http://www.nsf.gov/news/news_summ.jsp?cntn_id=124991

Patton, M.Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, Calif.: Sage Publications, Inc.

Pearce, J. L. (1993). *Volunteers: The organizational behavior of unpaid workers*. London: Routledge.

Penner, L. A. (2004). Volunteerism and social problems: Making things better or worse? *Journal of Social Issues, 60*, 3, 645-666.

Preece, J., & Shneiderman, B. (2009). The reader-to-leader framework: Motivating technology-mediated social participation. *AIS Transactions on Human-Computer Interaction, 1*, 1, 13-32.

Putnam, R. D. (2000). Bowling alone: The collapse and revival of American community. New York: Simon & Schuster.

Raddick, M. J., Bracey, G., Gay, P. L., Lintott, C. J., Murray, P., Schawinski, K., Szalay, A. S., ... Vandenberg, J. (2010). Galaxy Zoo: Exploring the motivations of citizen science volunteers. *Astronomy Education Review, 9*, 1.

Rotman, D. (2013). Collaborative science across the globe: The influence of motivation and culture on volunteers in the United States, India and Costa Rica. Ph.D. Dissertation, University of Maryland. http://drum.lib.umd.edu/handle/1903/14163

Rotman, D., Preece, J., Procita, K., Hansen, D., Lewis, D., Hammock, J., Parr, C., ... ACM 2012 Conference on Computer Supported Cooperative Work, CSCW '12. (2012, March). Dynamic changes in motivation in collaborative citizen-science projects. *Proceedings of the ACM Conference on Computer Supported Cooperative Work*, CSCW, 217-226.

Rubin, H. J., & Rubin, I. S. (1995). Qualitative interviewing: The art of hearing data. Thousand Oaks, Calif.: Sage Publications.

Strauss, A. L., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, Calif.: Sage Publications.

Terranova, T. (2000). Free labor: Producing culture for the digital economy. *Social Text, 18,* 2 63, 33-58.

Terry, B.D., Harder, A.M., & Pracht, D.W. (2012). Digital D: Options for volunteer involvement. In T.D. Connors (Ed.), *The volunteer management handbook: Leadership strategies for success*. (2nd ed.). John Wiley & Sons, Inc.

Wiggins, A. 2013 2nd ACM Conference on Computer Supported Cooperative Work, CSCW 2013. (2013, March). Free as in puppies: Compensating for ICT constraints in citizen science. *Proceedings of the ACM Conference on Computer Supported Cooperative Work*, CSCW, 1469-1480.

Wiggins, A., & Crowston, K. 44th Hawaii International Conference on System Sciences, HICSS 2011 (2011, January). From conservation to crowdsourcing: A typology of citizen science. *Proceedings of the Forty-fourth Hawai'i International Conference on System Science* (HICSS-44), 1-10.

Yin, R. K. (2003). Case study research: Design and methods. Thousand Oaks, Calif: Sage Publications.

Zhu, H., Zhang, A., He, J., Kraut, R. E., & Kittur, A. 31st Annual CHI Conference on Human Factors in Computing Systems: Changing Perspectives, CHI 2013. (2013, May). Effects of peer feedback on contribution: A field experiment in Wikipedia. *Conference on Human Factors in Computing Systems – Proceedings.*

8 Table of Tables