Insect Interactions in Entomology Citizen Science

Louise I. Lynch
Graduate Research Assistant, Department of Entomology, University of Nebraska-Lincoln
Room 220, Entomology Hall, UNL, Lincoln, NE 68583

Introduction

Citizen science is collaboration between science researchers and members of the general public to answer legitimate research questions with an unknown answer - as opposed to staged experiments with known outcomes often done in science classrooms. Members of the public are engaged as volunteers. With the help of hundreds, thousands or more volunteers, teams of scientists are given access to spatial and temporal scales they never could have accessed themselves due to constraints of time, travel capability, manpower and funding. Citizen science has allowed large, continental studies to be carried out. This has helped scientists research many complex problems currently facing society including extinction, habitat loss, pollution, climate change, growing food demands, disease treatment, etc.

The benefits that citizen science offers its participants are *believed* to be numerous and powerful, including increasing participants' scientific literacy, understanding of the nature of science and scientific process, increasing engagement in environmental policy decisions, increasing pro-environmental behaviors, and increasing logical debate and decision-making skills for handling scientific, social and political issues (Bonney et al., 2009; Clary et al., 2012; Dickinson & Bonney, 2012; Dickinson et al., 2012; Jordan et al., 2012a; Raddick et al., 2009; Trumbull et al., 2000). These benefits would, theoretically, contribute to a more scientifically knowledgeable and literate society. However, these gains have not received the same extensive research support granted to data validation and the utility of citizen science to researchers. These educational and literacy gains are assumed to occur by virtue of the fact that participants are collaborating with and have access to experts, receive high quality educational materials (reading, websites, etc.) and are contributing to research (whether collecting and reporting data or participating in research design) (Dickinson & Bonney, 2012).

Assessments of the impact of citizen science have been restricted, attempting to measure program impact directly on participants. Citizen science programs are thought of then, as educational interventions wherein science literacy increases after participation. However, some studies have reported volunteer-reported motivating factors suggesting that adult volunteers are already interested in and perhaps already knowledgeable about the field, the process of science, and already value participation in authentic science. This research intends to investigate these potential circumstances by explaining *how* adult citizen scientists participate in entomology research and to provide a more rigorous understanding of *how* citizen science may and does actually impact participants.

Purpose Statement

The purpose of this pilot study is to explore and describe how adult citizen scientists participate in entomology research. This will involve the description of their perceived role in a citizen

science program (Bumble Boosters), how they feel they benefitted from participating and how they shared their program experiences with others, as reported *by the participants themselves*. This will guide efforts in assessing and improving citizen science programs. The central, core question of this study is: How do adults experience citizen science within the field of entomology?

Methods

For the purposes of this pilot study, criterion and convenience sampling methods were utilized to provide quality assurance but also conserve time and effort (Marshall & Rossman, 2011). Research participants were selected from the Bumble Boosters program, a bumble bee citizen science program run by UNL's Department of Entomology. Three inclusion criteria were employed for this pilot study. Research participants had to: 1) Be adults (age 19 years or older), 2) be participants in the Bumble Boosters program, 3) have turned in a data report for the 2014 Bumble Bee Domicile. Approval for this study was obtained from the University of Nebraska-Lincoln's IRB (IRB# 20150415239 EX).

Adults represent a majority of citizen science participants. The Bumble Boosters program was selected in order to pilot test interview questions and research procedures. Nearly two hundred citizen scientists received introductory kits to participate in the Bumble Boosters program. However, not all recipients reported findings on their domiciles. The third inclusion criteria ensured that research participants had indeed participated to the fullest extent requested by the program leaders (myself included) and had experienced the central focus of this study. Bumble Boosters participants meeting the above three criteria were emailed a research recruitment email (included in appendices). Those individuals that replied to the email were provided with IRB-approved consent forms and a short demographic survey. Following completion of the consent form and survey, one-on-one telephone interviews were arranged at the convenience of the research participants. Research participants were provided with a sample of the interview questions to facilitate their comfort.

Six citizen scientists completed the consent process and comprised the preliminary sample interviewed at the time this paper was completed. A second recruitment email will be sent out to Bumble Boosters participants in the near future. In a short survey, participants were asked to list the number of entomology-related citizen science programs in which they participate, their age, sex, highest level of formal education, whether they had previous employment as a scientist, researcher or science educator and their ethnic background. Characteristics of participants are presented in Table 1 below. It should be noted that this sample does not represent a final sample for this study. Theoretical saturation has not yet been achieved. To protect the identity and privacy of research participants, participant's names were replaced with an alias and a number. This alias was obtained through an online random common name generator. All documents collected or provided by the research participants were immediately stripped of personally identifiable information and labeled with their alias.

Participant	1Carolyn Jones	2 Charles Moore	3 Ellen Howard	4 Anne Thomas	5 Lois Blue	6 Kathy Bell
No. of citizen science projects	*6*	*1*	*1*	*2*	*1*	*1*
Age (Years)	*43*	*64*	*67*	*64*	*47*	*38*
Sex	*Female*	*Male*	*Female*	*Female*	*Female*	*Female*
Highest level of formal education	*Master's Degree*	*Bachelor's Degree*	*Some college*	*Master's Degree*	*Bachelor's Degree*	*Bachelor's Degree*
Previous employment	*No*	*No*	*No*	*Yes*	*No*	*No*
Ethnic background	*White*	*White*	*White*	*White*	*White*	*White*

Table 1. Bumble Boosters citizen scientist characteristics.

Data Collection Methods

Intensive interviewing has long been employed in qualitative studies (Charmaz, 2006) and was the primary method of data collection in this study. One-on-one interviews were conducted over the telephone. These interviews were audio recorded for transcription purposes. I carried out transcription of audio recordings using InqScribe software in order to remain close to the data. Structured interview questions were designed and worded in order to provide an open-ended and non-judgmental setting (Charmaz, 2006) between the research participants and myself. The key mission was to get at the heart of what processes are employed and experienced by adult citizen scientists while participating in the Bumble Boosters program. The interview questions and demographic questions are provided in the appendices. The number of participants required to develop a substantive grounded theory cannot be predetermined and, as with many qualitative methodologies, interviews should continue until saturation is achieved. This pilot study does not report a substantive grounded theory as I have not yet achieved saturation. In proceeding with this research, I will employ a constant, comparative method of data analysis and will continue to collect interview data until no new information is revealed. Follow up interviews will be requested where necessary.

Qualitative researchers can never truly capture an objective reality, however the strategy of triangulation allows a researcher to increase the internal validity of a study (Merriam, 2009). Multiple sources of data have been and will be collected in this study. Virtual documents (Facebook and the Bumble Boosters website) and individually constructed materials (articles written by participants, photographs, emails, etc.) were part of the data and are outlined in Table 2 below. The use of these documents was detailed in the IRB application and to research participants.

Data Form	Type of Data
Interviews	Structured interviews using open-ended questions. • One-on-one, telephone or online video
Questionnaires	• Demographic survey using close-ended questions
Documents	• Entomology research data forms turned in for project

	• Research journal/diary if kept • Blog posts or articles • Educational materials provided to community or friends • Emails
Visual materials	• Photographs of objects or activities related to citizen scientists' activities

Table 2. Primary and secondary data sources collected for this study.

Data Analysis

The interpretive approach of constructivist grounded theory (Charmaz, 2006) guided this study. Initial, line-by-line coding was carried out using gerunds. In this process, nearly every transcript line is named (coded). Gerunds are nouns made from a verb and end in *–ing*. They were employed in order to facilitate the detection of processes in the data (Charmaz, 2006, p. 49). Currently, this coding was used for transcripts alone but is adaptable to other data forms (Charmaz, 2006, p. 50) and will be applied to secondary data forms collected (documents, articles, photographs if possible). Where appropriate, *in vivo* codes were utilized to preserve participants' meaning and views (Charmaz, 2006, p. 55) in initial codes and tentative categories. Initial codes were developed using early memo-writing to explain significant and frequent codes and to probe processes voiced by research participants (Charmaz, 2006, p. 80). Focused coding, a "more directed, selective and conceptual" (Charmaz, 2006, p. 57) was started, however additional data collection and interviews will be required to strengthen the analytic directions required for this stage of data analysis. In this study, potential focused codes are presented as and referred to as tentative categories. A workbook was created to group each tentative category with its early memo, initial gerund-based codes and direct transcript quotes.

Numerous strategies were employed for validation and reliability. Others will be employed as this study progresses. I utilized triangulation by making use of multiple and different sources of information (Creswell, 2013). Following the transcription of interviews, corroborating evidence was collected by requesting it directly from the research participants or acquiring the information from different online sources (ex. If a research participant reported that they led an educational program at a local nature center, I confirmed this in the Museum's online schedule of events. If they discussed photographs of their bumble bee domiciles, I requested copies of said photographs.). And such documents are stripped of the participant's name or other identifying information and labeled only with an alias. Lastly, I have provided rich, thick descriptions (Creswell, 2013), calling directly upon research participant's words and providing details when describing my initial codes, tentative categories and memos. Data was analyzed by hand and using simple software (InqScribe, Microsoft Word, Excel).

Findings

Five, key tentative categories were developed using the rich, detailed experiences shared by Bumble Boosters participants during this pilot study. These tentative categories represent significant processes voiced by some or all of the research participants in various ways. These include: having "second thoughts" about insects, employing scientific practices to pursue answers, assuming the role of expert, finding satisfaction in "being involved at a higher level",

and captivating a surprised public through everyday conversations. Below, each tentative category is described and discussed.

Having "second thoughts" about insects. This tentative category utilizes an *in vivo* phrase. Three of the four research participants reported having "second thoughts" about insects over time. Research participants described their transition from having a negative to positive (or more reserved) perception of insects. Research participants initially hated insects, being disgusted or fearful by the mere sight of them. They viewed insects as pests and killed them on sight. Research participants transitioned to their current perception, taking a moment to examine insects when their paths cross, rather than just seeing them as pests and swatting or killing them. Research participants take a moment to "really look" at the insect, to observe them with "a little more interest" and in some cases even admiration. The conditions under which this process developed varies. In Carolyn's case, it was initiated by moving from a city to a prairie remnant and experiencing increased interactions with wildlife. In Ellen and Anne's case, it was initiated by interaction with a close family member (myself) that was interested in bumble bees and other living organisms. In all three cases, involvement in entomology citizen science programs supported and strengthened this process. This tentative category will develop as I delve further into insect interactions during participation in entomology-based citizen science programs.

Employing scientific practices to pursue answers. Research participants employed various practices associated with science inquiry (or scientific method) in order to investigate the problem of designing a successful domicile design or obtaining an answer to unexpected results (trying to explain why monarch eggs didn't hatch). Research participants made observations, described unexpected results, created their own experimental designs, adjusted domicile locations based on observations and results, etc. Research participants voiced an enjoyment in experimenting and learning and trying to find out more about insects or entomology research. Participants used observations they made in the field to plan or design domicile designs and test out ideas. Anne, Carolyn and Charles reported that they have always been interested in nature or living things and that the Bumble Boosters program gave them an opportunity to concentrate on bumble bees in particular. Despite the fact that no domicile designs were successful, all research participants have adapted their location or approach for the coming season and will again pursue a successful design. This shows that these actions and an innate understanding of basic scientific methods are already present in some citizen scientists.

Assuming the role of expert. This tentative category refers to citizen scientists taking on, stepping into, or becoming, the expert within their social spheres. Carolyn and Anne, both of who are teachers, discussed this. These citizen scientists have acquired knowledge about living organisms and are called upon by their professional peers to answer questions, handle interactions and support learning about living organisms. "Organism" is used here, rather than insects, because they are called upon to handle living things beyond insects, including birds and snakes. Participants express initial surprise at being considered an expert to their peers but are pleased and even driven to share their knowledge and experiences. Anne shared that "They yelled for *me* to come and take care of it (laughter). I would have never been the one to be called." Similarly, Carolyn shared "I'm considered their entomologist (laughter). Now I *do* feel like my knowledge, I need to share it…now they'll say 'Go talk to Mrs. Jones. Go ask her, she'll know.' So they see me as a kind of a bug, a bird expert." This tentative category is related to "*Captivating a*

surprised public through everyday conversations" in that these citizen scientists are interacting with and impacting the public.

Finding satisfaction in "being involved at a higher level". This tentative category utilizes an *in vivo* phrase. All four research participants described this process to some degree. They described an "enjoyment" and "excitement" in the usefulness of their participation, the novelty and authenticity of the research, and their ability to impact science at an academic and policy level. Research participants felt they were doing something useful and adding to foundational knowledge about bumble bees research rather than, as noted by Charles, "rather than just casually observing something. This tentative category is related to a assuming the role of expert and long-term interest in insects reported by some of the research participants. It will be developed as I delve further into citizen scientist-program leader interactions (and potential power plays) during participation in entomology-based citizen science programs and the science identities of citizen scientists.

Captivating a surprised public through everyday conversations. This tentative category describes the process in which research participants casually interact with people they are talking to about the project. Others are often surprised, or shocked at the idea of a bumble bee citizen science project yet, to the pleasure of the research participants, these same people will discuss and want to know more about the project at length. All four research participants see a difference in "others", whether they saw it in themselves at first or not. They find it interesting that people respond in awe and shock and also find that people, despite their initial reaction, are interested in hearing more. All four research participants position themselves as feeling there is a lacking understanding or appreciation of bees in general, by the public. This tentative category needs much development in determining its conditions and consequences.

Discussion

This study has begun to scratch the surface of how adults experience citizen science within the field of entomology. Even the initial "scratches" of these interviews have uncovered exciting and valuable themes that will build towards a substantive theory explaining these processes and illustrate a more thorough understanding of program impacts and, most importantly, program participants.. When all is said and done, it is of particular interest to me that discussions with researchers and the very nature of program assessments suggest that citizen scientists are the visitors, the students, the blank slates upon which an impact can be made (and measured). Researchers have attempted to certify the value of citizen science programs, and rightfully so, but by attempting to show increases in understanding of the science process, science literacy, content knowledge, attitudes towards the environment, and attitudes towards science in individuals progressing through their citizen science program. In most cases, these assessments have been applied as pre- and post- tests, attempting to detect changes over the course of a season – which varies in length depending on the project. I have reviewed that results have been mixed. This pilot study suggests that the processes experienced by adult citizen scientists may be more complex and longer in duration than can be detected by instruments currently available. This pilot study also suggests that citizen scientists are not operating within a petri dish. Rather, they have a long, rich and complicated history interacting with science, entomology and their

communities. They are networking within the citizen science community and their local communities, building expertise, employing scientific practices and developing an appreciation of insects and living things sometimes over the course of several years.

The tentative category of employing scientific practices to pursue answers may explain why measurements, such as the Science and Engineering Indicator (Brossard et al., 2005; Cronje et al., 2011) have failed to detect increases in understanding of science process. Perhaps the understanding is already there in many citizen scientists! The tentative categories developed in this pilot study suggest that citizen scientists have indeed experienced a positive impact in their attitudes towards insects but over many months and even years. The citizen science programs in which they participate are one of the stones in this new path. Current literature attempting to assess citizen science impacts administered instruments over a single season. This does not allow enough time for impacts to occur. Further, instruments utilized to date are not sensitive enough or intended to measure changes in an individuals over such duration. Humans are complex creatures. Adults in citizen science programs are not subjected to the guided learning that student citizen scientists receive in the classroom. Adult citizen scientists may take a different path towards learning and engaging in citizen science programs.

This research also suggests that, in their current status, citizen scientists have developed great expertise, are seen as experts by their peers, and communicate regularly with family members, neighbors and community organizations. This is exciting! It is evident that, in the case of Bumble Boosters, the citizen scientists participate beyond the objectives outlined by our program. They participate in self-motivated experiments and observations. They perceive their role as assisting our research efforts and advancing science and conservation efforts through authentic research. Perhaps, as a community of researchers, we need to reassess how we approach program impacts and how *we* perceive the role of citizen scientists are in our programs. Perhaps, in some cases, these citizen scientists are collaborators not subjects, are colleagues not volunteer workers. Perhaps the greatest impact of these programs is through citizen scientists that are ambassadors, conveying conservation messages and affecting the attitudes and behaviors of those around them. This research begins to suggest that program impacts are beyond the list of registered participants. This is a difficult number to measure, but impact is there!

Lastly, there is an inherent power play between citizen scientists and program leaders that surfaced in two interviews. One research participant described their designs in a somewhat self-deprecating manner and another explicitly described frustrations in having their efforts to support bumble bee research dismissed. This may be a critical factor impacting the process of citizen science participation as it is the stage upon which these interactions occur. This power play will be further explored in subsequent interviews with both citizen scientists and program leaders.

References

Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., Wilderman, C. (2009). *Public participation in scientific research: defining the field and assessing its potential for informal science education*. Washington, DC: Center for the Advancement of Informal Science Education.

Brossard, D., Lewenstein, B. and Bonney, R. (2005). Scientific knowledge and attitude change: the impact of a citizen science project. *International Journal of Science Education* 9(15): 1099-1121.

Charmaz, K. (2006). *Constructing grounded theory: a practical guide through qualitative analysis*. Thousand Oaks, California: Sage Publications.

Clary, R., Wandersee, J., Guyton, J. and Williams. M. (2012). Citizen science in your own backyard. *The Science Teacher* December issue: 51-57.

Creswell, J. W. (2013). *Qualitative inquiry and research design: choosing among five approaches*, 3rd ed. Thousand Oaks, California: Sage Publications, Inc.

Cronje, R., S. Rohlinger, A. Crall, and G. Newman. (2011). Does participation in citizen science improve scientific literacy? A study to compare assessment methods. *Applied Environmental Education & Communication* 10: 135-145.

Dickinson, J. L., Bonney, eds. (2012). *Citizen science: public participation in environmental research*. Ithaca, New York: Cornell University Press.

Dickinson, J. L., J. Shirk, D. Bonner, R. Bonney, R. L. Crain, J. Martin, T. Phillips, and K. Purcell. (2012). The current state of citizen science as a tool for ecological research and public engagement. *Frontiers in Ecology* 10(6): 291-297.

Jordan, R. C., W. R. Brooks, D. V. Howe, J. G. Ehrenfeld. (2012). Evaluating the performance of volunteers in mapping invasive plants in public conservation lands. *Environmental Management* 49: 425-434.

Marshall, C. & Rossman, G. B. (2011). *Designing qualitative research*, 5th ed. Thousand Oaks: Sage Publications Inc.

Raddick, M J., G. Bracey, K. Carney, G. Gyuk, K. Borne, J. Wallin, and S. Jacoby. (2009). Citizen science: status and research directions for the coming decade. *AGB Stars and Related Phenomenastro 2010: The Astronomy and Astrophysics Decadal Survey*: 1-46.

Trumbull, D. J., Bonney, R., Bascom, D. and Cabral, A. (2000). Thinking scientifically during participation in a citizen-science project. *Science Education* 84: 265 – 275.