Citizen Science in 4-H: Youth Volunteer Motivations, Participation, Retention and Scientific Literacy

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CITIZEN SCIENCE IN 4-H: YOUTH VOLUNTEER MOTIVATIONS, PARTICIPATION, RETENTION AND SCIENTIFIC LITERACY

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor in Philosophy

in

Agricultural and Extension Education and Evaluation

by

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December 2018
To my daughters, curious creatures and world explorers.
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Abstract

The primary purpose of this study was to examine the influence of volunteer motivation, participation, and citizen science project type on the retention and scientific literacy of 4-H youth volunteers ages 8-19 years participating in science projects. The conceptual model of participation in organized activities (OA) proposed by Bohnert, Fredericks and Randall (2010) was used as a framework for the variables included in the study categorizing them as predictors of participation, participation, program characteristics, or outcomes. A systematic review of volunteer motivations, retention, and scientific literacy in citizen science projects exposed that the literature contains silos of information published in content area specific journals further supporting the need for the Journal of Citizen Science Practice and Theory established in 2016. The review revealed a gap in the literature on motivations of youth citizen science, the factors that influence volunteer retention in citizen science projects, and how to define and measure scientific literacy.

This study found two significant differences between 4-H youth participants in 4-H science programs and those in 4-H citizen science program. First, youth in science programs without a citizen science component were more motivated by social functions to volunteer and second, they are more likely to continue to volunteer than their counterparts. Further investigation into the influence of citizen science program characteristics on these variables is needed.

This study revealed relationships between engagement and consistency, in addition to consistency and both retention and scientific literacy outcomes. These relationships need to be examined for causation. A new framework for studying youth participation and youth outcomes in citizen science programs is proposed.
Chapter One. Introduction

What is scientific literacy? How do we measure it? What participant and program factors influence scientific literacy outcomes in a citizen science program? If we, as informal educators, are to assist in increasing scientific literacy of the youth with which we work, we must understand the key factors in program designs to increase participant engagement and improve outcomes.

Background and Content

While the tradition of public participation in scientific discovery has been established for almost 2,000 years (Follett & Strezov, 2015), what to call this concept has varied over time, geography and discipline (Eitzel et al., 2017). In 1995, the phrase citizen science was coined by two people in two different contexts. Bonney used citizen science to refer to the Cornell Lab of Ornithology’s (CLO) scientist-driven public research projects like the Christmas Bird Count. Irwin used citizen science to refer to citizen engagement in science policy (Bonney et al., 2009a). For two decades, the term and its variations were used without a single, agreed upon definition (Eitzel, et al., 2017). It was not until 2014 when the term “citizen science” was added to the Oxford English Dictionary as “scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions” (OED 2016). This definition was used for the purpose of this study.

Citizen science projects were further classified based on two aspects of the project: (a) type of volunteer involvement and (b) goals of the study of the project. The type of volunteer involvement...
involvement is determined by the tasks and steps of the scientific process that the volunteer partakes in. Volunteer involvement is divided into three categories:

1. Contributory projects, which are generally designed by scientists and for which members of the public primarily contribute data.

2. Collaborative projects, which are generally designed by scientists and for which members of the public contribute data but also may help to refine project design, analyze data, or disseminate findings.

3. Co-created projects, which are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all steps of the scientific process. (Bonney et al., 2009a, p.17).

Citizen science is often incorrectly assumed to be synonymous with crowdsourcing. There is overlap between these two concepts, however a clear difference remains. “Crowdsourcing designates the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, especially through online collaboration and participation” (Eitzel et al., 2017, p.10). For example, the Waze traffic app is a community-based traffic and navigation app where drivers share current traffic and road info. The traffic information is crowdsourced from drivers in real-time who contribute information about accidents or inexpensive gasoline prices. In contrast, contributory citizen science consists of both a scientific protocol for collecting data as well as a goal of scientific contribution. For instance, the Loss of the Night app was developed to help scientists measure and understand the effects of light pollution on health, environment, and society. After calibrating the compass on their phone, participants follow a protocol via prompts in the app to collect weather data and identify which stars are visible to the naked eye. Participants are able to access their data and the contributions
of others at myskyatnight.com. It should be clear now that crowdsourcing and contributory citizen science are two distinct concepts.

Another strategy for categorizing citizen science projects is by examining the goals of the project’s scientific study. Wiggins and Crowston (2011), identified five types of citizen projects based on the goals of the study:

1. Action Projects are initiated by volunteers designed to encourage intervention in local concerns.
2. Conservation Projects address natural resource management goals.
3. Investigation Projects focus on scientific research goals in a physical setting.
4. Virtual Projects focus on scientific goals but are entirely based on information technology with all volunteer interaction occurring online.
5. Education Projects that are often performed in the classroom or school grounds as part of science curriculum.

Public participation in scientific research is not new to the cooperative extension system. For decades, extension agents have been involving farmers, youth, Master Gardeners and other community members in the scientific process. In a nationwide survey of 4-H educators, 56% of 129 respondents from 21 states used citizen science or were knowledgeable of the successful use of citizen science in 4-H. The most common delivery methods were in clubs, after school programs and specialist interest projects (Enck, 2013). One goal of public participation is to increase scientific literacy in communities. It is hypothesized that citizen science projects help increase scientific literacy by involving participants in the scientific process and teaching them content knowledge about the project’s topic.
Scientific literacy was first coined in 1958 by three different sources and has morphed in definition and dimensions ever since (DeBoer, 2000). While the common definition of literacy refers to the ability to read or write, the Oxford English Dictionary notes that in extended use with a modifying word, for instance in the context of scientific literacy, the definition then evolves to “the ability to ‘read’ a specified subject or medium; competence or knowledge in a particular area” (OED). For research and evaluation purposes, standards need to be set in order to determine competence. In the National Science Education Standards, the authors defined scientific literacy as “the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (p.22). In 2015, California 4-H examined scientific literacy from a citizen’s perspective in the context of nonformal educational youth programs. They identified four anchor points: (I) science content, (II) scientific reasoning skills, (III) interest and attitude, and (IV) contribution through applied participation (Smith, Worker, Ambrose and Schmitt-McQuitty, 2015). For the purpose of this study, scientific literacy will be measured based on two of these anchors: scientific reasoning skills and interest and attitude.

**Problem Statement**

Scientific literacy is important for democratic processes and decision making as well as future employment opportunities which will be increasingly related to science, technology, engineering, and math, collectively referred to as STEM fields. Scientific literacy is of particular concern in the United States of America, where only 28% of adults are considered scientifically literate (Miller, 2016). Increasing America’s talent pool by improving K-12 science and mathematics education is considered “most urgent” by the National Academy of Sciences.
(2007). Citizen science is a new and growing field that holds real promise for improving the scientific literacy of its participants (Bonney et al., 2009b).

Why is science literacy important? First, an understanding of science offers personal fulfillment and excitement – benefits that should be shared by everyone. Second, Americans are confronted increasingly with questions in their lives that require scientific information and scientific ways of thinking for informed decision making. And the collective judgment of our people will determine how we manage shared resources—such as air, water, and national forests. *(National Science Education Standards*, p.12)*

What individual factors (motivation and participation) and science program design factors (citizen science component, volunteer involvement type, and goal of study) explain participant retention and scientific literacy outcomes?

**Purpose and Objectives**

**Study Objectives**

1. Describe 4-H youth volunteer participants in science programs in terms of age, gender, race/ethnicity, and geographic location.

2. Determine if a relationship exists between 4-H youth volunteer participants’ motivation (measured by score on Volunteer Functions Inventory) and participation (measured by engagement, duration, consistency, intensity and dosage) and/or retention (operationally defined as Affective Commitment and intention to continue volunteering).

3. Determine if a relationship exists between science project type (classified by citizen science component, type of volunteer involvement, and goals of study) and 4-H youth volunteer participation and/or retention.
Purpose of Study

The primary purpose of this study was to examine the influence of volunteer motivation, participation and citizen science project type on the retention and scientific literacy of 4-H youth volunteers ages 8-19 years participating in science projects.

Research Approach

Study Variables

The descriptive variables in this study are age, gender, grade, race/ethnicity and state of residence. The independent variables are:

(a) Subject motivation as measured by the Volunteer Functions Inventory (Clary et al., 1998)

(b) Subject participation in citizen science as measured by participant reported dosage, intensity, engagement, duration and consistency.

(c) Type of citizen science program as described by the Type of Volunteer Involvement (Bonney et al., CAISE, 2009) and the Goals of the Study (Wiggins & Crowston, 2011)

The dependent variables are:

(a) Subject retention as measured by Affective Commitment and intension to continue volunteering.

(b) Subject scientific literacy as measured by Science Process Skills Inventory (SPSI) (Bourdeau & Arnold, 2009) and Changes in Attitude about the Relevance of Science (CARS) (Siegel and Ranney, 2003)
Conceptual Framework

In a literature review of the current research on dimensions of youth involvement in organized activities, Bohnert, Fredericks, and Randall (2010) proposed a conceptual model of participation in organized activities (OA) (Figure 1.1) that was utilized in this study as a framework for 4-H youth volunteer participation in science programs (Figure 2.1). They focused on breadth, intensity, engagement, and duration/consistency and the best practices in measuring these dimensions.

![Conceptual Model](image)

Figure 1.1. The conceptual model of participation in organized activities (OA) proposed by Bohnert, Fredericks and Randall (2010, p. 579). Reprinted with permission.

While many previous studies have looked at the intrinsic and extrinsic motivations of citizen science project volunteers, this study takes a functional approach to motivation “that is explicitly concerned with the reasons and purposes, the plans and the goals, that underlie and
generate psychological phenomena – that is, the personal and social functions being served by an individual’s thoughts, feelings, and actions” (Clary et al. 1998, p. 1517). Clary et al. (1998) described six functions potentially served by involvement in volunteer activities: values, understanding, social, career, protective, and enhancement.

Figure 1.2. Bohnert, Fredericks and Randall’s conceptual model framing this study.

**Research Design**

This study is a descriptive, cross-sectional quantitative study. The target population was 4-H youth volunteers participating in citizen science programs during the spring and summer of 2018. Data was collected by paper survey and by Qualtrics survey software then analyzed using SPSS Version 25 statistical software.

**Assumptions**

In conducting this study, the following assumptions were made:

1. Scientific literacy can be described and measured.
2. The instrument measures the constructs it proposes to measure.
3. The instrument will elicit reliable responses.
4. The 4-H youth volunteer participants that respond to this survey were accurately identified as participating in 4-H citizen science programs.
5. The respondents will understand the questions asked on the instrument.
6. The respondents will answer honestly.

**Limitations**

Limitations of this study are that it was a cross-sectional, one-time snapshot of 4-H youth volunteers’ ages 8-19 years’ motivation, participation, retention and scientific literacy. Research shows that volunteers’ motivations can change over time from initial motivations to sustaining motivations (West & Pateman, 2016). Youth participation in organized activities, like a citizen science program, may also vary in intensity and dosage over a year with seasonal highs and lows (Bohnert et al., 2010). Another limitation is that the instrument was administered by different 4-H professionals and not one consistent individual or trained team. Finally, this study used a convenience sampling, a nonprobability technique, which could result in a biased sample and sampling error could not calculated.

**Rationale and Significance**

The field of citizen science is in its infancy. This study contributed to the growth of the field in four ways:

1. It provided a systematic review of literature.
2. It examined the motivations of 4-H youth volunteers ages 8-19. The average age in years reported in citizen science motivation studies is usually late 40s to mid-50s.

Volunteer motivation research is often qualitative case study work or evaluations of specific citizen science programs and their outcomes (see Chapter 2). Follett &
Strezov (2015) note that studies on the motivation of citizen scientist volunteers and the effect of those motivations are more recent and few in number.

3. In an analysis of citizen science based research, Follett & Strez (2015) identified the retention of volunteers in citizen science projects as a critical topic that needed further examination. This study explored the participant and program factors that may influence volunteer retention.

4. This study contributed to the body of knowledge by examining factors that influence scientific literacy outcomes of youth citizen science volunteers.

**Definition of Terms**

**Action Projects.** Projects initiated by citizens, not scientists, that “encourage participant intervention in local concerns, using scientific research as a tool to support civic agenda” (Wiggins & Crowston, 2011, p.5)

**American Indian and Alaska Native.** “A person having origins in any of the original peoples of North and South America (including Central America) and who maintains tribal affiliation or community attachment” (Humes et al., 2011, p.3).

**Asian.** “A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam” (Humes et al., 2011, p.3).

**Black or African American.** “A person having origins in any of the Black racial groups of Africa” (Humes et al., 2011, p.3).

**Career.** A functional motivation “concerned with career-related benefits that may be obtained from participation in volunteer work” (Clary et al., 1998, p.1518).
Citizen science. “Scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions” (OED 2016).

Co-created projects. Citizen science projects that “are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all steps of the scientific process.” (Bonney et al., 2009a, p. 17).

Collaborative projects. Citizen science projects that “are generally designed by scientists and for which members of the public contribute data but also may help to refine project design, analyze data, or disseminate findings (Bonney et al., 2009a, p. 17).

Conservation Projects. Citizen science projects that “support stewardship and natural resource management goals, primarily in the area of ecology; they engage citizens as a matter of practicality and outreach” (Wiggins & Crowston, 2011, p. 5)

Consistency. The stability of the youth’s participation over a period of time (Bohnert et al., 2010).

Contributory projects. Citizen science projects that “are generally designed by scientists and for which members of the public primarily contribute data” (Bonney et al., 2009a, p. 17).

Crowdsourcing. “The practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, especially through online collaboration and participation” (Eitzel et al., 2017, p.10).

Dosage. The frequency of participation in terms of amount of exposure to the program (treatment) and measured in hours per week (Bohnert, et al., 2010).

Duration. The number of months a youth has participated in an organized activity (Bohnert, et al., 2010).
**Education projects.** Citizen science projects that “are explicitly education-oriented, they provide informal learning resources, with most projects also offering formal curricular materials” (Wiggins & Crowston, 2011, p.7-9).

**Enhancement.** The functional motivation “that centers on the ego’s growth and development and involves positive strivings of the ego” (Clary et al., 1998, p.1518)

**Engagement.** A multidimensional construct consisting of cognitive, emotional and behavioral components (Bohnert, et al., 2010).

**Hispanic or Latino.** “A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race” (Humes et al., 2011, p. 2).

**Intensity.** The frequency a youth participates in a particular activity or activity context measured in terms of times per week (Bohnert, et al., 2010).

**Investigation Projects.** Citizen science projects that “are focused on scientific research goals requiring data collection in a physical environment” (Wiggins & Crowston, 2011, p.6)

**Multiracial.** Operationally defined as a person that identifies as two or more races.

**Native Hawaiian and Other Pacific Islander.** “A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands” (Humes, et al., 2011, p.3).

**Protective.** A functional motivation “involving processes associated with the functioning of the ego… protecting the ego from negative features of the self and, in the case of volunteerism, may serve to reduce guilt over being more fortunate that other and to address one’s own personal problems” (Clary et al. 1998, p. 1518).

**Retention.** Operationally defined as Affective Commitment and Intention to Continue Volunteering.
Scientific Literacy. “The knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (National Science Education Standards p.22).

Social. A functional motivation concerned with relationships with others and the belief that “volunteering may offer opportunities to be with one’s friends or to engage in an activity viewed favorably by important others” (Clary et al. 1998, p.1518).

Understanding. A functional motivation concerned with “new learning experiences and the chance to exercise knowledge, skills, and abilities that might otherwise go unpracticed” (Clary et al., 1998, p.1518).

Values: A functional motivation that “volunteerism provides for individuals to express values related to altruistic and humanitarian concerns for other” (Clary et al. 1998, p.1517).

Virtual Projects. Citizen science projects that “focus on scientific-research goals but are entirely based on information technology with all volunteer interaction occurring online” (Follett & Strezov, 2015, p.2).

Volunteer Motivation. “The reasons and purposes, the plans and the goals, that underlie and generate psychological phenomena – that is, the personal and social functions being served by an individual’s thoughts, feelings, and actions (Snyder, 1993)” (Clary et al. 1998, p. 1517).

White. “A person having origins in any of the original peoples of Europe, the Middle East, or North Africa” (Humes, Jones, & Ramirez, 2011, p.3).

Summary

Chapter one introduced the concepts of citizen science and scientific literacy, the background for this study, as well as the purpose, objectives, research approach, definition of terms, and the study’s expected contributions to the field of citizen science. There is a mounting
emphasis on the importance of scientific literacy in our society. Citizen science programs could be a promising way to increase it within youth populations but more is needed to be known about what individual and program characteristics influence retention and scientific literacy.
Chapter Two. A Systematic Review of Volunteer Motivations, Retention and Scientific Literacy in Citizen Science Projects

Citizen science research is an emerging field of study, independent from the areas of scientific research in which the citizen science projects are based. Terms are being defined (Eitzel, et al., 2017) and research agendas are being developed (C. Stylinski, personal communication, May 10, 2017). An assessment of the history and research of citizen science serves as a guide for understanding the current state of research on the motivations of citizen science participants, their retention, and scientific literacy outcomes. This body of work has implications for the sustainability and quality of citizen science projects.

Citizen science is defined as “scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions” (OED 2016). Citizen science is one of several models of public participation in scientific research (PPSR), a term used by the National Science Foundation (NSF) that emerged from a 1992 grant awarded to the Cornell Lab of Ornithology (CLO). PPSR is still used today in NSF call for research proposals (Bonney et al., 2009a).

PPSR projects, particularly projects based on a citizen science model, can be categorized based on the Level of Volunteer Involvement in the scientific process. Contributory projects have the least level of involvement because they are usually designed by scientists, with citizen science participants chiefly contributing data. Collaborative projects are also generally designed by scientists and participants primarily contribute data, but they may also assist in additional steps of the scientific process such as analyzing data or disseminating findings. The highest level of volunteer involvement is in co-created projects which are designed by both scientists and volunteer participants. Co-created projects allow volunteer participants to be actively involved in most or all steps of the scientific process (Bonney et al., 2009a).
For the purpose of this systematic review, it is important to distinguish between contributory citizen science and crowdsourcing because they are not synonymous. Crowdsourcing “designates the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, especially through online collaboration and participation” (Eitzel et al., 2017, p.10). In contrast to contributory citizen science, crowdsourcing does not explicitly imply scientific work and the contributions made by participants do not always follow a scientific protocol. Consequently, crowdsourcing is not tantamount to citizen science.

Contributions made by members of the general public to scientific work are the bedrock of citizen science projects. Often, the members of the general public are referred to as participants, when in fact they are ordinarily volunteers. Volunteer motivation research is concerned with the reason or purpose that individual volunteers choose to participate. While volunteer motivation is a mature theme in volunteer administration literature, it is a budding topic for research in the citizen science field (Follett & Strezov, 2015; Frensley et al., 2017).

Volunteer motivation has been linked to volunteer retention. When an individual’s purpose for volunteering is met by the organization they sustain their volunteer involvement; when an individual’s purpose for volunteering is unmet by the organization it results in turnover (Clary & Snyder, 1999; Ryan, Kaplan, & Grese, 2001; Peachey, Lyras, Cohen, Bruening &Cunningham, 2014). Retaining volunteers is critical for citizen science programs because recruiting and training volunteers’ uses project resources and data quality has been show to increase with volunteer tenure (Lewandowski & Specht, 2015).

One of the participant outcomes in citizen science is scientific literacy (Bonney et al., 2009b; Van Vilet & Moore, 2016). Scientific literacy is “the knowledge and understanding of
scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (National Science Education Standards, p.22) A more knowledgeable volunteer also produces more accurate data contributions (Lewandowski & Specht, 2015).

Rationale

Citizen science is a rapidly growing field of study in both the biological and social sciences. The growth of peer reviewed articles on citizen science has rapidly increased since 2007 but there are still few studies on the motives of the volunteer citizen science participants (Follett & Strezov, 2015). Until 2016, there was not a journal dedicated to the field of citizens science. Articles related to citizen science participants and outcomes were often published in journals related to the scientific fields of the specific project, for example astronomy or orinthology. A comprehensive, systematic review of the available literature on citizen science participants’ motivations, retention and scientific literacy outcomes is needed to assess the field’s current understanding of citizen science volunteers and where further research is needed to fill gaps in knowledge.

Purpose and Research Questions

The goal of this systematic review is to understand the state of the current research of volunteer participants in citizen science projects in order to inform future research. Three research questions guide this study:

1. What does existing research say about the motivations of volunteer participants in citizen science projects?
2. What does existing research say about factors that influence volunteer retention in citizen science projects?
3. What does existing research say about the scientific literacy of citizen science participants?

Methods

Protocol

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria (Moher et al., 2009). PRISMA adopted the Cochrane Collaboration’s definition and defines a systematic review as “a review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research and to collect and analyze data from the studies that are included in the review” (p.1, Moher et al. 2009). A literature search was conducted to identify peer-reviewed publications published between January 1, 2007 and August 31, 2017. Initially no language was specified but the limitation of English abstracts was added after a translation of one article could not be obtained.

Eligibility criteria

The electronic databases AGRICOLA, Communications & Mass Media Complete, Eric, PubMed, Directory of Open Access Journals, Academic Search Complete and BioOne were searched via article title and abstract. In addition, the search was expanded to include the journals Citizen Science: Theory and Practice and Journal of Science Communication because neither was showing up in the Directory of Open Access Journals although indexed there. The search terms used in all search engines were: (motiv* OR scientific literacy OR retention) AND “citizen science” OR “public participation in scientific research”. The articles identified in the electronic searches were exported to a citation management software (Zotero version 4.0.29.17) and duplicates were identified and removed.
Study Selection

Screening was conducted in two phases. During the primary phase, identified literature was screened based on the following inclusion criteria: (1) the article was published in a peer-reviewed journal; (2) the title and/or abstract contained the key term “citizen science” or “public participation in scientific research” and (3) the title and/or abstract contained one of the secondary search terms “motiv*”, “scientific literacy, and/or “retention”. Articles identified in the primary phase, were then excluded from this systematic review based on the following exclusion criteria: (1) about a crowdsourcing project not citizen science; (2) about citizen science project design not participants; (3) about citizen science data, not a citizen science project; and (4) about motivations of scientists or organizations, not volunteer participants.

Data collection process

Data were extracted by the author using a purposefully-designed worksheet (Appendix A) adapted from the coding form suggested by the Cochrane Handbook (p.157). Author was not blind to author names, institutions or publication title.

Data items

Data items collected included article source, eligibility confirmation of key term, secondary term or its reason for exclusion. Data items collected about the citizen science project were the project name, subject (area of scientific study), and type of volunteer involvement (contributory, collaborative, or co-created). Data items on the methods section of the articles included study design (qualitative, quantitative or mixed-methods), the study duration, the data collection method including instruments and theoretical frameworks. Participant demographics data items were total number of participants, age, sex, and ethnicity, as well as the country and setting (online, in the field). Data items on interventions (if any) included the total number of
intervention groups, descriptions of the specific interventions, and number of participants in each group. Key outcomes, unanswered questions, and miscellaneous data items like funding sources were also collected.

**Results**

A total of 131 articles were identified and extracted through database searches. The breakdown of the number of articles identified by each source is as follows: 15 from Agricola, 2 from Communications and Mass Media Complete, 24 from ERIC, 10 from PubMed, 8 from Directory of Open Access Journals, 70 from Academic Search Complete and 2 from BioOne. An additional 7 articles were extracted by hand search through two journals, *Journal of Science Communication* and *Citizen Science: Practice and Theory* (Figure 2.1). Together, a total of 138 articles were retrieved. Of the 138 extracted articles, 21 reappeared as duplicates and were removed from the review.

Articles were then screened by abstract and excluded based on the exclusion criteria written into protocol. In total, 58 articles were excluded. The abstracts of 23 articles did not include a key term and 14 did not include a secondary term. After being screened, two articles were removed because they were about crowdsourcing and not contributory citizen science. An additional two articles were excluded because they used citizen science project data only. Lastly, 15 articles were excluded because they were about the design of citizen science projects. The remaining 59 articles were screened for eligibility by full text. The screening process lead to the exclusion of an additional 25 articles: one did not contain the key term, six did not contain the secondary term, three were crowdsourcing, five about design, one used citizen science project data only, three were about motivations other than those of participants, five were essays and one was not in English. Included in this systematic review is the remaining 34 articles.
Narrative synthesis

Motivation

More than three fourths of the articles (27) extracted in this systematic literature review were on volunteer participant motivations in citizen science projects, and the majority of those have been published in the last four years beginning in January of 2014 (Graham, Tan, Jones, & Ellis, 2014; Hvenegaard & Fraser, 2014; Johnson et al., 2014; Nov, Arazy, & Anderson, 2014; Rotman et al., 2014; Curtis, 2015; Wright, Underhill, Keene, & Knight, 2015; Alender, 2016; Cappa, Laut, Nov, Giustiniano, & Porfiri, 2016; Jennett et al., 2016; Merenlender, Crall, Drill, Prysby, & Ballard, 2016; Roger & Kilstorner, 2016; West & Pateman, 2016; Beza et al., 2017; Domroese & Johnson, 2017; Kinchy, 2017; Rutten, Minkman, & van der Sanden, 2017; Frensley et al., 2017). The frameworks for these studies have their base in the social sciences, educational theories, and the hard sciences:

- Expectancy-Value Theory (Catkinson, 1957; Raddick et al., 2013)
- Grounded Theory (Rotman, et al 2014)
- Incentive Theory (Beza et al., 2017)
- Miller's Civic-Based Scientific Literacy (Price & Lee, 2013 )
- Social Cognitive Career Theory (Hiller & Kitsantas, 2014)
Volunteer Functions Inventory (Alender, 2016; Ferster, Coops, Harshaw, Kozak, & Meitner, 2013).

Two frameworks were created specifically for volunteer motivations of citizen science participants:

- Motivations, Learning, Creativity Model (Jennett et al., 2016)
- Citizen Science Motivation Framework for Online (Curtis, 2015)

Research Settings

Current in the field of citizen science is primarily being conducted in two locations, online (Curtis, 2015; Land-Zandstra et al., 2016; Mankowski et al., 2011; Nov, et al., 2014; Tinati et al., 2017; Wal et al., 2016; Raddick et al., 2010; Raddick et al., 2013; Jennet et al., 2016) or in the United States, most commonly the northeast (Cappa, Laut, Nov, Giustiniano, & Porfiri, 2016; Curtis, 2015; Domroese & Johnson, 2017; Hiller & Kitsantas, 2014; Hiller, 2016; Jorden et al., 2011; Kinchy, 2017). Only a handful of studies were located in other countries which included Australia (Roger & Kilstorner, 2016), Canada (Ferster, Coops, Harshaw, Kozak, & Meitner, 2013; Hvenfaard & Fraser, 2014), India (Johnson et al., 2014), Islands in the Kingdom of the Netherlands (Carballo-Cárdenas & Hilde, 2016), and South Africa (Wright et al., 2014). Notably, two studies examined volunteer motivations across countries and continents. Beza at al., 2017 discussed farmers’ motivations to participate as citizen scientists across India, Ethiopia and Honduras; Rotman et al. (2014) examined the motivations affecting short- and long-term volunteer participation in ecology-related citizen science programs in the United States, India, and Costa Rica.
Citizen Science Participant Demographics

A noticeable proportion of citizen scientist populations evaluated thus far have been over 40 years old (Hvenfaard & Fraser, 2014; Raddick et al., 2010, Jordan et al., 2011), more than 50% male (Cappa et al., 2016; Carballo-Cárdenas & Hilde, 2016; Frester et al., 2013; Johnson et al., 2014; ) or both(Alender, 2016; Beza et al., 2017; Curtis, 2015; Price & Lee, 2013; Raddick et al., 2013; Wright et al., 2015). The exceptions are American Master Gardener and Master Naturalist, and participants in a Norwegian influenza study. These citizen scientist populations are predominately women over 50 years of age (Frensley et al., 2017; Merenlender et al., 2016; Land-Zandstra, 2016). Two marine based conservation projects had participants ages 16-68 years old (Carballo-Cárdenas & Hilde, 2016 and 18-29 years old (Johnson et al., 2014). The most ethically/racially diverse citizen science project populations from extracted literature are those from research conducted in formal school populations (Hiller & Kitsantas, 2014; Hiller & Kitsantas, 20160.
Figure 2.1: Flow diagram of the systematic review process.


**Discussion**

The research topics of the citizen science projects are assorted from agriculture (Beza et al., 2017) to astronomy (Mankowski, Slater, & Slater, 2011; Nov, Arazy, & Anderson, 2014; Raddick et al., 2010; Raddick et al., 2013) to biochemistry (Curtis, 2015) to bird migration (Hvenegaard & Fraser, 2014) to public health (Land-Zandstra et al., 2016). However, the category of volunteer involvement in these projects does not vary; the literature is rich with studies on contributory citizen science projects with few articles focused on collaborative or co-created projects. This could be an accurate reflection of the proportion of contributory, collaborative and co-created projects in existence or a reflection of researchers’ bias.

The lack of diversity in citizen science participants in these studies is also worth mentioning. Studies involving males in their 40s and 50s dominate the literature. This points to the conclusion that participants in citizen science projects are homogenous. However, alternative hypothesis could be that the types of citizen science projects studied thus far have attracted certain volunteers or that respondents that are taking the time to partake in these optional studies reflect particular demographics.

**Retention**

In their study on Virginia Master Naturalists, Frensley et al. (2017) found no significant difference between the motivations of volunteers that persisted in the citizen science project and those that dropped out. This is contrary to some of the volunteer research reviewed by West and Pateman (2016) that found that individuals with certain motivations – for example, social reasons - are more likely to sustain volunteer involvement. The factors that did influence if a Virginia Master Gardener remained involved were they had (1) previous citizen science experience and (2) higher gross income. The authors suggest "Offering varying levels and types of engagement
for diverse participants may provide comfortable entry points from which they can begin to try new things, foster new interests, and deepen their engagement" (p.9) and conclude that “co-created projects that are salient with individuals appear to be critically important in motivating participation” (Frensley et al., 2017, p.10). Matching a volunteer’s reason for volunteering with the goal of the citizen science research is important for any project, however the importance of that fit increases from contributory to collaborative to co-created projects.

Seymour and Haklay (2017) were the first in citizen science volunteer research to look into patterns of distance traveled for participants in three UK regions and how this effects retention. They found that most volunteers lived within 20 miles to the volunteer site they attended, and that the proportion of volunteers decreased with increasing distance traveled indicating that distance and mobility are important factors to volunteer retention.

When examining the existing literature on motivations of sustained participation in citizen science projects, West and Pateman (2016) point out providing feedback to volunteers from science professionals in person or even via email or other technology can lead to continuous involvement. Similarly, in their evaluation of a short-term, focused campaign to increase participant activity in Nature’s Notebook, a national-scale citizen science program about phenology, Crimmins et al. (2014) speculate “that rapid reporting of interim results and interpretation may have a positive impact on observer's continued participation” (i.e. retention) (p. 70). In their study of Australian public interest in marine citizen science, Martin, Christidis and Pecl (2016) found that all stakeholders - fishermen, divers and others - scored feedback from scientists as important if they were to participate in any marine research project. Providing feedback, particularly positive or constructive feedback, is an important strategy for volunteer retention.
Motivation

Most of the current research on citizen science volunteer motivation is exploratory and focused on the motivations of volunteers in singular contributory citizen science projects. Less than a handful of researchers have compared volunteer motivations across projects (Alender, 2016; Nov, Arazy, & Anderson, 2014) or volunteer motivations across countries and continents (Beza et al., 2014; Rotman et al., 2014). Research on the motivations of online citizen science participants report worldwide involvement but do not analyze motivations from a geographic standpoint (Curtis, 2015; Raddick et al., 2010; Raddick et al., 2013).

The literature discussed ten different frameworks for discussing citizen science volunteer motivations. While Self-Determination Theory was the most common, (Frensley, et al., 2017; Nov, Arazy, & Anderson, 2014; Rutten, Minkman, & van der Sanden, 2017; Tinati, Luczak-Roesch, Simperl, & Hall, 2017 ) there is a practice of applying the Volunteer Functions Inventory Framework (Alender, 2016; Ferster, Coops, Harshaw, Kozak, & Meitner, 2013).

Participants in citizen science projects list more than one motivation for volunteering. Driving motivational factors usually include an interest in the content of the project, for example astronomy or birds, and a desire to contribute to scientific research (Curtis, 2015; Domroese & Johnson, 2017; Hvenega, et al.; 2014; Jennett et al., 2016; Raddick et al., 2013). However, Raddick et al. (2013) argue that what that contribution means varies between individuals. While most scientists view the outcome of an article in a peer-reviewed journal as the apex of scientific contribution, many non-scientist volunteers just want to be ensured that their observation or data set is being used in for something without defining what that is.

A number of studies compared initial volunteer motivations to their motivations to continue participating (Carballo-Cárdenas & Hilde, 2016; Curtis, 2015; Frensley et al., 2017;
Jeannett et al., 2016; Rotman et al., 2014). West and Pateman (2016) expand on this idea by describing motivations across “the journey that a participant takes when participating in a project” identifying four stages of volunteer participation: awareness of opportunity and decision to participate, initial participation, sustained participation, and finish participation.

**Scientific Literacy**

Research shows that feedback is also a valuable tool for increasing participant scientific literacy (Jennett et al., 2016; Roger & Kilstorner, 2016; Wal et al., 2016). A great amount of motivations are connected to the scientific content component of scientific literacy (i.e. learning about a specific species, conservation issue or concentration of science like astronomy). As a result of the component of scientific literacy being topic specific, it is the most difficult to measure across the field of citizen science yet is the most commonly reported in the literature. Jorden et al. (2011) investigated whether participants in a short term, contributory citizen science project on invasive plant species gained scientific-content knowledge, scientific reasoning skills, and knowledge of the nature of science. There was a 24% increase on content-related questions about invasive species between participants pre- and post-tests and 71% reported increased content knowledge. To examine content mastery in middle school age youth participating in a horseshoe crab based citizen science program, Hiller and Kitsantas (2014) used the Horseshoe Crab Content Science Measure, an instrument previously developed by Hiller specifically for this project. There was a statistically significant main effect for the treatment group that participated in the field-based citizen science related to this content mastery. It is problematic to compare science content knowledge gain across projects since different instruments are used to measure content knowledge for each topic.
Jorden at al. (2011) measured change in two specific science-process skills, controlling for confounding factors and discriminating between correlation and causation, and found that participation in the short-term invasive species citizen science project did not improve either one. However, in a different study to assess the effect of invasive species monitoring trainings on scientific literacy of citizen volunteers Cronje et al. (2011) discovered that a multi-item contextual instrument detected statistically significant improvements in scientific literacy when the more general, one item Science and Engineering Indicator measure did not. This suggests that careful consideration for the actual range of change expected should be considered when choosing an instrument to measure scientific literacy.

Price and Lee (2013) found that “volunteer's participation in social components of the program was significantly related to their improvement in scientific literacy while other project participation variables was not” (p.733). Overall, attitudes towards science increased through participation in this citizen science project. In their quasi-experimental study to examine the impact of a horseshoe crab citizen science program on student achievement with eighth-grade students, Hiller and Kitsantas (2014) found that contribution through applied participation mattered, even a one-day intervention consisting of a series of lectures, activities, and on-site modeling with field experts at a national park. The treatment group performed better than the comparison group on all measures except one, the Career Goals Scale.

**Conclusion**

The primary goal of this systematic review was to understand the state of current research of volunteer motivations, retention, and scientific literacy in citizen science projects in order to inform future research. Citizen science studies are often published in content area specific journals creating silos of information. A systematic review was necessary to conduct for a
comprehensive and exhaustive search of literature ensuring an accurate summary of the state of research in the field of citizen science.

The review revealed that volunteer motivation is a prevalent focus of research in the last four years but that the motivations of youth citizen science volunteers have not been reported. Motivation, mobility, and income are three of the variables investigated in the literature, however, questions remain about the factors that influence volunteer retention in citizen science projects. A handful of articles assessed the scientific literacy impacts of participating in citizen science projects but more research is needed to investigate the instruments and the outcomes. It should be clear now that a solid base of research has been conducted over the past 20 years examining volunteer motivations, retention, and scientific literacy in citizen science projects. From this body of knowledge, the foundation for the field of citizen science is now being laid.
Chapter Three. The Influence of Volunteer Motivation, Participation, and Science Project Type on the Scientific Literacy of 4-H Youth

Water scarcity, food security, and climate change are just three examples of worldwide issues that will need to be addressed by science. The question is, who will conduct the scientific investigations to solve these problems? In many countries, particularly the United States, there is a shortage of scientists, as well as citizens that have a basic understanding of the scientific process (Miller, 2016). As a result, the American Association for the Advancement of Science (AAAS), National Academy of Sciences (NAS), and National Research Council (NRC) have all prioritized increasing youth scientific literacy, “the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (National Research Council, 1996, p.22). Participation in a democratic society requires understanding of scientific information and process in order to make informed choices. Today’s youth will be making tomorrow’s decisions resulting in social, economic, and environmental impacts.

Literature Review

Making a declaration to improve scientific literacy is one thing; actually achieving it is another. First, scientific literacy is a complex concept with no agreement in the literature on an exact measurement (Roberts, 2007; Chang Rundgren & Rundgren, 2017). Existing instruments have suffered a Goldilocks syndrome of being too big and broad to capture change while others have been described as too narrow and contextualized to be utilized on a broad scale (Cronje et al., 2011). There remains a need for the development of an instrument that is just right for capturing increases of scientific literacy on an individual participant level while still being broad enough to be applicable across science programs and settings.
The first, and most difficult, step is to decide which scientific concepts citizens need to have knowledge and understanding of in order to make personal and civic decisions. For example, science content questions are used by the Pew Research Center and International Center for the Advancement of Scientific Literacy at the University of Michigan to report on the scientific literacy of Americans. Questions from the Pew Research Council’s twelve question survey test whether an individual can distinguish between astrology and astronomy and if they know uranium is needed to make nuclear energy and weapons (Pew Research Center, 2015). These items illustrate the difficulty in trying to measure scientific content knowledge across a vast spectrum of scientific disciplines in only a few questions. Furthermore, broad content questions are often the result of stakeholder negotiations, and not solely developed for accuracy and precision of the instrument, which can result in a bias in the experimental design that threatens construct validity of the instrument. Having said that, gains in project specific content knowledge by participants are commonly reported by citizen science projects as evidence of improvement in scientific literacy (Bonney et al., 2009b; Jordan et al., 2011; Hiller & Kitsantas, 2014). Problems in generalizability may occur because science content measures are content specific and difficult to compare across projects (Hiller & Kitsantas, 2014).

A second component used to measure scientific literacy is scientific reasoning skills, the cognitive skills required to comprehend and evaluate scientific information (Bonney et al., 2009b; Cronje et al., 2011; Smith, Worker, Ambrose and Schmitt-McQuitty, 2015). The National Research Council (2012) published the following list of skills needed to carry out and critique the scientific process: asking questions, collecting data, analyzing and interpreting evidence, developing and using models, planning and carry out investigations, making inferences and constructing explanations based on data, engaging in arguments from evidence and
communicating results. An advantage of accessing scientific literacy using scientific reasoning skills is that they are not content or project specific so could be used to compare outcomes across science programs.

A third component of scientific literacy is interest and attitudes towards science (Bonney et al., 2009b; Smith, Worker, Ambrose & Schmitt-McQuitty, 2015). Research has shown modest positive correlations between science attitude and science achievement (Siegel and Ranney, 2003). In youth, this is an especially important component of scientific literacy because interest and attitudes towards science can influence education and career choices, as well as their views on science-related issues in civic situations (Else-Quest, Mineo, & Higgins, 2013; Smith, Worker, Ambrose and Schmitt-McQuitty, 2015).

**Citizen Science**

Citizen science is “scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions” (OED 2016). For the purpose of this study, citizen science projects were classified according to two program characteristics: one, based on the goals of the study of the project, and two, based on the type of volunteer involvement. p.17). The first method was based on the work of Wiggins & Crowston (2011) who proposed categorizing citizen science projects by the goals of the study: action, conservation, investigation, virtual and education. Action projects were initiated by citizens, not scientists. Conservation projects supported stewardship and natural resource management. Investigative projects focused on scientific research goals in a physical setting. Virtual projects also focused on scientific goals but are entirely online. And educational projects were explicitly education oriented and provided informal and/or formal curricular learning resources for practitioners.
The second method of categorization, type of volunteer involvement was determined by steps of the scientific process that the volunteer participated in and can be classified as:

a. Contributory projects, which are generally designed by scientists and for which members of the public primarily contribute data.

b. Collaborative projects, which are generally designed by scientists and for which members of the public contribute data but also may help to refine project design, analyze data, or disseminate findings.

c. Co-created projects, which are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all steps of the scientific process. (Bonney et al., 2009a).

It is worth noting that the citizen science classification of type of volunteer involvement, also referred to as the model of public participation in scientific research, overlaps with the youth development model of youth-adult partnership (Y-AP). Both models reflect a gradient of youth involvement from contributory to actively part of the authentic decision-making. Camino (2000) identified three dimensions to Y-AP, (1) principles and values, skills and competencies, and an action-oriented method. According to Zeldin, Christens and Powers (2013, p.385), “Y-AP involves citizens across generations working together to address common concerns”. They hypothesize that Y-AP is a fundamental practice for all positive youth development and civic engagement. Therefore, since citizen science is by definition a civic engagement activity, youth-adult partnerships are fundamental for any citizen science project that involves youth. From contributory to co-created citizen science projects, the more involved youth are in authentic
decision making in the citizen science project, the higher in Y-AP the project is (Wu, Kornbluh, Weiss & Roddy, 2016).

Motivation

Bohnert et al. (2010) have conceptualized that an individual’s motivation to participate is one factor predicting youth participation in organized activity, such as a 4-H sponsored science program. Volunteer motivations have also been found to be predictors of participation and retention in some citizen science programs (Jennett et al., 2016; Rotman, et al., 2014). Top motivations usually include an interest in the topic of the research project, for example bees or Purple Martins, (Domroese & Johnson, 2017; Graham et al., 2014; Hvenegaard, et al., 2014) and a desire to contribute to scientific research (Alender, 2016; Curtis, 2015; Jennett et al., 2016; Raddick et al., 2013). Based on the literature, there is a precedent for looking at motivations of volunteer participants in citizen science projects through the Volunteer Functions Inventory framework (Alender, 2016; Ferster, Coops, Harshaw, Kozak, & Meitner, 2013). Alender (2016) used the VFI to assess volunteer motivations in eight water quality monitoring organizations, and Fester et al. (2013) utilized it to determine the motivations of citizens to collect data about forest fuels in a wildfire-effected community.

Participation

Participation in citizen science programs have been measured by number of data or observation contributions (Crimmens et al., 2014), longevity and frequency of volunteer event attendance (Seymor et al., 2017), and online forum contributions (Curtis, 2015). These measures of participation are grounded in the literature from the fields of science and volunteer management. This study examines participation from a youth development perspective. The conceptual model of participation in organized activities (Figure 1.1) proposed by Bohnert et al.
was applied to youth participation in science programs (Figure 1.2). Participation will be defined by the constructs:

- **Dosage** - the number of months a youth has participated in an organized activity
- **Intensity** - the frequency a youth participates in a particular activity or activity context measured in terms of times per week
- **Engagement** - multidimensional construct consisting of cognitive, emotional and behavioral components
- **Consistency** - the stability of the youth’s participation over a period of time
- **Duration** - the number of months a youth has participated in an organized activity

Research shows that youth benefit more if they participate in an organized activity for two or more years (Bohnert et al., 2010).

The importance of scientific literacy in our society is clear. Participation in science programs may increase scientific literacy in youth. The key question remains what participant and program characteristics influence scientific literacy?

**Purpose and Objectives**

**Purpose of Study**

The primary purpose of this study is to examine the influence of volunteer motivation, participation and science project type on the scientific literacy of 4-H youth volunteers ages 8-19 years participating in science projects. The independent variables are volunteer motivation, participation, and science project type. The dependent variable is scientific literacy as measured by Science Process Skills Inventory (SPSI) and Changes in Attitude about the Relevance of Science (CARS).
Study Objectives

1. Describe 4-H youth volunteer participants in science programs in terms of gender, age, and race/ethnicity, and geographic location.

2. Describe 4-H youth volunteer participants in science programs in terms of individual motivation as measured by the Volunteer Functions Inventory.

3. Describe 4-H youth volunteer participants in science programs in terms of participation as measured by dosage, intensity, consistency, duration, behavioral engagement, emotional engagement and cognitive engagement.

4. Describe 4-H youth volunteer participants in science programs in terms of a science or citizen science then characteristics of the citizen science program by Level of Volunteer Involvement and Goals of the Study.

5. Describe 4-H youth volunteer participants in science programs in terms of scientific literacy as measured by Science Process Skills Inventory (SPSI) and Changes in Attitude about the Relevance of Science (CARS).

6. Determine if a relationship exists between 4-H youth volunteer participants’ demographics and motivations, dosage, and intensity of participation.

7. Determine if a relationship exists between the dosage and intensity of participation and individuals’ behavioral, emotional and cognitive engagement.

8. Determine if a relationship exists between behavioral, emotional and cognitive engagement and participant consistency and duration.

9. Determine if a relationship exists between consistency, duration and scientific literacy as measured by Science Process Skills Inventory (SPSI) and Changes in Attitude about the Relevance of Science (CARS).
10. Determine if there is a statistically significant difference between VFI, Behavioral, Emotional, and Cognitive Engagement, SPSI, CARS, and gender, race, and science program type.

Methods

Overview of Research Methods

This study is a descriptive, cross-sectional quantitative study.

Population and Sample

The target population was 4-H youth volunteers ages 8-19 years participating in citizen science programs during the spring and summer of 2018. The accessible population was 4-H youth volunteers ages 8-19 years participating in science programs identified by 4-H professionals and through social media with hashtags #citizenscience, #science, #STEM and #4H during the spring of 2018. The sample population consisted of 4-H youth ages 8-19 years participating in science programs during the spring and summer of 2018 in Louisiana, Virginia, and Tennessee.

Instrument

The instrument used for this study included both existing survey scales and researcher-developed items. The questionnaire included two group identifier questions, the zip code of the citizen science project meeting location – as well as the name of the science project the 4-H youth they work with are involved in. The survey contained two additional questions related specifically to citizen science, Level of Volunteer Involvement and Goal of Citizen Science Study measures. Scales related to volunteer motivation, participation and scientific literacy were located in the survey along with demographic questions about age, gender, and race/ethnicity.
Measures

**Group Identification.** At the beginning of the survey, participants were asked the zip code of their meeting place. This provided a geographic location for the participant, as well as identified the group they were participating in.

**Level of Volunteer Involvement Measure.** The Level of Volunteer Involvement Measure was created for this study based on the three models, or levels, of citizen science programs described by Bonney at al. (2009): contributory (1), collaborative (2), and co-created (3). It is a one item measure with the three model types as the three responses. Descriptions were provided for each response. For example, contributory was explained as “The participant (you) contribute to data collection, and sometimes help analyze the data and disseminate results”.

**Goal of Citizen Science Study Measure.** The Goal of Citizen Science Study measure was created for this study based on the typology work of Wiggins & Crowston (2011). The aim of this measure was to categorize citizen science projects by the scientific goal. It contained one multiple choice item with five response choices: action project, conservation project, investigation project, virtual project, and educational project. Descriptions were also provided for each response. For instance, one response was “An Action Project is initiated by citizens, not scientists, and encourages participant intervention in local concerns, using scientific research as a tool to support civic agenda”.

**Duration.** While previous studies had measured duration in years, this study defined duration based on the recommendations of Bohnert, et al. (2010) who suggest measuring duration in months that youth have spent in a particular activity context, not in years. A one item measure of duration was the number of months a youth had participated in the science project. The response was numeric.
Intensity. Intensity of participation is defined as “how frequently a youth participates in a particular activity or activity context” (Bohnert, et al., 2010, p. 585) normally measured in terms of times per week. This one question measure asked, “In the last 12 months, how many times per week did you spend volunteering on the science project?” The response was also numeric.

Dosage. Similar to intensity, dosage was defined as a measure of frequency of participation, however it measured the amount of exposure to the program (treatment) in hours per week (Bohnert, et al., 2010) The aim of this on question measure was to determine the dosage in hours per week participants were exposed to the 4-H science program. The response was numeric.

Consistency. Consistency was defined as the stability of the youth’s commitment over the duration of their involvement. This one item construct asked, “Since you began participating in the science project, has your participation increased, stayed the same, or decreased? The responses were increased (3), stayed the same (2), and decreased (1).

Engagement (Adapted from Li & Lerner, 2013). The multidimensional construct of engagement was conceptualized by Bohnert et al. (2010) with three dimensions: behavioral, emotional and cognitive. This engagement measure consists of 15 items in three subscales. Scoring for all three subscales was a calculated mean score.

Behavioral Engagement. The first 5 item subscale measured behavioral engagement with a 4-point Likert-type scale asking respondents how frequently they do certain behaviors. The response choices were never (1), sometimes (2), often (3), and always (4). An example item was “How often do you . . . complete tasks on time?” Negative worded items, such as “How often do you . . . skip meetings without permission?” were reverse coded. The Cronbach’s Alphas for a longitudinal sample of 4-H youth from 18 states (n=1,029) were 0.70, 0.68, and
0.67 for Grades 9, 10 and 11 (Li & Lerner, 2013). The Cronbach’s Alpha for Boy Scouts in the Boston area with a mean age of 9.97 years (n=32) was 0.95 (Champine and Johnson, 2017).

**Emotional Engagement.** The second 5 item subscale measured emotional engagement with statements that included “I feel a part of my program” and a 4-point Likert-type scale responses ranging from strongly disagree (1) to strongly agree (4). One item, “I don’t find the program fun and exciting” was reverse coded. The Cronbach’s Alphas for a longitudinal sample of 4-H youth from 18 states (n=1,029) were 0.82, 0.82, and 0.84 for Grades 9, 10 and 11 (Li & Lerner, 2013) and 0.79 for Boy Scouts in the Boston area with a mean age of 9.97 years (n=32) (Champine and Johnson, 2017).

**Cognitive Engagement.** The third and final subscale measured cognitive engagement and also had a 4-point Likert scale responses ranging from strongly disagree (1) to strongly agree (4). A sample statement included “I want to learn as much as I can in the program.” The Cronbach’s Alphas for this subscale was .90 for a longitudinal sample of 4-H youth from 18 states in grades 9-11 (n=1,029) (Li & Lerner, 2013) and 0.60 for Boy Scouts in the Boston area with a mean age of 9.97 years (n=32)

**Science Process Skills Inventory (Bourdeau & Arnold, 2009).** The goal of this inventory was to measure the ability to practice the full cycle of the steps in the scientific inquiry process with youth ages 12 and older. The inventory consisted of 11 items with a 4-point Likert-type scale indicating how often they practice each of the items when doing science ranging from never (1) to always (4). Scoring of the SPSI was calculated as a mean score. Example items included “I can record data accurately” and “I can use science terms to share my results”. The Cronbach’s Alpha calculated pre-program/post-program with middle schools students attending a residential summer camp in Oregon (n = 106) was reported by the survey’s developers as .84
and .94 respectively. They also reported split-half reliability (Spearman-Brown) was .93 (Arnold & Bourdeau, 2009).

**Changes in Attitude about the Relevance of Science (CARS) (Siegel and Ranney, 2003).** As the title implies, this measure was developed to reflect changes in attitudes in science over time with middle and high school students, however it has been used in cross-sectional studies. Three versions of the scale were created and this study used version A. The CARS scale A consisted of 25 items with a 5-point Likert scale (strongly disagree, disagree, neutral, agree, strongly agree). Example items consisted of “Emotion has no place in science” and “Science helps me to work with others to find answers”. The reported Cronbach Alpha calculated with inner-city 10th grade students (n=47) for all three forms of the scale was above .80 (Siegel & Ranney, 2003).

**Volunteer Functions Inventory (Clary et al., 1998).** Volunteer motivation was defined as the reason an individual decides to volunteer. The inventory contained six motivational constructs with 5 items each for a total of 30 items. Items were rated on a 7 point response scale ranging from 1 (not at all important/accurate) to 7 (extremely important/accurate). An example item included “Volunteering experience will look good on my resume”. A mean score was calculated for each of the six functional motivation constructs. A systematic review of the VFI discovered eight studies that provided data on the Cronbach’s alpha for the total scale with a mean internal consistency of .90, and a range between .83 and .94 (Chacón, Gutiérrez, Sauto, Vecina, & Pérez, 2017).

**Demographic variables.** The survey contained three standard demographic questions and one additional question that was used as a group identifier. Participants were asked their gender (male = 0, female = 1), age (numeric response), and race/ethnicity (Black or African
American = 1, White = 2, Hispanic or Latino = 3, American Indian or Alaska Native = 4, Asian American = 5, Native Hawaiian or other Pacific Islander = 6, and Multiracial = 7). If more than one box was checked for race/ethnicity, it was coded as multiracial: the same as if the multiracial box had been chosen.

**Data Collection**

The request for participants was e-mailed via listserv to 4-H State Program Leaders, Science and SET Specialists, and National Association of Extension 4-H Agents (NAE4HA) members. The researcher also employed snowball sampling, a nonprobability sampling technique where existing study subjects help identify other subjects from among their colleagues, since the population of 4-H youth participating in citizen science projects is unknown. The final strategy for identifying 4-H citizen science programs was searching social media for #citizen science and #4H hashtags then contacting the 4-H professionals about the programs featured on social media.

Data were collected by paper survey and by Qualtrics survey software in May and June of 2018 from participants in six 4-H science programs in three states. The three sites in Tennessee participated in 4-H citizen science programs; the two sites in Louisiana and one site in Virginia participated in 4-H science programs without a citizen science component. Surveys were administered by 4-H agents instructed by e-mail. This research was approved by the Internal Review Board of the LSU AgCenter. Parental consent was given at the time of the youth’s enrollment in 4-H and youth assent was requested at the beginning of the survey.

**Data Analysis**

Data were analyzed using SPSS Version 25 statistical software. Missing data were coded as 99, a value that did not occur as a real data value in any of the construct responses. Objectives
one through five were descriptive. Frequency and percent were reported for all responses. Objectives six through ten explored relationships among variables (see Figure 3.1). Pearson correlation coefficients were computed to determine relationships between two interval variables. Spearman’s rho correlations were run between two variables where at least one was measured on an ordinal scale and the other was interval. Kendall’s tau-b was calculated for correlations between two ordinal variables. For nominal independent variables, \( \eta \) (eta) and \( \eta^2 \) (eta squared) were calculated because \( \eta \) (eta) is a measure of association between two nominal variables, and \( \eta^2 \) (eta squared), which is also known as the correlation ratio or R2, is interpreted as the portion of total variance in the dependent variable that is accounted for by variation in the independent variable (Levine & Hullet, 2002; Richardson, 2011). Using \( \eta^2 \) as the measure of association, the strength of association between the variables was determined as small (\( \eta^2 = .01 \)), medium (\( \eta^2 = .06 \)), and large (\( \eta^2 = .14 \)) (Cohen, 1988, p. 285-287). For the independent sample t-tests, the p value was set at \( p = .002 \) to limit the experiment-wise error rate (Warner, 2013).

![Diagram](image)

Figure 3.1. Relationships examined between the variables in this study as outlined based on the framework of Bohnert, Fredericks and Randall’s conceptual model.
Results

Objective one: participants and setting. In total, 180 4-H youth participated in the study. Participants in the study represented six 4-H science programs across three states: Louisiana, Tennessee and Virginia (Table 3.1). The age range of participants was eight to eighteen years old with a mean age of 12.73 years old (SD = 1.66; N = 169). The gender was nearly split evenly with 93 boys (52.5%) and 84 girls (47.5%). Three respondents did not answer the question. The racial and ethnic distribution of the 4-H youth participants included 47.2% white (n = 83), 23.9% Black or African American (n = 42) 16.5% multiracial (n = 29), 10.2% Hispanic or Latino (n = 18), 1.1% American Indian or Alaska Native (n = 2) and 1.1% Asian (n = 2). Four individuals did not report race/ethnicity.

Table 3.1

<table>
<thead>
<tr>
<th>Geographic Location</th>
<th>Frequency</th>
<th>Valid Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montross, VA</td>
<td>95</td>
<td>52.8</td>
</tr>
<tr>
<td>Acadia Parish, LA</td>
<td>30</td>
<td>16.7</td>
</tr>
<tr>
<td>Athens, TN</td>
<td>21</td>
<td>11.7</td>
</tr>
<tr>
<td>Nashville, TN</td>
<td>19</td>
<td>10.6</td>
</tr>
<tr>
<td>East Nashville, TN</td>
<td>8</td>
<td>4.4</td>
</tr>
<tr>
<td>Evangeline Parish, LA</td>
<td>7</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Objective two: motivation. The purpose of objective two was to describe 4-H youth volunteer participants in science programs in terms of individual motivation as measured by the Volunteer Functions Inventory, which consists of six functional motivations: career, volunteering
for career-related benefits, enhancement, motivation that centers on the ego’s growth and development, protective, motivation that centers on protecting the ego from one’s own guilt or personal problems, social, motivated by relationships with others, understanding, a motivation to learn new knowledge and skills, and values, an altruistic and humanitarian motivation (Clary et al. 1998). The minimum score was 1.00 and the maximum score was 7.00 across all six motivation function constructs. The function with the highest mean score was Values (M = 5.08, SD = 1.67), followed by Understanding (M = 5.03, SD = 1.73) and Career (M = 4.93, SD = 1.79). The other three motivations average scores were lower: Enhancement (M = 4.85, SD = 1.80), Social (M = 4.68, SD = 1.85), Protective (M = 4.63, SD = 1.89). Cronbach’s alpha for the complete scale was .985.

**Objective three: participation.** Youth participation in the 4-H science programs was measured in terms of dosage, intensity, behavioral, emotional and cognitive engagement, consistency, and duration (Table 3.2). Incorrect data were removed if the number was impossible, such as reporting volunteering with the 4-H science program more hours than existed in a week. In terms of consistency, almost all of the 4-H youth volunteers reported their participation in the 4-H science program increased (55.1%, n = 98) or stayed the same (41.6%, n = 74). Only 3.4% (n = 6) of participants indicated their participation had decreased in the last 12 months. Two youth gave no response to this question.

**Objective four: science program characteristics.** Of the 180 respondents in the study, 132 youth (73.3%) participated in 4-H science programs and 48 youth (26.7%) participated in 4-H citizen science programs. The science programs were located in Louisiana and Virginia. The citizen science programs were located in Tennessee. The overwhelming majority of the 48 4-H youth volunteers that participated in citizen science programs described these programs
similarly: the Goal of Citizen Science Study as education (93.8%, n = 45) and the Level of Volunteer Involvement as contributory (97.9%, n = 47). Action, Investigation, and Virtual were each named once by a respondent as the Goal of Citizen Science Study. Also, one individual described the citizen science project they were involved in as collaborative; none described their citizen science program as co-created.

Table 3.2

| Descriptive Statistics for Participation and Scientific Literacy Measures |
|-----------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                             | N               | Minimum         | Maximum         | Mean            | Std. Deviation  | Cronbach’s Alpha |
| Dosage                      | 167             | 0.00            | 37.00           | 3.88            | 6.69            | -               |
| Intensity                   | 168             | 0.00            | 18.00           | 3.61            | 4.24            | -               |
| Duration                    | 176             | 0.00            | 25.00           | 6.13            | 3.34            | -               |
| BE                          | 179             | 1.80            | 4.00            | 3.30            | 0.53            | .474            |
| EE                          | 176             | 1.00            | 4.00            | 3.22            | 0.62            | .631            |
| CE                          | 178             | 1.00            | 4.00            | 3.22            | 0.73            | .928            |
| SPSI                        | 179             | 0.00            | 3.00            | 2.21            | 0.70            | .967            |
| CARS                        | 178             | 1.80            | 4.76            | 3.64            | 0.61            | .889            |

Note: BE = Behavioral Engagement, EE = Emotional Engagement, CE = Cognitive Engagement, SPSI = Science Process Skills Inventory, CARS = Changes in Attitude about the Relevance of Science

Objective five: scientific literacy. The purpose of objective five was to describe 4-H youth volunteer participants in science programs in terms of scientific literacy as measured by Science Process Skills Inventory (SPSI) and Changes in Attitude about the Relevance of Science (CARS). As shown in Table 3.2, 4-H youth participants reported that they can usually use
science process skills when working on a science investigation. The results also indicate that they have a positive view of science and its relevance to their lives (Table 3.2).

**Objective six.** The purpose of objective six was to determine if a relationship existed between 4-H youth volunteer participants’ demographics and motivations, dosage, and intensity of participation. A Pearson correlation coefficient was computed to assess the relationship between 4-H youth volunteer participants’ age and gender, and their motivations, dosage, and intensity of participation. The results suggest that participation intensity is negatively related to age ($r = -.230$, $n = 157$, $p = 0.004$), and positively related to dosage ($r = .422$, $n = 162$, $p = 0.000$), and the VFI’s Social motivational construct ($r = .185$, $n = 165$, $p = 0.017$). There was also a positive association between gender and all six motivational constructs as can be seen in Table 3.3. For correlation analysis, race was a nominal variable that used all race responses provided. Motivations, intensity and dosage were continuous variables. Therefore, the appropriate correlation coefficient was eta which was converted to eta squared for interpretation. Eta and eta squared were calculated between race and participant motivations, dosage, and intensity of participation. The results in Table 3.4 show a small strength of association between race and dosage, and race and several of the motivation constructs. The results also revealed an association of medium strength between race and intensity of participation, as well as between race and the functional motivations of values and understanding.

**Objective seven.** To determine if a relationship existed between the dosage and intensity of participation and individuals’ behavioral, emotional and cognitive engagement, Pearson correlation coefficients were computed. Only one statistically significant association was found: a positive relationship between participation intensity and cognitive engagement ($r = .157$, $n = 166$, $p = 0.044$).
Table 3.3

Correlations of 4-H Youth Participants’ Age and Gender, Motivations, and Dosage and Intensity of Participation

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Gender</th>
<th>Dosage</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gender</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dosage</td>
<td>-0.131</td>
<td>-.005</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Intensity</td>
<td>-.230**</td>
<td>.057</td>
<td>.422**</td>
<td>-</td>
</tr>
<tr>
<td>VFI Protection</td>
<td>.091</td>
<td>.185*</td>
<td>-.018</td>
<td>.128</td>
</tr>
<tr>
<td>VFI Values</td>
<td>.066</td>
<td>.187*</td>
<td>-.031</td>
<td>.069</td>
</tr>
<tr>
<td>VFI Career</td>
<td>.093</td>
<td>.195**</td>
<td>-.032</td>
<td>.082</td>
</tr>
<tr>
<td>VFI Social</td>
<td>.076</td>
<td>.182*</td>
<td>.060</td>
<td>.185*</td>
</tr>
<tr>
<td>VFI Understanding</td>
<td>.074</td>
<td>.166*</td>
<td>-.044</td>
<td>.066</td>
</tr>
<tr>
<td>VFI Enhancement</td>
<td>.099</td>
<td>.200**</td>
<td>.005</td>
<td>.093</td>
</tr>
</tbody>
</table>

** p < 0.01 (2-tailed).
* p < 0.05 (2-tailed).

Note: VFI = Volunteer Functions Inventory
Age x all variables in that column = Pearson’s r
Gender x all variables in that column = point biserial
Dosage x all variables in that column = Pearson’s r
Intensity x all variables in that column = Pearson’s r

**Objective eight.** The purpose of objective eight was to determine if a relationship existed between behavioral, emotional and cognitive engagement and consistency and duration of participation. A Spearman’s rho correlation was computed to assess the relationship between consistency of participation and individual’s behavioral, emotional and cognitive engagement. As can be seen in Table 3.5, positive relationships were found between consistency and all three dimensions of engagement. Pearson correlation coefficients were calculated to determine if a
relationship existed between duration of participation and the three dimensions of engagement, however, no significant correlations were found.

Table 3.4

Correlations of 4-H Youth Participants’ Race and Motivations, Dosage, and Intensity of Participation

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variable</th>
<th>η</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race</td>
<td>Intensity</td>
<td>0.335</td>
<td>0.112**</td>
</tr>
<tr>
<td></td>
<td>Dosage</td>
<td>0.14</td>
<td>0.020*</td>
</tr>
<tr>
<td></td>
<td>VFI Protective</td>
<td>0.192</td>
<td>0.037*</td>
</tr>
<tr>
<td></td>
<td>VFI Values</td>
<td>0.25</td>
<td>0.063**</td>
</tr>
<tr>
<td></td>
<td>VFI Career</td>
<td>0.207</td>
<td>0.043*</td>
</tr>
<tr>
<td></td>
<td>VFI Social</td>
<td>0.199</td>
<td>0.040*</td>
</tr>
<tr>
<td></td>
<td>VFI Understanding</td>
<td>0.249</td>
<td>0.062**</td>
</tr>
<tr>
<td></td>
<td>VFI Enhancement</td>
<td>0.222</td>
<td>0.049*</td>
</tr>
</tbody>
</table>

*small association (η² = .01)
**medium association (η² = .06)

Note: VFI = Volunteer Functions Inventory

Objective nine. The purpose of objective nine was to determine if a relationship existed between consistency and duration of participation and scientific literacy as measured by Science Process Skills Inventory (SPSI) and Changes in Attitude about the Relevance of Science (CARS). Spearman’s rho correlation was also run to determine the relationship between consistency of participation and SPSI and CARS. Results of the Spearman correlation indicated that there was a significant positive association between consistency and both measures of scientific literacy, SPSI (rs(177) = .160, p = .033) and CARS (rs(176) = .260, p = .000). A Pearson’s correlation coefficient analysis revealed no significant relationship between duration of participation and SPSI or CARS either.
Table 3.5

*Correlations of Consistency Participation and Individuals’ Behavioral Engagement (BE), Emotional Engagement (EE), and Cognitive Engagement (CE).*

<table>
<thead>
<tr>
<th></th>
<th>BE</th>
<th>EE</th>
<th>CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency</td>
<td>.191**</td>
<td>.283**</td>
<td>.300**</td>
</tr>
</tbody>
</table>

** p < 0.01 (2-tailed).

**Objective ten.** The purpose of objective ten is to determine if there is a statistically significant difference between VFI, Behavioral, Emotional, and Cognitive Engagement, SPSI, CARS, and gender, race, and science program type. Independent sample t-tests were run between the dependent variables (VFI, Behavioral, Emotional, and Cognitive Engagement, SPSI, CARS) and the independent variables (gender, race, and science program type). For the t-tests, race was recoded as white or non-white.

**Gender.** Gender had no significant relationships with any of the six volunteer motivational constructs measured in the VFI, nor either measure of scientific literacy. There were significant difference in the scores of behavioral engagement for boys (M = 3.15, SD = .54) and girls (M = 3.44, SD = .49); t(174) = -3.68, p = .001 and cognitive engagement for boys (M = 3.02, SD = .81) and girls (M = 3.45, SD = .55); t (161.47), p = .001. Girls reported higher scores of engagement in behavior and thinking than boys.

**Race.** Eleven t-tests were calculated to determine if there were any differences in scores for volunteer motivations, behavioral, emotional, and cognitive engagement, SPSI and CARS between white and non-white youth respondents. No statistically significant differences were found between mean scores based on race. The motivations, engagement, and scientific literacy of whites and non-whites appeared similar.
**Science Program Type.** There was a significant difference in scores for the social motivational construct between youth in 4-H science programs (M = 4.9, SD = 1.82) and youth in 4-H citizen science programs (M = 3.95, SD = 1.74); t(174) = 3.17, p = .002. Youth in 4-H science programs were more motivated by social functions to volunteer than youth in 4-H citizen science programs. This was the only difference found between the two groups.

**Conclusions, Implications, and Recommendations**

This study examined the influence of volunteer motivation, participation, and citizen science project type on the scientific literacy of 4-H youth within the framework of youth participation in organized activities proposed by Bohnert et al. (2010).

**Predictors of Participation**

Demographic variables and volunteer motivations were examined as predictors of participation. 4-H youth reported their three strongest functional motivations as values, understanding and career. This is consistent with previous studies where younger volunteers emphasized career over older volunteers who are more established in this aspect of their lives (Okun & Schultz, 2003). However, the social motivation – a functional motivation concerned with relationships with others and the belief that “volunteering may offer opportunities to be with one’s friends or to engage in an activity viewed favorably by important others” (Clary et al. 1998, p.1518) – appears more significantly related to other key variables than any other motivation (see Figure 3.2). Further investigation into the causal nature of these relationships may yield valuable insights into youth volunteer participation and scientific literacy outcomes. Notably, this study found a statistically significant difference in social motivation to volunteer between 4-H youth participating in science programs and those participating in citizen science programs.
Participation

This study measured both dosage, the frequency of participation measured in hours per week, and intensity, the frequency measured in terms of times per week (Bohnert, et al., 2010). Not surprisingly, a statistically significant relationship was found between the two. That said, only intensity was found to have significant relationships with predictors of participation variables, program characteristic variables, and other engagement variables (see Figure 3.2). These findings suggest intensity should be used in future studies of youth participation in organized activities.

Another important factor of participation is consistency, the stability of the youth’s participation over a period of time. Previous research has shown consistency is positively associated with the formation of relationships with a caring adult, an essential element of youth development (Broh, 2002; Bohnert, et al., 2010) The current study found consistency to be associated with all three dimensions of engagement and both measures of scientific literacy. In this case, consistency may be a result of participation through an organization like 4-H, not just being an individual signing up to participate or volunteer on the youth’s own. A longitudinal study to explore consistency of youth participation is needed.

Despite its exploratory nature, this study offers some insight into the significance of engagement, a variable previously described as the missing link in organized activity research (Bohnert, et al., 2010). In particular, cognitive engagement was found to have positive relationships with both intensity and consistency of participation. This study also found that female participants were more engaged behaviorally and cognitively in the 4-H science programs their male counterparts. A natural progression of this work is to investigate the causes of these differences.
Program Characteristics

In this study conducted with youth involved in 4-H citizen science programs, it is not surprising that the goal of the citizen science projects were educational. This goal is common for many citizen science projects that youth are involved with. Also, in this study the majority of citizen science programs were contributory, most likely because the projects youth are encouraged to participate in are even more likely to be contributory (Enck, 2013). Youth-adult partnership (Y-AP) principles could help guide citizen science program designs by allowing youth more involvement in the analysis and even in the original investigation questions. Inquiry is an important component in scientific learning and the outcome of scientific literacy.

Youth Outcomes: Scientific Literacy

This study found that consistency is significantly related to the two measures of scientific literacy. This finding is of interest because while there is a belief that components of scientific literacy would increase across the spectrum of volunteer involvement from contributory to co-created projects (Bonney et al., 2009a), this author believes the educational value of contributory projects is undervalued. The results of this research suggests that consistent participation is significant for the scientific literacy outcomes of the volunteer.

A new conceptual hypothesis was created based on the significant relationships found in this study (Figure 3.2). Further work is required to determine the causal nature of these associations. This model can serve as a framework for future studies investigating scientific literacy outcomes in youth based programs.
Figure 3.2. Proposed framework for investigating scientific literacy outcomes in youth based programs.
Chapter Four. 4-H Youth Volunteer Retention in Science Projects

Citizen science is emerging as a valuable research approach for scientific discovery (Follett & Strezov, 2015). It enables researchers to look at large scale patterns in nature, space, and even amino acids (Bonney et al., 2009b; Raddick et al., 2010; Curtis, 2015). Unlike other research techniques, citizen science relies heavily on volunteers because by definition it is “scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions” (OED 2016). Yet, attrition rates in three citizen science programs were estimated between 80 to 95% (Rotman et al., 2014). Clearly, this indicates volunteer retention is a critical issue in citizen science programs.

Review of Literature

Despite retention being identified as a key concern, limited empirical research on volunteer retention exists (Newton, Becker & Bell, 2014). A systematic review of the literature revealed only a handful of articles focused on citizen science volunteer retention (Crimmins, et al., 2014; Frendley et al., 2017; Martin, Christidis, & Pecl, 2016; Seymour & Haklay, 2017; West & Pateman, 2016).

In adult volunteer audiences, previous experience in citizen science programs, high gross income, and increased mobility have all been found to be predictors of sustained volunteer involvement in citizen science programs (Frensley et al., 2017; Seymour & Haklay, 2017). Feedback from scientists whether by automated feedback, newsletters or face-to-face methods on the accuracy, interruption, and use of volunteers’ data submissions is also a strong motivator for volunteer retention (Crimmins et al., 2014; Martin et al., 2016; Wal et al., 2016).
Youth volunteer retention in citizen science programs has not been studied. However, a study examining young adults’ environmental volunteerism, found that those motivated to volunteer for social reasons were more likely to invest greater amounts of time in volunteering than individuals with other motivations (McDougle, Greenspan, & Handy, 2011). Demographic variables such as gender, race/ethnicity, have also been shown to be predictors of volunteer participation and youth participation in organized activities (Bohnert et al., 2010; Mahoney, Vandell, Simpkins, & Zarrett, 2009). The question remains are they predictors of retention?

Measuring retention, particularly in a cross-sectional study, is difficult. Research in human resource management has shown that intention to stay and the affective component of organizational commitment - an individual’s “emotional attachment to, identification with and involvement in, the organization” (Allen & Meyer, 1990, p.1) - are predictors of retention in employees. These two indicators of retention have been adapted by the volunteer literature (Newton, Becker & Bell, 2014) and were utilized in this study to measure the retention of 4-H youth volunteers in science projects.

**Purpose and Objectives**

The primary purpose of this study is to examine the influence of volunteer motivation, participation, and science project type on the retention of 4-H youth volunteers ages 8-19 years participating in science projects.

**Study Objectives**

1. Describe 4-H youth volunteer participants in science programs in terms of retention as measured by Affective Commitment (AC) and Intention to Continue Volunteering (ICV).
2. Determine if a relationship exists between 4-H youth volunteer participants’ motivation as measured by score on Volunteer Functions Inventory and retention.
3. Determine if a relationship exists between 4-H youth volunteer participation as measured by engagement, duration, consistency, intensity and dosage and retention.

4. Determine if differences exist in retention between groups based on gender, race/ethnicity, and science program characteristic.

Figure 4.1. Hypothesized relationships between the variables as outlined in this study based on the framework of Bohnert, Fredericks and Randall’s conceptual model.

Methods

Overview of Research Methods

This study is a descriptive, cross-sectional quantitative study.

Population and Sample

The target population was 4-H youth volunteers ages 8-19 years participating in citizen science programs during the spring and summer of 2018. The accessible population was 4-H youth volunteers ages 8-19 years participating in science programs identified by 4-H professionals and through social media with hashtags #citizenscience, #science, #STEM and #4H during the spring of 2018. The sample population consisted of 4-H youth ages 8-19 years
participating in science programs during the spring and summer of 2018 in Louisiana, Virginia, and Tennessee.

**Instrument**

The instrument used for this study included both existing survey scales and researcher-developed items. The questionnaire included two group identifier questions, the zip code of the citizen science project meeting location – as well as the name of the science project the 4-H youth they work with are involved in. The survey contained two additional questions related specifically to citizen science, Level of Volunteer Involvement and Goal of Citizen Science Study measures. Scales related to volunteer motivation, participation and retention were located in the survey along with demographic questions about age, gender, and race/ethnicity.

**Measures**

**Group Identification.** At the beginning of the survey, participants were asked the zip code of their meeting place. This provided a geographic location for the participant, as well as identified the group they were participating in.

**Level of Volunteer Involvement Measure.** The Level of Volunteer Involvement Measure was created for this study based on the three models, or levels, of citizen science programs described by Bonney at al. (2009): contributory (1), collaborative (2), and co-created (3). It is a one item measure with the three model types as the three responses. Descriptions were provided for each response. For example, contributory was explained as “The participant (you) contribute to data collection, and sometimes help analyze the data and disseminate results”.

**Goal of Citizen Science Study Measure.** The Goal of Citizen Science Study measure was created for this study based on the typology work of Wiggins & Crowston (2011). The aim of this measure was to categorize citizen science projects by the scientific goal. It contained one
multiple choice item with five response choices: action project, conservation project, investigation project, virtual project, and educational project. Descriptions were also provided for each response. For instance, one response was “An Action Project is initiated by citizens, not scientists, and encourages participant intervention in local concerns, using scientific research as a tool to support civic agenda”.

**Duration.** A one item measure of duration is the number of months a youth has participated in the science project. The response was numeric.

**Intensity.** Intensity of participation is defined as “how frequently a youth participates in a particular activity or activity context” (Bohnert, et al., 2010, p. 585) normally measured in terms of times per week. This one question measure asks, “In the last 12 months, how many times per week did you spend volunteering on the science project?” The response was also numeric.

**Dosage.** Similar to intensity, dosage is a measure of frequency of participation, however it measures the amount of exposure to the program (treatment) in hours per week (Bohnert, et al., 2010) The aim of this on question measure is to determine the dosage in hours per week participants were exposed to the 4-H science program. The response is numeric.

**Consistency.** Consistency is the stability of the youth’s commitment over the duration of their involvement. This one item construct asks, “Since you began participating in the science project, has your participation increased, stayed the same, or decreased? The responses were increased (3), stayed the same (2), and decreased (1).

**Engagement (Adapted from Li & Lerner, 2013).** The multidimensional construct of engagement was conceptualized by Bohnert et al. (2010) with three dimensions: behavioral, emotional and cognitive. This engagement measure consists of 15 items in three subscales. Scoring for all three subscales was a calculated mean score.
**Behavioral Engagement.** The first 5 item subscale measured behavioral engagement with a 4-point Likert-type scale asking respondents how frequently they do certain behaviors. The response choices were never (1), sometimes (2), often (3), and always (4). An example item was “How often do you . . . complete tasks on time?” Negative worded items, such as “How often do you . . . skip meetings without permission?” were reverse coded. The Cronbach’s Alphas for a longitudinal sample of 4-H youth from 18 states (n=1,029) were 0.70, 0.68, and 0.67 for Grades 9, 10 and 11 (Li & Lerner, 2013). The Cronbach’s Alpha for Boy Scouts in the Boston area with a mean age of 9.97 years (n=32) was 0.95 (Champine and Johnson, 2017).

**Emotional Engagement.** The second 5 item subscale measured emotional engagement with statements that included “I feel a part of my program” and a 4-point Likert-type scale responses ranging from strongly disagree (1) to strongly agree (4). One item, “I don’t find the program fun and exciting” was reverse coded. The Cronbach’s Alphas for a longitudinal sample of 4-H youth from 18 states (n=1,029) were 0.82, 0.82, and 0.84 for Grades 9, 10 and 11 (Li & Lerner, 2013) and 0.79 for Boy Scouts in the Boston area with a mean age of 9.97 years (n=32) (Champine and Johnson, 2017).

**Cognitive Engagement.** The third and final subscale measured cognitive engagement and also had a 4-point Likert scale responses ranging from strongly disagree (1) to strongly agree (4). A sample statement included “I want to learn as much as I can in the program.” The Cronbach’s Alphas for this subscale was .90 for a longitudinal sample of 4-H youth from 18 states in grades 9-11 (n=1,029) (Li & Lerner, 2013) and 0.60 for Boy Scouts in the Boston area with a mean age of 9.97 years (n=32)

**Intention to Continue Volunteering Measure – (Adapted from the work of Fishbein and Ajzen, 1975, 1980).** The intention to continue volunteering measure is a 5 item construct
with four responses ranging from strongly disagree (1) to strongly agree (4). A sample item is “I will continue to volunteer in the citizen science project at least once a month for the next 12 months”. A mean score was calculated.

**Affective Commitment Scale (Adapted from Eisinga et al., 2010 based on the work of Allen & Meyer, 1990).** The aim of this scale is to measure the “psychological state that binds the individual to the organization (i.e. makes turnover less likely)” (Allen & Meyer, 1990). The 4 item construct for affective commitment, a component of organizational commitment, was adapted from Eisinga et al. (2010) to the extent that the word *program* replaced *faculty* in this modified survey. A 5-point Likert scale response format is used ranging from totally disagree (1) to totally agree (5). Scoring was calculated as a mean score. In a study of organizational commitment of university faculty in six European countries (n=940), the reliability coefficient, Cronbach’s alpha, ranged from .806 to .872.

**Volunteer Functions Inventory (Clary et al., 1998).** The inventory contains six motivational constructs with 5 items each for a total of 30 items. Items are rated on a 7 point response scale ranging from 1 (not at all important/accurate) to 7 (extremely important/accurate). An example item includes “Volunteering experience will look good on my resume”. A mean score was calculated for each of the six functional motivation constructs. A systematic review of the VFI discovered eight studies that provided data on the Cronbach alpha for the total scale with a mean of .90, and a range between .83 and .94 (Chacón, Gutiérrez, Sauto, Vecina, & Pérez, 2017).

**Demographic variables.** The survey contained three standard demographic questions and one additional question that was used as a group identifier. Participants were asked their gender (male = 0, female = 1), age (numeric response), and race/ethnicity (Black or African
American = 1, White = 2, Hispanic or Latino = 3, American Indian or Alaska Native = 4, Asian American = 5, Native Hawaiian or other Pacific Islander = 6, and Multiracial = 7) If more than one box is checked for race/ethnicity, it was coded as multiracial: the same as if the multiracial box had been chosen.

Data Collection

The request for participants was e-mailed via listserv to 4-H State Program Leaders, Science and SET Specialists, and National Association of Extension 4-H Agents (NAE4HA) members. The researcher also employed snowball sampling, a nonprobability sampling technique where existing study subjects help identify other subjects from among their colleagues, since the population of 4-H youth participating in citizen science projects is unknown. The final strategy for identifying 4-H citizen science programs was searching social media for #citizen science and #4H hashtags then contacting the 4-H professionals about the programs featured on social media.

Data were collected by paper survey and by Qualtrics survey software in May and June of 2018 from participants in six 4-H science programs in three states. The three sites in Tennessee participated in 4-H citizen science programs; the two sites in Louisiana and one site in Virginia participated in 4-H science programs without a citizen science component. Surveys were administered by 4-H agents instructed by e-mail. This research was approved by the Internal Review Board of the LSU AgCenter. Parental consent was given at the time of the youth’s enrollment in 4-H and youth assent was requested at the beginning of the survey.

Data Analysis

Data were analyzed using SPSS Version 25 statistical software. Missing data were coded as 99, a value that cannot occur as a real data value in any of the construct responses. The first
objective was descriptive; frequency and percent were reported for all responses. Objectives two, three, and four were correlations (Figure 4.1). Pearson correlation coefficients were computed to determine relationships between two quantitative variables. Spearman’s rho correlations were run between two variables were at least one was measured on an ordinal scale. For the independent sample t-tests, the p value was set at p = .008 because six different t-tests were conducted. Race/ethnicity was also coded as non-white (0) and white (1) for independent t-test analysis.

Results

In total, 180 4-H youth participated in the study and 177 completed all the measures pertaining to retention. Descriptive information about study participants’ gender, age, race/ethnicity, and geographic location may be found in Del Bianco and Cater, 2018. In addition, descriptive information about study participants’ responses to the six constructs of the VFI, the five measures of participation, and the two measures of citizen science project type have been described in a previous manuscript (Del Bianco & Cater, 2018).

Retention. The purpose of objective one was to describe 4-H youth volunteer participants in science programs in terms of retention as measured by Affective Commitment (AC) and Intention to Continue Volunteering (ICV) scales. On average, 4-H youth participants had positive responses indicating agreement when asked questions about feeling connected to their program (AC) and if they planned to continue volunteering in the next 12 months (ICV) (see Table 4.1).
Table 4.1

Descriptive Statistics for Retention Measures: Affective Commitment (AC) and Intention to Continue Volunteering (ICV)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitment</td>
<td>175</td>
<td>1.00</td>
<td>5.00</td>
<td>3.61</td>
<td>1.09</td>
<td>.894</td>
</tr>
<tr>
<td>Intention</td>
<td>177</td>
<td>1.00</td>
<td>4.00</td>
<td>2.81</td>
<td>.93</td>
<td>.974</td>
</tr>
</tbody>
</table>

**Objective Two: Motivation and Retention.** The purpose of objective two was to determine if a relationship existed between 4-H youth volunteer participants’ motivation (measured by score on Volunteer Functions Inventory) and retention (operationally defined as Affective Commitment and intention to continue volunteering). Results of Pearson correlations indicated there was a positive correlation between all six motivational constructs and participant’s Affective Commitment and Intention to Continue Volunteering (see Table 4.2). The results suggest that participants with higher motivational scores are more likely to feel more connected to the organization and to continue volunteering.

**Objective Three: Participation and Retention.** The purpose of objective three was to determine if a relationship existed between 4-H youth volunteer participation (measured by engagement, duration, consistency, intensity and dosage) and retention. Pearson’s correlations found no significant relationship between duration, intensity and dosage and the retention measures. Results from Pearson’s correlations between the three dimensions of engagement and the two measures of retention showed significant positive relationships between all the variables (see Table 4.3). As behavioral, emotional, and cognitive engagement increases so does Affective Commitment and Intention to Continue Volunteering - the predictors of retention.
Table 4.2

Correlations of 4-H Youth Participants’ Motivations and Retention as measured by Affective Commitment (AC) and Intention to Continue Volunteering (ICV).

<table>
<thead>
<tr>
<th></th>
<th>Affective Commitment (AC)</th>
<th>Intention to Continue Volunteering (ICV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ICV</td>
<td>.752**</td>
<td>-</td>
</tr>
<tr>
<td>VFI Protection</td>
<td>.689**</td>
<td>.713**</td>
</tr>
<tr>
<td>VFI Values</td>
<td>.650**</td>
<td>.680**</td>
</tr>
<tr>
<td>VFI Career</td>
<td>.645**</td>
<td>.713**</td>
</tr>
<tr>
<td>VFI Social</td>
<td>.664**</td>
<td>.693**</td>
</tr>
<tr>
<td>VFI Understanding</td>
<td>.712**</td>
<td>.674**</td>
</tr>
<tr>
<td>VFI Enhancement</td>
<td>.680**</td>
<td>.780**</td>
</tr>
</tbody>
</table>

** p < 0.01 (2-tailed).

Table 4.3

Correlations of Participant’s Behavioral Engagement (BE), Emotional Engagement (EE), and Cognitive Engagement (CE) and their Affective Commitment (AC) and Intention to Continue Volunteering (ICV)

<table>
<thead>
<tr>
<th></th>
<th>AC</th>
<th>ICV</th>
<th>BE</th>
<th>EE</th>
<th>CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>-</td>
<td>.752**</td>
<td>.387**</td>
<td>.673**</td>
<td>.749**</td>
</tr>
<tr>
<td>ICV</td>
<td>-</td>
<td>-</td>
<td>.350**</td>
<td>.629**</td>
<td>.718**</td>
</tr>
</tbody>
</table>

** p > 0.01 (2-tailed).

Results of the Spearman correlation indicated that there was a significant positive association between consistency and the retention measures of Affective Commitment, (rs(171) = .353, p = .000) and Intention to Continue Volunteering (rs(173) = .277, p = .000). In other words, as youth’s consistency of participation increases and so does the probability of their retention.
**Objective Five: Demographics and Retention.** The purpose of objective five was to determine if there are differences in retention between groups based on demographic variables, of gender, race/ethnicity, and program characteristics. Independent sample t-test were conducted. There was a significant difference in the scores for Intention to Continue Volunteering between girls (M = 3.03, SD = .72) and boys (M = 2.61, SD = 1.06), t(160.73) = 3.08, p = .002. No statistically significant difference was found between whites and non-whites. In contrast, there was a significant difference in the scores for both Intention to Continue Volunteering and Affective Commitment between participants in science programs and those in citizen science programs (Table 4.4). Youth in citizen science programs reported less positively to questions about their commitment to the program and intention to continue volunteering, the indicators of retention.

**Table 4.4**

*Independent Sample T-tests between 4-H Science and 4-H Citizen Science Program and Affective Commitment (AC) and Intention to Continue Volunteering (ICV)*

<table>
<thead>
<tr>
<th></th>
<th>Citizen Science</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Commitment</td>
<td>3.16</td>
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</tr>
<tr>
<td>Intention</td>
<td>2.36</td>
<td>.90</td>
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</table>

**p < .001 level**

**Conclusions, Implications and Recommendations**

This study examined the influence of volunteer motivation, participation, and citizen science project type on the retention of 4-H youth volunteers ages 8-19 years participating in science and citizen science projects. The intent of this study was to study a target population of 4-H youth volunteers participating in citizen science programs only but accessing this population
proved difficult because (a) there was no centralized listing, (b) many 4-H agents and other practitioners were not familiar with the term “citizen science” so they were unsure if the science programs they conducted with youth qualified as citizen science, and (c) some 4-H citizen science programs have their own evaluations and did not want to oversaturate the youth with surveys. Therefore, the accessible population included 4-H youth ages 8-19 years participating in both science and citizen science projects. These barriers for research in youth participation in citizen science have been noted by other researchers in the field and may account for the limited literature about the impacts of citizen science participation for youth in both formal and informal settings (Bonney, Phillips, Enck, Shirk, & Trautmann, 2014). It highlights the need for such research to continue to be conducted despite the hardships of identifying and accessing youth participants.

In fact, this inability to access enough 4-H youth participating in citizen science to sustain this study created an opportunity for comparison between 4-H science and citizen science programming and one of this study’s most important findings: 4-H science programs have a significantly higher likelihood of retaining youth participants than 4-H citizen science program. One hypothesis for the difference in retention between the two groups may be that youth in 4-H science programs were more motivated by social functions to volunteer than youth in 4-H citizen science programs (see Del Bianco & Cater, 2018). Research has shown that individuals who volunteer for social reasons are more likely to sustain volunteer involvement (McDougle et al., 2011; Newton et al., 2014).

In the youth development literature, the importance of duration, intensity, and dosage is well documented (Bohnert, Fredericks, & Randall, 2010), by contrast this study did not find evidence of a relationship between these variables and predictors of youth retention. It is possible
that because 4-H is a national organization with program standards based on best practices that
the 4-H science and citizen science programs participating in this study did not differ in those
variables. Additional studies with more of a spectrum of duration, intensity, and dosage may
yield different results.

This study found that consistently, the stability of a youth’s participation over time, and
all three dimensions of engagement – behavioral, emotional, and cognitive – are correlated with
the predictors of retention –Affective Commitment and Intention to Continue Volunteering. Only
a longitudinal study could determine if they are correlated with actual retention. In light of the
evidence of a relationship between consistency and engagement previously described in Del
Bianco and Cater (2018) the association of youth’s consistency and engagement in participation
and retention should be investigated.

Notably, this study with its considerably diverse participants (see Del Bianco & Cater,
2018) did not find any difference between the retention of white and non-white youth in 4-H
science programs. That, coupled with the finding that girls have a higher reported Intention to
Continue Volunteering, is promising considering research shows volunteering is associated with
a 27% higher odds of employment (Spera, Ghertner, Nerino, & DiTommaso, 2013) and that
African-Americans and Hispanic workers remain underrepresented in the STEM workforce (Pew
Research Center, 2018). If 4-H and other youth science and citizen science programs can retain
female and non-white participants, those youth may enter the STEM talent pipeline.
The main goal of this current study was to examine the influence of volunteer motivation, participation, and science project type on the retention of 4-H youth volunteers participating in science projects. This research extends our limited empirical research on volunteer retention and adds to the growing body of knowledge of citizen science volunteer retention. Based on the significant relationships found in this study, a new conceptual hypothesis for investigating retention outcomes in youth based science programs was created (Figure 4.2). Although this study was limited to 4-H participants in three states, the framework could be applied to any informal youth science or volunteer program.

Figure 4.2. Proposed framework for investigating retention outcomes in youth based science programs.
This study set out to examine the influence of volunteer motivation, participation and citizen science project type on the retention and scientific literacy of 4-H youth volunteers ages 8-19 years participating in citizen science projects. Yet despite the affirmation that the 4-H youth development program participated in citizen science programs, identifying and collaborating with practitioners in the field conducting such programs proved the greatest barrier to the research. However, it also provided an opening for comparison between 4-H science programs with and without a citizen science component.

The present study combined research from the citizen science, volunteer development, and youth development fields to provide a model for studying youth volunteers motivation, participation, retention and scientific literacy in citizen science projects (see Figure 5.1). This conceptual model is a combination of Figures 3.2. and 4.2. which illustrate the statistically significant relationships found in this study. Although our sample did not have enough variation of project types to study the relationships between citizen science program characteristics and

Figure 5.1. Framework for studying youth participation and youth outcomes in citizen science programs.
predictors of participation, participation, and youth outcomes, they remain important factors to examine for future research and are included in the framework.


Pew Research Center, September 2015, “A Look at What the Public Knows and Does Not Know About Science”.


Appendix A. Letters of Permission

Del Bianco, Veronica

From: Arnold, Mary Elizabeth <mary.arnold@oregonstate.edu>
Sent: Friday, January 26, 2018 11:35 AM
To: Del Bianco, Veronica
Subject: Re: Request for permission to use SPSI
Attachments: image001.png; image002.jpg

Dear Veronica

Of course! If the SPSI is useful for your study, by all means please use it.

Please say hello to Dr. Cater for me as well.

Mary
Mary E. Arnold, Ph.D.
Professor and Youth Development Specialist
Oregon State University
541-737-1315(V)

From: “Del Bianco, Veronica” <vdelbianco@agcenter.lsu.edu>
Date: Friday, January 26, 2018 at 8:29 AM
To: “Mary E. Arnold” <mary.arnold@oregonstate.edu>
Subject: Request for permission to use SPSI

Dear Dr. Arnold,

I am a doctoral student at Louisiana State University writing my dissertation on the 4-H youth participation in citizen science programs and the scientific literacy outcomes under the direction of my dissertation committee chair Dr. Melissa Cater who can be reached at mcater@agcenter.lsu.edu.

I would like your permission to use the Science Process Skills Inventory (SPSI) instrument in my research study. I would like to use and print your survey under the following conditions:

1. I will use the surveys only for my research study and will not sell or use it with any compensated or curriculum development activities.
2. I will include the copyright statement on all copies of the instrument.
3. I will send a copy of my completed research study to your attention upon completion of the study.

If these are acceptable terms and conditions, please indicate so by replying to me through e-mail at vdelbianco@agcenter.lsu.edu

Sincerely,

Veronica Del Bianco
Del Bianco, Veronica

From: Bohnert, Amy <abohner@luc.edu>
Sent: Thursday, February 1, 2018 10:31 AM
To: Del Bianco, Veronica
Subject: RE: Request for permission

You have my permission.

Good luck!
Amy

From: Del Bianco, Veronica [mailto:DelBianco@agcenter.lsu.edu]
Sent: Wednesday, January 24, 2018 8:25 AM
To: Bohnert, Amy <abohner@luc.edu>
Subject: Request for permission

Dear Dr. Bohnert,

I am a doctoral student at Louisiana State University writing my dissertation on the 4-H youth participation in citizen science programs and the scientific literacy outcomes under the direction of my dissertation committee chair Dr. Melissa Cater who can be reached at mcater@agcenter.lsu.edu.

I would like your permission to use your figure, Conceptual model of participation in organized activities (OA), from Capturing Unique Dimensions of Youth Organized Activity Involvement: Theoretical and Methodological Considerations in my dissertation. I will cite your work as the source and send you a copy of my research study when complete.

If these are acceptable terms and conditions, please indicate so by replying to me through e-mail at rdelbianco@agcenter.lsu.edu.

Sincerely,

Veronica Del Bianco
### Appendix B. Systematic Review Article Worksheet

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<th>item</th>
<th>notes</th>
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<td>confirm criteria - Key term: Cit Sci or PPSR and Secondary Term: motiv*, retain, scientific literacy</td>
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<td>Citizen Science</td>
<td>CS Subject (area of scientific study, Ex: Astronomy)</td>
<td></td>
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<tr>
<td></td>
<td>CS Type: contributory, collaborative, co-created</td>
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<tr>
<td></td>
<td>CS Project Name</td>
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<tr>
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Unanswered Questions

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<td>key conclusions of study authors</td>
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<tr>
<td></td>
<td>comments from study authors</td>
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<tr>
<td></td>
<td>comments from review authors</td>
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Appendix C. IRB Approval

LSU AgCenter Institutional Review Board (IRB)
Dr. Michael J. Keenan, Chair
School of Human Ecology
209 Knapp Hall
225-578-1708
mkeenan@agctr.lsu.edu

Application for Exemption from Institutional Oversight

All research projects using living humans as subjects, or samples or data obtained from humans must be approved or exempted in advance by the LSU AgCenter IRB. This form helps the principal investigator determine if a project may be exempted, and is used to request an exemption.

- Applicant, please fill out the application in its entirety and include the completed application as well as parts A-E, listed below, when submitting to the LSU AgCenter IRB. Once the application is completed, please submit the original and one copy to the chair, Dr. Michael J. Keenan, in 209 Knapp Hall.

- A Complete Application Includes All of the Following:
  (A) The original and a copy of this completed form and a copy of parts B through E.
  (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1 & 2)
  (C) Copies of all instruments and all recruitment material to be used.
    - If this proposal is part of a grant proposal, include a copy of the proposal.
  (D) The consent form you will use in the study (see part 3 for more information)
  (E) Beginning January 1, 2009: Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing and handling data, unless already on file with the LSU AgCenter IRB.
    Training link: (http://grants.nih.gov/grants/policy/hs/training.htm)

1) Principal Investigator: Veronica Del Bianco  Rank: Instructor Student? Y/N: Yes
   Dept: AEEE (student) and 4-H Youth Development (work) Ph: 225-578-2978 E-mail:
   vdelbianco@agcenter.lsu.edu
2) Co-Investigator(s): Dr. Melissa Cater
   - If student as principal or co-investigator(s), please identify and name supervising professor in this space

3) Project Title: Citizen Science in 4-H: Youth volunteer motivations, participation, retention and scientific literacy.

4) Grant Proposal? (yes or no) ___ no ___ If Yes, Proposal Number and funding Agency_______________________
   Also, if Yes, either: this application completely matches the scope of work in the grant Y/N
   OR
   more IRB applications will be filed later Y/N

5) Subject pool (e.g. Nutrition Students) 4-H youth ages 12-19 years
   - Circle any "vulnerable populations" to be used: (children<18, the mentally impaired, pregnant women, the aged, other).
   - Projects with incarcerated persons cannot be exempted.

6) PI signature __________ **Date 3/5/18** (no per signatures)
   **I certify that my responses are accurate and complete. If the project scope or design is later changed
   I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-
   LSU AgCenter institutions in which the study is conducted. I also understand that it is my responsibility to
   maintain copies of all consent forms at the LSU AgCenter for three years after completion of the study.
   If I leave the LSU AgCenter before that time the consent forms should be preserved in the Departmental
   Office.

   Committee Action: Exempted ___ Not Exempted ___ IRB# #E18-8
   Reviewer Michael Keenan Signature Michael Keenan Date 3-19-2018
Vita

Born in Washington, D.C. and a proud product of Maryland public schools, Veronica Del Bianco grew up idolizing Jim Henson and the writers of National Geographic Magazine. As a graduate of Tulane University with a Masters in Environmental Biology, Veronica studied minnow spawning in the streams of North Carolina, adjustments in leaf epidermal UV transmittance of plants on the Big Island of Hawaii, and community ecology and trophic cascades in the jungles of Nicaragua. She enjoyed fieldwork but hated the lab because it lacked interaction with community. Today, she manages, trains, and empowers others as the Volunteer and Leadership Development Specialist for Louisiana 4-H. Whether in-person at national, state, or regional conferences or on e-learning platforms like Adobe Connect and Moodle, she creates useful, research-based programs for teens and adults that demonstrate measurable impact. The greatest impact on her life is the people who make her house a home, her husband Rob and their two daughters, Marilyn and Alice.