User's Guide for Evaluating Learning Outcomes from Citizen Science

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USER'S GUIDE FOR

EVALUATING LEARNING OUTCOMES FROM CITIZEN SCIENCE

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CONTENTS

BACKGROUND

PHASE 1: PLAN YOUR EVALUATION

PHASE 2: IMPLEMENT YOUR EVALUATION

PHASE 3: SHARE YOUR EVALUATION

APPENDICES

LIST OF FIGURES, TABLES AND SIDEBARS

FIGURES

TABLES

SIDEBARS

Hiking to a survey site, Glacier National Park Citizen-Science Program, courtesy Glacier National Park Service

BACKGROUND

Citizen science is the engagement of volunteers and scientists in collaborative research to generate new science-based knowledge.

PURPOSE

This guide is designed for practitioners who seek assistance in evaluating outcomes from their citizen-science projects, which are also known as **Public Participation in Scientific Research (PPSR)** projects. Evaluation is the systematic collection of information to determine strengths and weaknesses of programs, projects, and products, so as to improve their overall effectiveness. Evaluating outcomes from citizen-science participation is a high priority for practitioners, yet it is often rated as one of their greatest challenges. We have developed this guide to address this need and provide support to practitioners with limited evaluation experience in carrying out a quality evaluation of their project.

While there are many things to evaluate in citizen science, we focus here on the development and implementation of **summative** (also referred to as outcomes) **evaluations**, with a particular emphasis on measuring **individual learning outcomes (ILOs)**. In considering ILOs, we take a broad view of learning that includes cognitive outcomes (the things people know), affective outcomes (how people feel), and behavioral outcomes (what people do). The guide incorporates best practices from the Informal STEM (Science, Technology, Math and Engineering) and evaluation communities, as well as perspectives from other disciplines such as psychology, communication, sociology, and ecology.

There is no universally "correct" approach to conducting citizen-science research—it involves a diversity of techniques that engage the public in scientific investigation and science-based learning. A recent effort to explore participant learning outcomes across different projects identified three models of citizen science that focus on the degree to which participants are included in various aspects of scientific investigation (Bonney et al., 2009). Most "top-down" projects for which participants primarily collect and submit data under the guidance of a scientific organization, often referred to as "citizen science," fall under the label of "contributory" approaches. This contrasts with "collaborative" and "co-created" approaches, for which participants are more deeply involved with analyzing data or even help to develop project protocols **(FIGURE 1)**.

An important finding from this research was that similar participant learning outcomes were evident across different projects. Another critical finding was that a majority of citizen-science projects developed to date have conducted less than rigorous evaluations or neglected evaluation altogether. Without evidence of project outcomes, the field of citizen science is left with a critical gap in understanding the effectiveness of its efforts. Does participation in citizen science help to influence gains in knowledge of science content or process, increase engagement and interest in science, or change attitudes and behaviors? The paucity of quality evaluations to answer such questions may stem from the misconception that conducting evaluations is costly, cumbersome, and time-consuming. In reality, by following some basic best practices, even practitioners with limited experience can successfully develop and administer evaluations that provide valuable information about project outcomes.

Over the last decade, the scope and scale of citizen-science projects has expanded at an extraordinary pace, reaching into nearly every scientific discipline from astronomy to zoology. How can a field as diverse as citizen science be evaluated in the same way across different projects? In truth, it can't. Every citizen-science evaluation will be unique to that project. However, most citizen-science projects are similar in that they seek to answer a scientific question or to address an environmental issue or problem, and most operate in a similar structure (see Shirk et al., 2012). Moreover, most citizen-science projects strive to meet a common set of goals related to either research, conservation, education, or some combination of these. Thus, even different types of citizen-science projects share many common outcomes, particularly for participant learning.

Increasingly, funding sources, employers, and other **stakeholders** are asking for information on all these types of outcomes as a way to highlight program strengths and justify continued funding. Practitioners can use information about ILOs to tailor projects to meet specific audience needs, improve existing projects, develop new projects, and reach new audiences. Findings from outcome studies can also inform ongoing exercises in setting goals and objectives, and can suggest additional evidence-based strategies for project design and evaluation.

APPROACHES TO CITIZEN SCIENCE

	CONTRIBUTORY	COLLABORATIVE	CO-CREATED
Define a Question/Issue			✓
Gather Information			✓
Develop Explanations		✓	✓
Design Data Collection Methods		✓	✓
Collect Samples	✓	✓	✓
Analyze Samples	✓	✓	✓
Analyze Data		✓	✓
Interpret Data/Conclude			✓
Disseminate Conclusions			✓
Discuss Results/Inquire Further			✓

FIGURE 1: Three different approaches to citizen-science research, characterized by the degree of participant involvement in carrying out scientific investigations (Bonney et al. 2009).

EVALUATION PRIMER

A. What is Evaluation? (And what is it not?)

Evaluation is the systematic collection of data to determine strengths and weaknesses of programs, policies, or products, so as to improve their overall effectiveness. Evaluation is also a discipline of study that is grounded in accountability and social inquiry-based theories relating to use, methods, and values. Program evaluation occurs in both public and private sectors such as government, education, and public health.

Evaluation is sometimes confused with related activities such as audits, assessments, surveys, and research. These activities, however, are not synonymous with evaluation. An audit, for example, typically focuses on compliance with existing rules or common standards, and auditors have a different relationship with a project team than evaluators do. Whereas an evaluator works very closely with a project team, auditors typically observe and inspect and develop little synergy with project teams. Assessments are also different. While they can be part of an evaluation, an assessment's main purpose is to measure or to calculate a value for something. Assessments often use standardized values to measure against; standardized tests are good examples. Surveys are sets of questions used to collect systematic information about a defined population that also can be administered as part of an evaluation, but in and of themselves, they are not evaluations. Finally, evaluation is not the same as research, which is intended to add to the body of knowledge about a particular topic through dissemination of findings via publication in peer-reviewed journals. In contrast, evaluations are conducted to gather evidence that clients can use to improve whatever is being evaluated. Evaluation uses many of the same methodologies as scientific research but the goals, audience, and end products of evaluation are different.

Evaluation is a comprehensive process that involves a strategy to plan, implement, and report results.

Scanning for mountain goats, Glacier National Park Citizen-Science Program, courtesy of Glacier National Park

In sum, evaluation is a comprehensive process that involves a strategy to plan, implement, and report results. The unit of analysis for evaluation is often quite broad, and executing a quality evaluation involves a thorough understanding of all of the stakeholders involved, their needs, and the environment or context in which the program operates.

B. Who is Involved?

Evaluation involves a diverse array of people and organizations – often referred to as stakeholders – who have a vested interest in the project. Stakeholders can include project developers, project staff, participants and their communities, partner organizations, and project funders. It is important to identify all the stakeholders in a project before beginning an evaluation as there may be conflicting opinions regarding the evaluation's purpose.

Evaluations can be carried out by an internal evaluator, an external evaluator, or both. There are pros and cons to all approaches. For example, internal staff who conduct evaluations are likely to have a high degree of knowledge of the culture of the organization and subject matter, be more accessible for ongoing dialogue and meetings, and are typically less expensive then external evaluators. However, internal evaluators may be seen as biased because they may have a vested interest in the outcome of the evaluation and they also may face internal political challenges. External evaluators are generally more expensive and maintaining regular communication with them can be challenging, but they are less prone to bias because they are not directly influenced by an evaluation's outcome.

Some projects blend these approaches by having internal staff conduct evaluations under the guidance of an independent evaluator who reviews the evaluation design and assesses the validity of the findings and conclusions. This approach can maintain external expertise and impartiality along with the benefit of an internal person's first-hand project knowledge (Marcussen 2012).

C. When to Evaluate

Evaluation can happen at any time in a project life cycle, but for best results, it should be considered throughout the entire life of a project – before, during, and after. For example, when a project or a component of a project is taking shape, evaluation can provide baseline data about your audience or project. Evaluation conducted during the project development phase, when there is still room for change and adaptation, can help to determine if the project is running as expected. Finally, evaluations can occur once a project has become established to measure outcomes and impacts.

Even if evaluation is not actually conducted, thinking about and planning for an evaluation will provide an outline for articulating your project's goals and outcomes and the pathways by which to achieve them. Failing to at least plan for evaluation can result in a project without focus and direction. You can read more about when to conduct certain types of evaluations in the next section.

D. Why Evaluate?

Some of the major reasons that organizations or projects undertake evaluation include:

- *To determine program strengths and weaknesses*
- *To gather evidence of success*
- *To understand audience needs*
- *To sustain or obtain additional funding*

Evaluations are also conducted to measure overall program efficiency, to conduct cost-benefit analyses, to help plan for the future or reflect on program history, to gather baseline data, to measure ongoing progress, to compare to other similar projects, and to test usability and functionality of discrete project components.

E. Ethics in Evaluation

Following a tumultuous time in history (1950s-1990s) when ethical standards for conducting research on human subjects was neglected, contemporary social and medical research now operates under a set of standards aimed at protecting human rights. Conducting evaluation means respecting the security, dignity, and self-worth of respondents, program participants, clients, and other evaluation stakeholders. Any evaluation involving people should attempt to follow these basic ethical standards:

Voluntary participation – Requires that people agree to participate in research without any coercion.

Informed consent – Tells potential participants about the procedures and risks involved in the research and ensures that they give their consent to participate.

Explaining risks of harm – Ensures that participants are not placed in a situation where they risk being harmed physically or mentally.

Confidentiality – Assures participants that their information will not be made available to anyone who is not directly involved in the study.

Anonymity – Guarantees privacy, ensuring that even the researchers cannot identify individuals in the study. In many types of evaluation, anonymity can be difficult to achieve.

For more information on ethics in evaluation, see the sidebar: "What is an IRB?" on page 16.

Conducting evaluation means respecting the security, dignity, and self-worth of respondents, program participants, clients, and other evaluation stakeholders.

F. A Note About Cultural Competence in Evaluation

Evaluators interact with a broad range of people from many political, religious, ethnic, language, and racial groups and need special qualities to conduct culturally competent work. Frierson, Hood, Hughes, and Thomas state in *The 2010 User-Friendly Guide to Project Evaluation* (NSF 2010a, p. 75): "Culturally responsive evaluators honor the cultural context in which an evaluation takes place by bringing needed, shared life experiences and understandings to the evaluation tasks at hand and hearing diverse voices and perspectives. The approach requires that evaluators critically examine culturally relevant but often neglected variables in project design and evaluation. In order to accomplish this task, the evaluator must have a keen awareness of the context in which the project is taking place and an understanding of how this context might influence the behavior of individuals in the project."

The American Evaluation Association affirms the significance of cultural competence in evaluation, stating: "To ensure recognition, accurate interpretation, and respect for diversity, evaluators should ensure that the members of the evaluation team collectively demonstrate cultural competence. Cultural competence is a stance taken toward culture, not a discrete status or simple mastery of particular knowledge and skills. A culturally competent evaluator is prepared to engage with diverse segments of communities to include cultural and contextual dimensions important to the evaluation. Culturally competent evaluators respect the cultures represented in the evaluation throughout the process.

Evaluations cannot be culture free. Cultural competence in evaluation requires that evaluators maintain a high degree of self-awareness and self-examination to better understand how their own backgrounds and other life experiences serve as assets or limitations in the conduct of an evaluation. In constructing logic models and evaluation plans, the culturally competent evaluator reflects the diverse values and perspectives of all key stakeholder groups (including project participants)." (AEA, 2011).

In order to conduct a culturally responsive evaluation, you should be conscious of how it might be attentive to issues of culture and context. Find ways to make this a part of your planning. For example, you might do this by ensuring that partners or advisors from the community are included to help inform the evaluation process and implementation.

Citizen Scientist with frog, Mount Rainier National Park Citizen-Science Program, courtesy Mount Rainier National Park Service

TYPES OF EVALUATIONS

The goal of any evaluation is to provide accurate information that can be used to determine the effectiveness of a project, product, or process. The type of evaluation you conduct should depend on the questions that you are asking and the resources available. Three basic types of evaluations each reflect a different type of programmatic need:

Front-end evaluation occurs during the defining phase of a project to obtain baseline information about an audience and is sometimes referred to as needs assessment or feasibility assessment. Front-end evaluation questions focus on understanding audience demographics, knowledge, performance, and attitudes or feelings toward a particular topic or program. Findings from front-end research help to inform project goals and objectives that can be aligned with audience needs and interests. Examples of front-end evaluation questions include:

- *What does the audience already know about _________ (science topic, project, etc)?*
- *What misconceptions exist among the audience regarding ________ (environmental issue, science topic, etc)?*
- *How does the audience feel about the new ________ (emerging tool/project, etc)?*

Formative evaluation, also known as process or implementation evaluation, is conducted during project development and provides direction for improving project implementation and operation. Formative evaluation questions focus on understanding the extent to which projects are functioning as expected, uncovering barriers to project participation, and highlighting strengths and weaknesses. Findings from formative evaluations may result in changes to the project structure or implementation. Examples of formative evaluation questions include:

- *Is the project organized, staffed, and implemented as planned?*
- *Are the training and support materials of high quality?*
- *Do participants understand the materials adequately to engage with the project?*

Summative evaluation, also known as outcomes or impact evaluation, is conducted once a project has been established and is used to describe project outcomes, determine a project's effectiveness, or describe project value. Summative evaluation questions focus on understanding the components of a project that are most effective, uncovering unintended outcomes, and highlighting aspects of the project that are replicable and transferable to similar projects. Findings from summative evaluations help to determine if the project accomplished its stated goals and met its target outcomes. Examples of summative evaluation questions include:

- *Was there evidence of an increase or change in knowledge/interest after, or as a result of, participation in ________ project?*
- *Was there evidence that participants improved their data collection or data interpretation skills after, or as a result of, participation in ________ project?*
- *Was there evidence that participants changed aspects of their behavior after, or as a result of, participation in ________ project?*

Understanding the type of evaluation that you are undertaking is fundamental to the rest of the planning and implementation process. The type of evaluation will determine the types of questions you are likely to ask and will influence your study design and data collection strategy.

This User's Guide is focused on summative evaluations, although many of the tools and strategies can be applied to front-end and formative work.

HOW TO USE THIS GUIDE

While the guide is not intended to serve as an introduction to evaluation (for that, we refer readers to the many excellent resources located in the References and Resources sections), we offer a brief overview of evaluation in the previous section. Throughout the guide we provide practical advice to increase practitioner comfort and confidence in carrying out evaluations within the context of citizen science. This guide also provides an evaluation framework (pg. 10) that we hope will be widely adopted by citizen-science practitioners to facilitate comparisons of individual learning outcomes across projects.

Designing and implementing a quality evaluation does not have to be a complex, time-consuming, or daunting process. This guide provides a common-sense approach to project evaluation, which can minimize the complexity and allow you to conduct an evaluation that is both informative and efficient. Keep in mind that conducting a quality evaluation is as much an art as it is a science. No two evaluations are the same, and there is no single universal step-by-step approach. There are, however, recognized processes that are essential to any evaluation.

Although presented as a linear process, in reality, evaluation is an iterative process that requires flexibility as project needs change or priorities shift. We present the evaluation process as three distinct phases: Plan, Implement, and Share **(FIGURE 2)**. The planning phase emphasizes the importance of clearly articulating goals, outcomes, and indicators early in the evaluation process, and we provide a framework to do this within the context of citizen science. The implementation phase focuses on carrying out the activities articulated in the planning phase. The sharing phase provides guidance on how to communicate your evaluation results to a wider audience and how to use your findings for future planning. Within each of the three phases, we provide the language and common practices of evaluation. Even if you have limited time or resources for evaluation, it's important to have a basic understanding of the phases described here.

The Appendix section contains resources, templates and worksheets that can be modified for your own use, including a matrix of learning outcomes and indicators for citizen science **(APPENDIX A)**.

Visit www.citizenscience.org/evaluation for tools to measure learning outcomes from citizen-science projects.

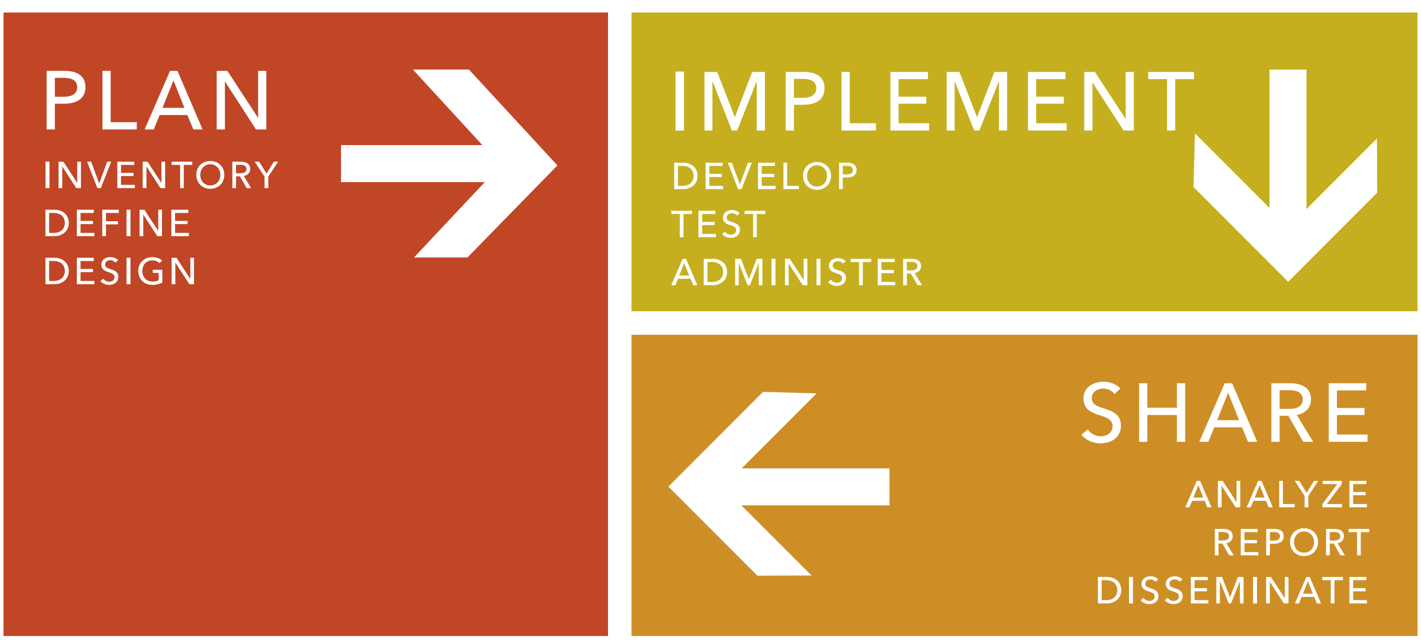


FIGURE 2: A generalized strategy for carrying out an evaluation.

Recording observations, Project BudBurst by Dennis Ward

PHASE 1: PLAN

INVENTORY

The planning phase is broken up into three parts: inventory, define, and design. In the inventory phase, you want to document as much information as possible to effectively describe the context and background of your project. Descriptions should be fair and accurate and present a balanced review of the project's strengths and weaknesses. Documenting this information will provide other stakeholders who are less familiar with your project with key background. In addition, you can include this information in any eventual reports that you create and disseminate. By the end of the planning phase, you should have an **evaluation** plan that will guide the implementation and sharing phases.

A. Describe the project to be evaluated and its audience

Start by describing the project in its totality, including information about the intended audience, deliverables, project staff, partners, additional stakeholders, organizational structure, and funding sources. If possible, describe the way that the project is intended to function and the way it is actually implemented.

Do you have access to demographic data about your intended audience or similar audiences? Have previous surveys been conducted that you can review to better understand the needs, resources, and interests of your audience? Is there an existing program theory? You may also wish to include the political, cultural, organizational, and historical context of the program. The description should avoid jargon and be sufficiently detailed so that an outsider would understand the overall project and how it functions.

B. Articulate the goals and targeted outcomes of the project

An outcomes-based approach to evaluation utilizes a backward research design to first determine the desired goals for a particular audience and then to determine the best approach to achieve those goals (Friedman, 2008). **Goals** tend to be broad and abstract, often employing lofty expressions such as "appreciation for science" or "increase interest in technology." Measuring such goals is challenging because they are inherently vague. Goals should be articulated in a format that is both relevant to citizen science and aligns with similar projects. Although goals can be difficult to measure as written, using goals to develop targeted **outcomes** will help to determine if the goals were met. Outcomes are more specific than goals and refer to concrete and measurable statements. Well-stated outcomes are SMART, i.e., Specific, Measurable, Attainable, Relevant, and Time-bound (Doran, 1981). Multiple outcomes may be identified for a single goal, and each outcome should

TABLE 1. NSF FRAMEWORK AND LSIE STRANDS COMPARED

NSF FRAMEWORK CATEGORY	LSIE STRANDS
Knowledge, awareness, understanding: Measurable demonstration of assessment of, change in, or exercise of awareness, knowledge, understanding of a particular scientific topic, concept, phenomena, theory, or career central to the project.	**Understanding** (Strand 2): Come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science.
Engagement, interest, or motivation in science: Measurable demonstration of assessment of, change in, or exercise of engagement/interest in a particular scientific topic, concept, phenomena, theory, or career central to the project.	**Interest** (Strand 1): Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.
Skills related to science inquiry: Measurable demonstration of the development and/or reinforcement of skills, either entirely new ones or the reinforcement, even practice, of developing skills.	**Science Exploration** (Strand 3): Manipulate, test, explore, predict, question, and make sense of the natural and physical world.
Attitudes toward science: Measurable demonstration of assessment of, change in, or exercise of attitude toward a particular scientific topic, concept, phenomena, theory, or career central to the project or one's capabilities relative to these areas. Attitudes refer to changes in relatively stable, more intractable constructs such as empathy for animals and their habitats, appreciation for the role of scientists in society, or attitudes toward stem cell research, for example.	**Identity** (related to Strand 6): Think about themselves as science learners, and develop an identity as someone who knows about, uses, and sometimes contributes to science. Also related to Strand (4), Reflection: Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.
Behavior: Measurable demonstration of assessment of, change in, or exercise of behavior related to a STEM topic. Behavioral impacts are particularly relevant to projects that are environmental in nature because action is a desired outcome.	**Skills** (related to Strand 5): Participate in scientific activities and learning practices with others, using scientific language and tools.

include information about the setting or conditions as well as a description of the desired behavior.

Recent work in the field of Informal Science Education (ISE) has begun to categorize potential outcomes in a variety of ways. Most notable are the "Framework for Evaluating Impacts of Informal Science Education" (Friedman et al., 2008) and "Learning Science in Informal Environments" (LSIE, National Research Council, 2009).

These complementary publications have put forth suggested categories of potential outcomes (Friedman) and ways of considering outcomes in a variety of "strands" (NRC). The outcome categories from both of these documents are described in **TABLE 1**. In determining what outcomes might be most relevant to citizen-science projects, researchers at the Cornell Lab of Ornithology used survey data as well as the LSIE document and NSF set to create a framework for measuring ILOs that is common among citizen-science projects **(FIGURE 3)**. Of course, citizen-science projects can also result in programmatic, conservation, and community-based outcomes, but because the focus of this User's Guide is on individual learning outcomes, we exclude these other outcomes from the framework. (See Jordan et al., 2012 for information on programmatic and community-based outcomes.)

EVALUATOR TIP

Consult with program insiders as well as outsiders and coordinate with multiple stakeholders throughout the evaluation process to increase the evaluation's usefulness and credibility.

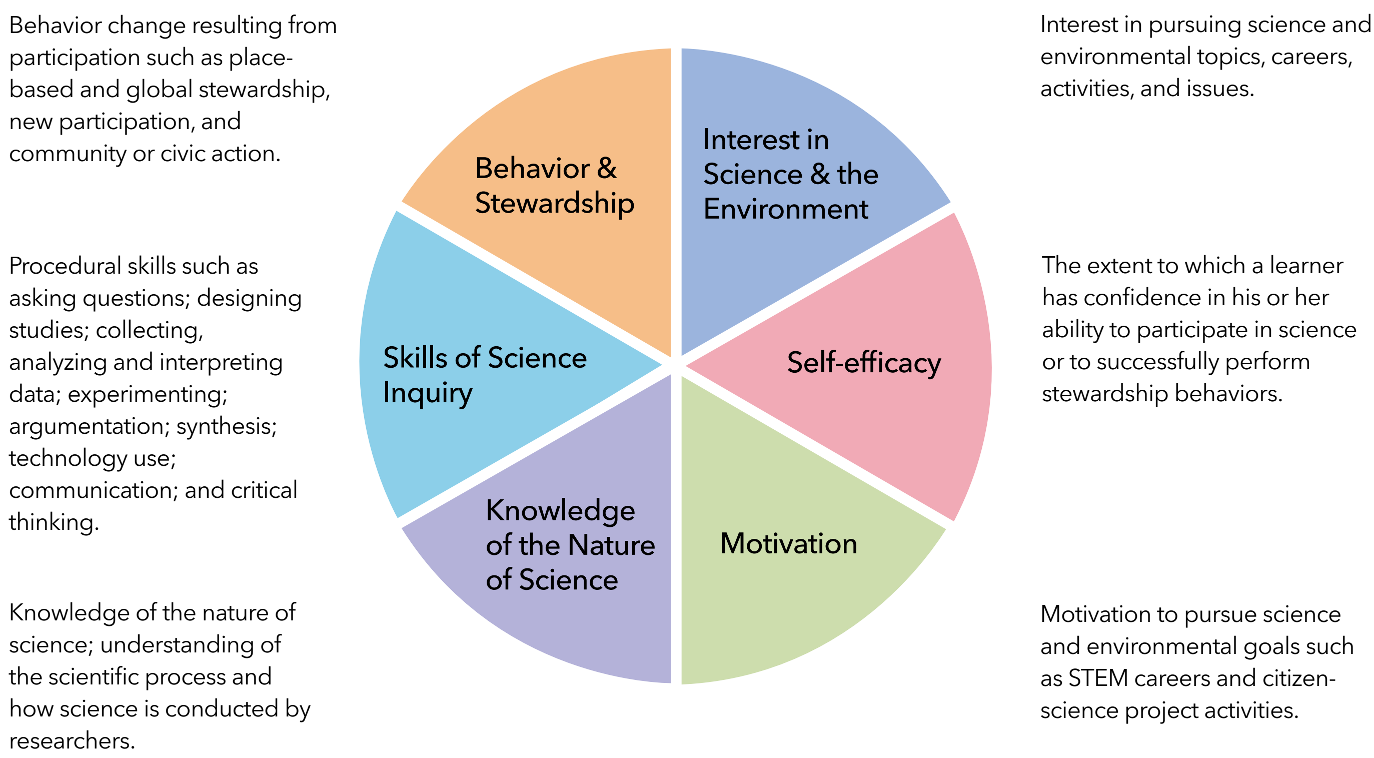


FIGURE 3: A guiding framework for evaluating individual learning outcomes from citizen-science projects.

Even though citizen-science projects provide ample opportunity to influence many of the outcomes shown in **FIGURE 3**, no single project should try to achieve them all. To do so would be costly, time-consuming, and probably unsuccessful. Instead, project developers and evaluators must work closely to determine the most relevant outcomes for individual projects. In addition to being SMART, outcomes must be aligned to the actual experiences that participants will have within the course of project activities. For example, it would be unwise to assume that a project focused on teaching specific content about watershed ecology could also influence behavior about recycling, unless recycling was explicitly part of the project activity.

Many evaluations have gone astray because there was no clear articulation of goals and outcomes from the outset, leaving evaluators unsure of what to measure. Articulating broad goals and measurable outcomes will provide a road map for your overall project evaluation. See **APPENDIX A** for examples of various learning outcomes commonly used in citizen science.

C. Describe the program logic model

Once you have a general understanding of your goals, outcomes, and audience, you can draft a preliminary logic model to share with relevant stakeholders including funders, program staff, volunteers, and others who may be affected by the evaluation. A logic model is a graphical representation of your project that shows the relationships between each project component and the expected outcomes. Logic models help to articulate programmatic objectives and strategies, and focus attention on key interventions and intended outcomes. See W. K. Kellogg Foundation (2004) for more information on developing a logic model.

Logic models are usually presented as inputs, activities, outputs, outcomes, and impacts. **Inputs**, or resources dedicated or consumed by a project, typically include things like funding agencies, scientists, staff, volunteers, and technology infrastructure.

Activities refer to ways the project uses the inputs. The activities should focus on tasks that directly relate to the participants and should not include those that are administrative in nature. In most large-scale citizen-science projects, scientists and staff typically develop the research topics, questions, and protocols, while the activities of volunteers tend to revolve around data collection. However, in smaller projects or those classified as collaborative or co-created, activities related to study design may vary widely. Also, many projects provide various forms of training for participants, and these should be included as activities.

Outputs are the direct products of the stated activities and demonstrate immediate results of activities. In general, outputs are easy to quantify and focus on things done by participants. Examples are the amount of data collected, the number of trainings conducted, the number of web visits, or the number of data forms downloaded.

Outcomes, described in the previous section, refer to the changes in behavior that a project is intended to produce in individuals, groups, or communities as a result of project participation. Summative evaluations typically focus on measuring outcomes, for example, knowledge gains, increased interest and motivation, improved skills, or changed behaviors. Outcomes are more difficult to quantify than outputs and are often described as short-term, occurring within a few years of the activity; medium-term, happening within four to seven years after the activity; or long-term, happening many years after an activity has commenced (W. K. Kellogg Foundation, 1998).

Impacts are generally considered long-term outcomes that are broad in scope, aimed at expanding knowledge and capacity for a particular field of study, and meant to provide benefits to society. Although difficult to measure, impacts are important to describe as they are of particular interest to funding agencies.

TABLE 2 provides examples of inputs, activities, outputs, outcomes, and impacts for citizen-science projects that might be used in a logic model. Your project will likely have different, and fewer examples. To show the distinction between participant and program outcomes, we provide examples from both. A typical logic model would focus only on one of these depending on the overall goals of the evaluation. See **APPENDIX B** for a **Logic Model** template (adapted from University of Wisconsin Extension, 2005).

EVALUATOR TIP

Logic models are dynamic! Revise any part of the logic model that is affected by iterative design changes.

Articulating short- and long-term outcomes and how they will be achieved is an extremely important step that must be conducted prior to beginning an evaluation.

CITIZEN SCIENTIST WITH FROG, MOUNT RAINIER NATIONAL PARK CITIZEN-SCIENCE PROGRAM, COURTESY MOUNT RAINIER NATIONAL PARK SERVICE

TABLE 2: SAMPLE PROGARM LOGIC MODEL

AUDIENCE	INPUTS	ACTIVITIES	OUTPUTS	SHORT-TERM OUTCOMES	MEDIUM-TERM OUTCOMES	LONG-TERM IMPACTS
PARTICIPANTS	• Baseline knowledge, technical skills • Access to Internet • Private landowner access (if necessary) • Time • Baseline interest, motivation, and confidence • Local knowledge of community and landscape • Project infrastructure	• Learn and understand project protocol • Engage in training • Collect data • Assist in study design • Make observations of natural world • Submit data • View, explore data • Communicate with others via groups, list serves • Provide feedback to project staff	• Amount of volunteer-collected data • Publicly accessible database • Data visualization tools • Number of individuals engaged with program • Number of individual web visits • Number of individual hours engaged • Number of individual hours or total effort • Personal data accounts	• Increased public access to scientific enterprise • Increased confidence to engage with science and the environment • Increased interest in science and the environment • Increased motivation to do and learn science	• Improved knowledge of science content and process • Improved data collection and interpretation skills • Increased appreciation for science and the environment • Serve as project "ambassadors" to promote the project • Increased environmental activism	• Increased public support of science • Improved science-society relationship • Better informed citizenry • Enhanced scientific and environmental literacy • Increased conservation of natural resources • Healthier communities • Scientific recognition of value of volunteer-collected observational data • Increased social capital/community capacity • Policy initiatives that address environmental issues
PROGRAM	• Project team (scientists, technologists, regional editors) • Infrastructure for recruitment, training, support, data collection • Clients/Partners • Evaluator • Funding sources • Partner groups	• Develop project design, protocol, educational materials • Recruit participants • Provide training and support to volunteers • Implement and operate project • Analyze volunteer-collected data • Communicate project findings to wide audience • Network with partner organizations • Website development and maintenance	• Interactive website • Data quality/data assurance filters • Reference data set for scientific community • Number of trainings and workshops offered • Number of sites or acreage monitored • Data tools for managing data, rewards • Increased exposure of project to wider audience	• Increased knowledge of natural systems • Collection and central organization of scientific data • Increased utility and accessibility of data • Peer-reviewed publications, reports, meetings	• Enable and inform conservation actions • Program sustainability • Increased knowledge of best practices for operating citizen-science projects • Increased capacity to improve future citizen-science projects • Improved relationship between project and local community	

Three Monarchs, Monarch Larvae Monitoring Project by Linda Straight

THEORY of CHANGE

In addition to a logic model, you may also find it helpful to articulate your "**Theory of Change**," i.e., how you think each of your project activities will lead to your desired outcomes. Despite the name, theory of change does not have to be based on documented theories; it can be based on your prior experiences, assumptions, expert knowledge, or even wishful thinking. Once you make your theory of change explicit, you need to communicate it to other members of your team and have them share how they think the project activities will lead to desired outcomes.

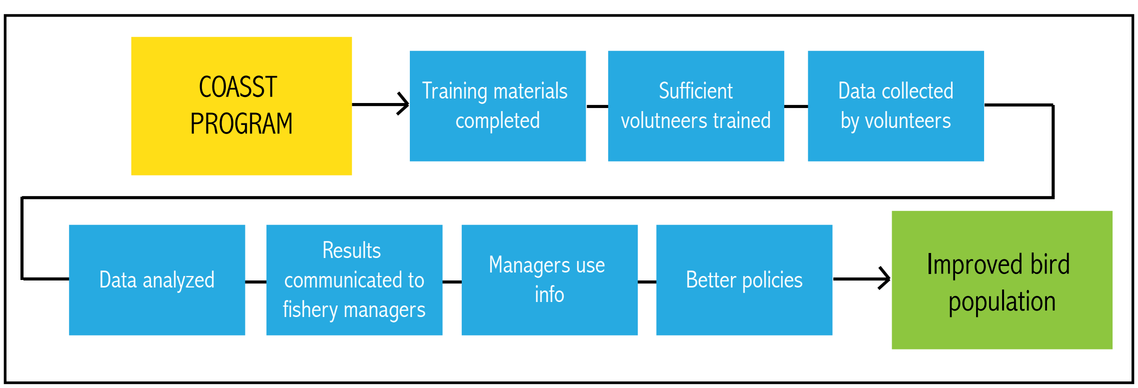
After your team's assumptions are made explicit, you can begin to test them by creating statements that link your activities with the desired outcome from those activities. The easiest way to do this is by using "if… then" statements. For example, let's say that you are implementing a citizen- science project in an afterschool setting aimed at increasing interest in science careers. For this outcome, begin by listing your assumptions: we assume that exposing kids to science will increase their interest in science careers. Then describe the activities as they relate to the outcomes with "if … then" statements. You may find that you need to provide additional activities or supports to reach the desired outcome.

EX #1: *If* we provide fun, compelling science-related activities, *then* we will increase interest in science careers.

Are there holes in example one? Are there assumptions that need to be addressed? Could it be improved? Let's try another one…

EX #2: *If* we provide science-based activities, and describe how they relate to science careers, *then* students in the afterschool program will have knowledge of some different science careers. *If* students know about different science careers, *then* they may seek out additional information about a particular career. *If* they seek out more information on a topic, *then* they may show increased interest in science careers.

The set of statements in example two makes it clearer how the activities are linked to the desired outcomes. As project developers we are often too embedded in programs to see and identify assumptions about audience needs and interests, and the explicit mechanisms in place for influencing change. Clarifying why certain program activities could lead to expected goals or outcomes will help to highlight the perceived versus actual linkages between activities and outcomes. Working with others to develop logical "if…then" statements can help uncover–and address–these assumptions so that activities and outcomes are aligned.



Courtesy COASST and Miradi

DEFINE

The next step in planning your evaluation is working with stakeholders to define what exactly will be evaluated, determine key evaluation questions, and lay out the evaluation timeline, budget, and limitations.

A. State the purpose of the evaluation

Explicitly articulating the reasons for your evaluation will structure the scope of work you will do. Inexperienced evaluators sometimes try to evaluate every aspect of a program. Attempting to do so will be very costly and may result in findings that are incomplete or lack depth. To avoid this problem, consider just one or two main reasons for conducting an evaluation. Frequently, evaluations are conducted to:

- *gauge participant learning;*
- *identify project strengths and weaknesses;*
- *promote a project more broadly;*
- *obtain additional funding or support;*
- *clarify program purpose or theory;*
- *increase organizational capacity building;*
- *reflect on project history;*
- *provide recommendations to improve project functioning.*

Once you decide on the main purpose of the evaluation, discuss it with significant stakeholders and then document *what is and what is not* going to be evaluated.

Great Backyard Bird Count Participants, from GBBC Archives

B. Develop and prioritize key questions that you hope will be answered as a result of the evaluation

Successful evaluation requires framing appropriate evaluation questions within the context of desired outcomes and the evaluation purpose. Defining and refining your evaluation questions is perhaps the most critical aspect of planning your evaluation because it hones in on what to evaluate. Evaluation questions should be broad enough to frame the overall evaluation, yet specific enough to focus the evaluation. Articulating well-formed questions (those that frame the overall study, not questions that might be asked of participants) will help you determine the overall study design, approach, and selection of methods (Diamond 2009). For example, a needs assessment evaluation to better understand a project's audience might include the following types of questions:

- *What does the audience already know about this particular topic?*
- *What misconceptions exist among the audience regarding this topic?*
- *How interested is the intended audience in this new emerging topic?*

Formative evaluation questions, which focus on understanding the extent to which a project is functioning as expected, might ask:

- *What, if any, were the barriers to participation?*
- *Were project participants satisfied with their experience? Why or why not?*
- *Did the project reach its intended audience? Why or why not?*
- *What lessons have we learned about developing and implementing this project?*

Outcome evaluations, for which the emphasis is on determining if projects have met their goals, might ask the following questions:

- *Was there evidence of an increase or change in knowledge as a result of engaging with this project?*
- *Was there evidence that participants improved their skills in data interpretation after or as a result of participating in the project?*

- *Was there evidence that participants changed aspects of their consumer behavior as a result of participating in this project?*

You will likely come up with many questions for which you would like answers, but it is important to remember that not all questions can be answered given allotted time and resources, and not all questions have the same importance to all stakeholders.

To get the most bang for your buck, ensure that the questions are 1) answerable; 2) appropriate for the various stages of evaluation; 3) aligned to the desired outcomes; and 4) provide important information for stakeholders. In addition to these criteria, you should also prioritize the questions by considering the following aspects:

- *The resources needed to answer the question*
- *The time required*
- *The value of the information in informing the evaluation purpose*

As each question is examined through the lens of these criteria, some will present themselves as high priority, while others will be eliminated altogether. At the end of this process you should feel comfortable knowing that the questions you focus on will demonstrate measurability, relevance, and feasibility, while setting the stage for the rest of the evaluation.

C. Determine the indicators for each intended outcome

With goals, outcomes, and evaluation questions articulated, the next task is developing quality **indicators**, or criteria for measuring the extent to which your desired outcomes are being achieved. An indicator answers the question: How will you know success when you see it? Indicators provide specific types of information that let you know that an outcome has been achieved. Effective indicators align directly to outcomes and are clear, measurable, unbiased, and sensitive to change. So, if an outcome relates to knowledge gains, the indicator should measure knowledge gains. You may come up with more than one indicator for each desired outcome. And while indicators are measurable, they do not always need to be quantifiable. They can be qualitative and descriptive, i.e., "Participants will describe that they. . ." Indicators are the main source of information that will be used as credible evidence.

An example of goals, outcomes, and indicators is provided below:

Goal: Participation in citizen science will result in development of science inquiry skills.

Short-term Outcome: Within three months of joining the project, at least half of participants will be able to successfully collect and submit data.

Indicator: The number of new participants that submit data and show increased confidence in being able to collect data.

When developing indicators, it is important to consider the type of program or activity, the duration of the program, and the logistics of administering the measurement instrument. For a list of measurement instruments aligned to the framework on page 10, please visit **www.citizenscience.org/evaluation**.

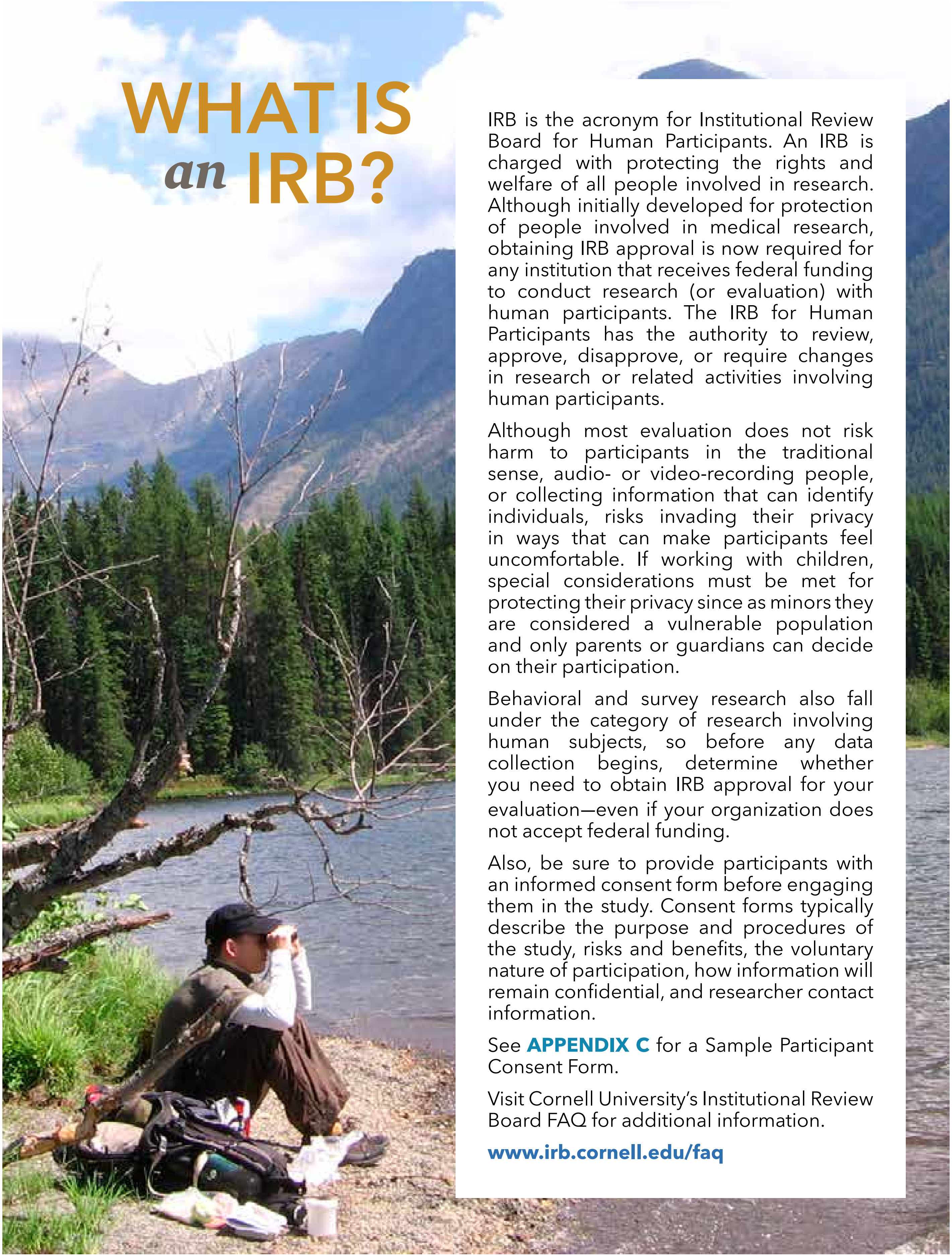
D. Construct a timeline for the evaluation (include major milestones)

Somewhere in the evaluation plan, you should develop an estimated timeline that provides anticipated start and end dates for completing key tasks and meeting established milestones. Such timelines are often presented in calendar format. Tap into your knowledge of your project and its audience to help you develop a reasonable timeline. Although all timelines inevitably change, having the timeline be as accurate as possible early in the evaluation will help avoid frustration later because of initial unrealistic expectations.

E. Construct a rough budget for the evaluation

This section of the plan estimates how much the evaluation will cost, which can vary greatly depending on the complexity of the evaluation. For example, evaluations incorporating experimental designs with control groups may be very costly. However, interviewing, transcribing, and analyzing information from 50 people for 60–90 minutes each can also be very time intensive (and thereby expensive). Recruiting participants can be costly depending on how you intend to engage them, particularly if incentives are required to ensure their participation. Obviously larger, more complex evaluations will cost more than those that are smaller in scope. Include costs related to salaries, travel, consultants, printing, mailing, copying, telephoning, and any necessary software or equipment.

WHAT IS *an* IRB?



Scanning for loons, the Common Loon Monitoring Citizen-Science Project, courtesy Glacier National Park Service

IRB is the acronym for Institutional Review Board for Human Participants. An IRB is charged with protecting the rights and welfare of all people involved in research. Although initially developed for protection of people involved in medical research, obtaining IRB approval is now required for any institution that receives federal funding to conduct research (or evaluation) with human participants. The IRB for Human Participants has the authority to review, approve, disapprove, or require changes in research or related activities involving human participants.

Although most evaluation does not risk harm to participants in the traditional sense, audio- or video-recording people, or collecting information that can identify individuals, risks invading their privacy in ways that can make participants feel uncomfortable. If working with children, special considerations must be met for protecting their privacy since as minors they are considered a vulnerable population and only parents or guardians can decide on their participation.

Behavioral and survey research also fall under the category of research involving human subjects, so before any data collection begins, determine whether you need to obtain IRB approval for your evaluation—even if your organization does not accept federal funding.

Also, be sure to provide participants with an informed consent form before engaging them in the study. Consent forms typically describe the purpose and procedures of the study, risks and benefits, the voluntary nature of participation, how information will remain confidential, and researcher contact information.

See **APPENDIX C** for a Sample Participant Consent Form.

Visit Cornell University's Institutional Review Board FAQ for additional information.

www.irb.cornell.edu/faq

DESIGN

The last part of the planning phase is designing the plan for data collection. The goal is to create a data collection strategy that identifies procedures that are feasible, cost-effective, and viable to keep the project focused and on schedule. Before implementation begins, all relevant personnel should review and understand the data collection strategy.

A. Determine your study design

At this point you will need to determine the strategy you will use to design the overall evaluation. The design should reflect the types of questions you need answered, the reason for conducting the evaluation, the methods that best address the evaluation question, the amount of resources you can commit to the evaluation, and the information stakeholders hope to learn.

Many different evaluation approaches and study designs exist, and it is beyond the scope of this guide to describe them all. Different study designs are better suited for different types of evaluation questions. If your question is concerned with comparing outcomes for participants directly before and after project participation, then pre-post designs will likely fit the bill. Questions that seek to answer causal processes where you can include control groups and random assignment are best suited for experimental designs.

Researchers usually consider evaluation designs to be either quantitative—for example, surveys, tests, or other methods of collecting evaluation data that can be analyzed numerically—or qualitative, i.e., interviews, focus groups, or observations whose findings must be interpreted by the researcher. If you are comfortable with multiple methodologies you can combine these approaches to achieve mixed-methods designs, incorporating both quantitative and qualitative techniques. For example, if one of your questions is best answered by broad representation of a population and data are easy to acquire through questionnaires, then quantitative survey methods work very well. If another question requires gathering robust information on participant experiences and you can gain easy access to participants, then qualitative interview or focus group methods can also be used. Combining these methods into a single study can increase the **validity** of results by triangulating the findings (Creswell, 2003).

TABLE 3 compares quantitative, qualitative, and mixed-methods approaches and the corresponding strengths and weaknesses of various design strategies that are typical of each.

In deciding on a study design, consider the following questions:

- *How well do you know your topic? You may need to conduct a literature review to understand the topic and determine how past evaluations have been designed.*
- *What approach to research are you most comfortable with (i.e., qualitative, quantitative, mixed)?*
- *Can you dedicate enough time, resources, and staff expertise to the evaluation? If not, you may need to consider hiring an external evaluator.*
- *Who are the stakeholders and what do they hope to learn from the evaluation?*

Determining the approach that is best for you will depend on the types of questions you're asking and the time, budget, and expertise available to do the work.

B. For each outcome, determine the population to sample from and the appropriate sample size

The **sample** is a representative subset of the larger group or **population**. A representative sample will help minimize sampling **bias** and error. Simple random sampling (where each member of the population has an equal chance of selection) is the preferred **sampling** method. However, you may have more than one subset of the population you need to include, in which case you might employ a **stratified** sample. If your study is not aiming to generalize to the whole population, you can consider using a **convenience** sample—which allows you to include participants that are easy to contact—or a **purposeful** sample, which emphasizes extreme cases or those that provide maximum variation.

The procedure for determining sample size, or the number of people you need for your study, can be complicated, but if you are comfortable with a 95% confidence interval and 5% margin of error, the table below provides a general rule of thumb for determining sample size from a given population. For example, if your citizen-science project has approximately 1,000 participants, your population would be 1,000 and your sample would be approximately 280. If you are seeking a different confidence interval and margin of error, visit: www.research-advisors.com for a table of suggested sample sizes.

POPULATION	SAMPLE
50 OR LESS	50 OR LESS
500	~200
1,000	~280
10,000	~370
U.S. POPULATION	~400

C. Draft the data collection strategy

For each targeted outcome, identify the data collection methods to be used, the sample for collection (i.e., before, during, or after the project/intervention), and the source of the data.

When deciding on data collection methods, consider the need for statistical precision, in-depth information, standardization of data, cultural attributes of the audience, and availability of contact information for the sample. Common data collection methods are presented below; many of these methods are often used in combination. Descriptions and a comparison of strengths and weaknesses of the following data collection methods are presented in **APPENDIX D**.

- *Surveys*
- *Professional critique/expert review*
- *Interviews*
- *Portfolio reviews*
- *Focus groups*
- *Content analysis*
- *Observations*
- *Examine email/list serve messages*
- *Journals*
- *Case study analysis*
- *Tests/quizzes*
- *Literature review*
- *Concept maps*
- *Simulations*
- *Tracking & timing*
- *Web analytics*
- *Creative expression*

Once you have completed the previous steps of the design phase, compile all of the information into a table such as the one shown in **APPENDIX E**. The completed Data Collection Strategy will serve as a foundation for your evaluation plan and will be an invaluable source of documentation for your work.

EVALUATOR TIP

Estimate in advance the amount of information required, or establish criteria for determining when to cease data collection.

Recording mountain goat observations, Glacier National Park Citizen-Science Program courtesy Glacier National Park Service

TABLE 3: STRENGTHS AND WEAKNESSES OF VARIOUS EVALUATION DESIGNS

(Adapted from Friedman 2008 and Creswell 2003)

STUDY DESIGNS	TYPICAL DATA COLLECTION TYPES	DESIGN STRATEGIES	STRENGTHS	WEAKNESSES
QUANTITATIVE Rely primarily on the collection of quantitative or numerical data that can be analyzed using statistical methods. Results are typically displayed as tables, charts, histograms, and graphs. Findings tend to be broad and generalizable.	Surveys, quasi-experiments, experiments, statistical analyses of data	One-time post-test, no comparison group	Simple to administer, provides current information quickly	Does not measure change
		Quasi-experimental pre-post test, no comparison group	Measures change over time	Determining causal relationships may be difficult
		Quasi-experimental post-test only with comparison group	Fairly simple comparisons to another group	Does not control for initial group differences
		Quasi-experimental pre-post test with comparison group	Provides for control of variables	Doesn't control for changes due to testing
		Experimental, post only with random assignment	Reduces group differences	Difficult to administer in citizen-science projects
		Experimental, pre-post with random assignment	Controls for group differences and irrelevant variables	Difficult to administer in citizen-science projects and doesn't control for changes due to testing
QUALITATIVE Rely on the collection of data in the form of text and images. Designs are iterative and reflexive. Data analysis is interpretative based on individual researcher perspective. Findings tend to be richly detailed and less generalizable to large populations.	Observations, interviews, focus groups, document analysis, journaling, personal meaning mapping	Narrative	Allows participant to write their own story	Storytelling approach may have limited applicability
		Phenomenological	Provides data on meaning and how individuals experience a phenomenon	Requires extensive and prolonged engagement by the researcher
		Ethnography	Produces rich and detailed cultural data over long time periods	Requires extensive and prolonged engagement by the researcher
		Grounded Theory	Development of a theory from data that the researcher collects	Complex and intensive data collection and analysis
		Case Study	Uses a variety of data collection procedures to provide detailed accounts	Limited generalizability
MIXED METHODS Quantitative and qualitative methods or techniques can be mixed in one overall study.	Any mixture of quantitative and qualitative data collection types	Any mixture of quantitative and qualitative design strategies	Combines complementary strengths of qualitative and quantitative designs	Requires skill in interpreting data from qualitative and quantitative approaches

Monitoring mountain goats, Glacier National Park Citizen-Science Program, Courtesy Glacier National Park Service

PHASE 2: IMPLEMENT

DEVELOP

The previous section described how to plan an evaluation. This section explains how to use the plan to guide implementation of your evaluation. The goal of the implementation phase is to collect credible data that will increase the accuracy and utility of the evaluation.

A. Choose your instrument

Instruments can include protocols for interviews, observation, or focus groups; **surveys** and **questionnaires**; and tests and quizzes. If you are planning on using surveys or questionnaires for data collection, use existing measures whenever possible, (see sidebar "What is an Instrument" on page 22). The drawback to using an existing instrument is that it may not fit your exact needs, in which case you may need to modify it slightly. If you do modify an instrument, check with the developers to make sure that your changes do not effect its validity and **reliability**.

Sometimes it is necessary to develop original instruments to measure outcomes of your intended audience. The most important part of instrument development is to clearly define what you want to measure, often called a "**construct**" or an idea containing various conceptual elements. See page 10 for examples of learning constructs relevant to citizen science. You may also need to review the literature to determine how the construct you are interested in measuring has been studied.

B. Follow best practices for survey development

If you are creating a new instrument such as a survey, create a draft and share it with your colleagues or with individuals considered to be experts in the construct. Seek their feedback on the instrument's relevance to the construct, as well as its language, clarity, and redundancy. Make any changes or revisions to the instrument from your internal review. Keep the instrument as brief as possible and collect only the data that you are certain will be analyzed and used. See **APPENDIX F** for guidance on developing a quality survey.

Whatever instrument you use, be sure to include demographic items that describe your population. Common demographic items include age, gender, ethnicity, and education level. Examples of demographic items can be found in **APPENDIX G**.

FIELD TEST

Testing your instrument is important for ensuring that it is understandable to the intended audience. Testing instruments before data collection begins—whether they are surveys, interview, or observation protocols—will help to minimize measurement error and in turn increase the credibility of your results.

A. Field test draft instruments and refine as needed based on test results

If you are using an instrument that has not been tested previously, it is important that you field test it on at least 8–10 individuals who are similar to your intended population. The goal here is to test the instrument's suitability, utility, and clarity to your audience. It is also a good idea to gather feedback on the instrument's wording and length. Although field tests are best done as in-person interviews, they also can be done over the phone or even online. Your field test will likely provide you with insightful information about how your audience perceives the instrument. This feedback should be used to revise the instrument in preparation for pilot testing it to a wider audience.

B. Create a data management plan

Whether or not you have an IRB approval in place, you must take steps to safeguard the confidentiality of data in all of its forms. If data are confidential and anonymous, make sure they are effectively and ethically maintained. Document the protocols for maintaining confidentiality and anonymity of all subjects. Determine intellectual property rights, i.e., who owns the data, who can access the data, and who can publish the data. Before data collection begins, create a **data management plan** to document the following:

- *What is the source of the data?*
- *Who will be collecting the data?*
- *Where will the data be stored and archived?*
- *Who will be in charge of data analysis?*
- *Who else will have access to the data?*
- *Any changes made to instruments, questions, evaluation design, or procedures.*

Lichen Monitoring, Great Smoky Mountain Institute at Tremont, courtesy GSMIT Archives

EVALUATOR TIP

If developing an original survey, make sure questions and answers are specific, short, and use simple language. Avoid using jargon, abbreviations, and double-barreled questions. Review "How to Conduct Your Own Survey" by Salant and Dillman (1994) for information on survey design.

EVALUATOR TIP

Whenever possible, avoid creating your own instrument. Instead opt for one that has been tested and shown to be valid and reliable (see next page for more information about instruments).

Stream monitoring, Water Action Volunteers by Kris Stepenuck

WHAT IS *an* "INSTRUMENT?"

In evaluation, an instrument is a tool used to collect and organize information about project participants either through self reports or observation. Examples include surveys, questionnaires, tests, checklists, and rating scales. When deciding on what to use to measure your outcomes, you have basically three choices: 1) use an existing instrument that has been shown to be valid and reliable; 2) modify an existing instrument to tailor it to your needs; 3) develop your own instrument. A valid instrument has been shown by its developers to measure what it is intended to measure, and a reliable instrument will measure accurately across time and in different contexts.

The Cornell Lab of Ornithology has developed an "online toolkit" with tested surveys that are contextually relevant to citizen science at **www.citizenscience.org/evaluation**. Additionally, you can visit **www.pearweb.org/atis** for a database of Assessment Tools for Informal Science.

ADMINISTER

Administering your data collection instrument(s) is perhaps the most exciting phase of conducting your evaluation. Whether you are administering a survey or series of interviews, observations, or focus groups, this is where all your hard work begins to pay off by collecting credible evidence about your project.

A. Recruit participants

Recruiting participants for your evaluation is often harder and more time-consuming than expected. Give yourself plenty of time to recruit participants and plan on recruiting more than you need, with the expectation that many will not agree to participate. You also will need to determine the best medium for collecting your data. Will you use an online survey tool, phone, in-person, or mail campaign?

Before collecting data, be sure participants understand the purpose of the evaluation, the time required, any potential risks and benefits of participating, how data will be used, who to contact for more information, and how confidentiality will be protected. If you are collecting any type of personal information, including email, it is wise to have participants read and sign a consent form tailored to your study (see **APPENDIX C** for a sample form). If you are working with children, be sure to have parents and/or guardians consent to their participation. Importantly, determine if your institution has an Institutional Review Board (IRB); if so you will likely need to obtain its approval before initiating your study.

B. Administer final instruments and collect data

Once data collection begins, keep a detailed electronic spreadsheet that tracks all of your data collection efforts and includes information such as the instrument name, creation date, administration date, initial and final sample size, overall response rate (final sample size/initial sample size) and any changes made to the instrument.

It is also a good idea to periodically monitor the data being collected and take steps to improve data quality if necessary. Check your data early to help answer the following important questions:

- *Are you reaching your intended audience or are some groups under or overrepresented?*
- *Are the data providing the kind of useful information you intended? Do they help answer your initial evaluation questions?*
- *Are the data being collected in a way that can be analyzed?*
- *Are you collecting the right amount of data?*

EVALUATOR TIP

For more information on ethics in evaluation, see the American Evaluation Association's Guiding Principles for Evaluators at: http://www.eval.org/publications/guidingprinciples.asp.

Monitoring mountain Goats, Glacier National Park Citizen-Science Program, courtesy Glacier National Park Service

Aquatic Salamander Monitoring, Great Smoky Mountain Institute at Tremont, courtesy GSMIT Archives

PHASE 3: SHARE

ANALYZE

Data analysis can take many different forms depending on the project need, audience, and how the information will be used. If expertise in data analysis is not available internally, consider hiring someone with the required skill set. Before analysis takes place, review the evaluation questions to focus your data analysis.

A. Make a copy of the original raw data

Irrespective of the kind of data collected, and before any data analysis takes place, copy and rename a working data file. Whether the data arrive electronically or on paper, be sure to keep the original, raw data untouched. Document the description and location of the file, as well as any changes to the working data file such as cleaning, transformation, and **coding**.

B. Working with quantitative data (numerically-based data)

Quantitative data are numerical in nature, and typically analyzed using statistical tests and methods. Common stats packages include Excel, Access, JMP, SAS, SPSS, STATA, R, and Minitab. Most of these are not free, but check with your organization regarding the availability of a group license. Results are typically displayed as tables, charts, and graphs.

1. Create a codebook for organizing all your data.

If data arrive to you on paper, take the time to convert the information to an electronic database. Then develop a codebook, which helps you manage your data by providing definitions of variable labels and other important information that can be shared with anyone who is analyzing the data. As you examine your data, determine the type of data for each variable (i.e., categorical, ordinal, interval, or continuous—see sidebar on page 27). **TABLE 4** illustrates an example codebook.

2. Clean and transform the data

Most quantitative data will need to be checked for errors. For example, look to see that for each variable, the answers are within acceptable ranges. In some cases you can fix the errors but sometimes you may have to treat the errors as missing data. You also may decide to exclude certain data in your analysis, e.g., if some respondents skipped a majority of questions.

After error-checking is complete, you will likely need to transform the data. For example, yes/no responses are typically coded as "1" for yes and "0" for no. If you have **scale** items (i.e., strongly disagree to strongly agree), you will need to record each of these as numbers. In general, number the recoded items such that the higher the number the more positive the response.

TABLE 4: EXAMPLE DATA CODEBOOK

DATA COLUMN	VARIABLE NAME	DESCRIPTION	ACTUAL QUESTION	VARIABLE VALUE	VARIABLE TYPE
A	State	State of residence	In what U.S. state or Canadian province do you currently reside?	State Code	Categorical
B	Years_Duration	Number of years participating	About how many years have you participated in…?	Range 0 - 20	Continuous
C	Hours_ Intensity	Average number of hours per week	About how many hours on average do you spend each week monitoring your site?	Range 0 -100	Continuous
D	Satisfaction_1	Measure of satisfaction (1 of 5)	The current format of the project is excellent	Strongly Disagree (1), Disagree (2), Slightly Disagree (3), Slightly Agree (4), Agree (5), Strongly Agree (6)	Ordinal
E	Intention	Measure of intention (1 of 1)	How likely are you to participate in the project again next year?	Not at all likely (1), Not very likely (2), Haven't decided (3), Somewhat likely (4), Very likely (5)	Ordinal
F	Gender	Gender of respondent	What is your gender?	Male (1), Female (2)	Categorical
G	Birth_Year	Year of birth	In what year were you born?	1900-1998	Interval
H	Education	Highest level of education	What is your highest level of formal education?	High school graduate (1), College/ university courses (2), College/university degree (3), Post-graduate studies (4), Post-graduate degree (5) Other =	Categorical
I	Comments		Is there anything else that you would like to tell us about your experiences with the project?	Open-ended text	Alphatext
J	Ethnicity	Ethnicity of respondent	What is your ethnicity or national origin? Please check all that apply.	African American, American Indian, Native American, Asian, Caribbean Islander, American, White/Caucasian, Latino or Hispanic	Categorical

3. Summarize the data using descriptive statistics

Once data are clean and coded, you can conduct **descriptive statistics** that provide you with a basic summary of the properties of your data. Basic descriptives include the sum, mean, median, mode, range, percentile, standard deviation, standard error, and skewness. These types of summaries should give you a basic understanding of your data, whether it is "normal" (parametric) or non-parametric, and can inform the type of test to use for more sophisticated inferential statistics, if you so choose. **Inferential statistics** allow you to determine relationships between one or more variables and whether the relationship is real (significant) or by chance (non-significant).

4. Interpret your data

Data interpretation allows you to assign meaning to the data collected and determine the conclusions, significance, and implications of the information. Data interpretation will be a function of the type of information collected and the initial questions and reason for the evaluation.

C. Working with qualitative data (text- and image-based data)

Qualitative data consist of almost any information or data that is not numerical in nature. Generally, qualitative data is gathered from interviews and discussions, open-ended questions and written comments on surveys, through observation, and from written documents such as diaries, journals, and news articles.

Analyzing and interpreting qualitative data usually consists of some form of content analysis. There are many ways to analyze and interpret qualitative data and your approach will depend on the questions you want to answer, the goals for the individuals who will use the information, and the resources you have available. You may also need to use a few different types of analysis depending on the types of data that you collect. For example, analyzing visual sources of data (e.g., photographs) will differ greatly from the techniques used to analyze written data.

Here are some techniques that you might pursue in the analysis of your qualitative data:

1. Determine the procedure for analyzing and interpreting your data based on the type of data that you have

Consider the qualitative approach used (i.e., grounded theory, phenomenological, ethnography, biography, case studies, etc.) to determine the type of analysis to conduct (qualitative thematic analysis, content analysis, summaries, and/or scenarios).

2. Employ data reduction techniques

Data reduction is necessary to transform unstructured audio or visual data into a useful data source for answering evaluation questions. Data reduction can occur through a process of reading documents, creating initial codes, focused coding, and data re-organization.

A common data reduction technique is to develop common categories that your data might be placed into. For example, you may want to develop a few categories or labels that capture similarities and differences in people's responses to a question. These categories may expand or narrow through the process of reducing your data. This process is also referred to as "coding" your data. Codes can be based on themes and topics, ideas and concepts, terms and phrases, or on keywords found in the data. The process can be done manually, which can be as simple as highlighting different concepts with different colors or separating people's responses into different columns in a spreadsheet, or fed into a software package. Frequently used qualitative software packages include: Computer-Assisted Qualitative Data Analysis Software (CAQDAS), MAXqda, Nvivo, Atlas. ti5, and HyperRESEARCH.

3. Interpret your data

Interpreting your data consists of using the themes, trends, or patterns developed during the data reduction process to explain the findings of your evaluation. How you interpret your data will depend on the goal of your evaluation, how you wish to present your findings, and your intended audience. There are numerous ways to interpret your data, from diagrams and graphs to detailed flow charts with descriptions and quotes.
Resources for learning more about qualitative data are included in the reference section.

D. Working with mixed methods data

In mixed methods datasets, the above principles for qualitative and quantitative data apply, but analysis of data from a mixed methods design will vary depending on the relationship between the quantitative and qualitative data.

1. Compare and contrast qualitative and quantitative data

When appropriate, identify corroborating and contradictory results by contrasting qualitative and quantitative data. For example, when a similar construct is measured using both quantitative and qualitative variables, the two sets of data can be compared and contrasted to detect nuances in how respondents may have interpreted each type of question. Particularly illustrative examples can also be selected from the qualitative data set and reported alongside quantitative summaries of the same or closely related construct.

2. Synthesize mixed methods data

Synthesize mixed methods data by using qualitative data to illustrate and elaborate quantitative findings or embed quantitative data into the qualitative narrative. In some cases, such as with open-ended additions to categorical question types (e.g., "select one of the following" or "check all that apply"), qualitative responses will need to be coded, added, or integrated into the preexisting response categories and analyzed alongside and in the same manner as those preexisting categories.

3. Analyze separately

A third common scenario involves quantitative and qualitative data sets that are independent of each other and are thus analyzed separately. This is most common when measuring constructs that lend themselves to only one type of method. For instance, questions about the meaning that respondents attribute to an activity can often be captured only through interviews or open-ended essay-type questions which can then be summarized as case studies or coded and analyzed as a qualitative narrative.

TYPES *of* DATA

TYPES OF DATA	POSSIBLE TYPE OF ANALYSIS
Categorical Data (also called Nominal Data) Data that are categorical can be sorted according to a mutually exclusive category. An example of categorical data is "gender" with categories "male" and "female." Categorical data can be counted, but not measured.	Frequency (count of categories) Mode (the most common item)
Ordinal Data Ordinal data are values or observations that can be ranked or ordered. **Likert-type scales** are often ordinal data, however, with ordinal data, the interval between any two values is not necessarily equal (for example 3 and 4, are not necessarily the same value as between 4 and 5). Ordinal data can be counted and ordered, but not measured.	Frequency (count of values) Mode (the most common item) Median (middle ranked item) Percentiles
Interval Data Interval data have equal distances between values, but do not have an absolute zero point. Time and temperature are examples of interval data. Interval data can be ordered and measured, but do not indicate the relative sizes of two or more values, thus ratios cannot be calculated. For example, while 40 degrees is 10 more degrees than 30, 40 degrees is not two times as hot as 20 degrees (the numbers do not represent a 2:1 ratio).	Frequency (count of values) Mode (the most common item) Median (middle ranked item) Percentiles Addition, subtraction Mean, standard deviation, standard error
Continuous or Ratio Data Ratio data have the same attributes of interval data but also have a true zero, which allows the calculation of relative differences between any two points. Height and weight are examples of continuous or ratio data. Thus, we can accurately say that 10 pounds are twice as heavy as 5 pounds.	Frequency (count of values) Mode (the most common item) Median (middle ranked item) Percentiles Addition, subtraction Mean, standard deviation, standard error Ratio, or coefficient of variation

Courtesy of Monarch Larvae Monitoring Project

REPORT

Once data have been analyzed and synthesized, an evaluation report should be completed so that stakeholders are aware of the evaluation process and its findings. If the planning and implementation phases were adequately documented, much of the final report will already be drafted. Below are the major sections to include within an evaluation report, but keep in mind that your report should be attentive to the audience for whom it is intended.

A. Executive Summary

If your readers read only one thing, it will likely be the **executive summary**, so it is important to include this in your report. Provide a brief overview and purpose of the program; a description of the activities, setting, and audience served; a description of the evaluation purpose; and a brief overview of findings and recommendations. The executive summary should not be more than a few pages in length.

B. Program Description

Provide a brief history of the program and how it relates to the mission, existing research, or organizational structure. Describe the goals and intended outcomes of the program, project activities, setting, target audience, and historical milestones.

C. Evaluation Methodology

Include the type of information collected (i.e., quantitative, qualitative, mixed) and the rationale for collection, how information was collected, a description of tools used and their development or adoption, and how tools were intended to answer the evaluation questions. Describe from whom information was collected, how samples were chosen, and the study design used. Report who collected the information and any limitations of the design or implementation such as access to information, appropriate data collection tools, challenges, or changes to the methodology during the evaluation process.

D. Findings & Results

Repeat the intended program outcomes and present appropriate qualitative or quantitative data. Shared findings must be clearly written, honest, concise, and complete. Describe reasons for missing data if necessary. Use charts, graphs, and tables to graphically illustrate findings.

E. Discussion & Interpretation

Determine what the results say about the program and what was expected. Describe the outcomes that were and were not met and why. Determine if limitations or other circumstances contributed to the results. Discuss unintended outcomes and how these may be incorporated into future program improvements. Compare results with those from similar programs, if possible. Determine if there is anything you did not learn about the program but would like to. Reflect on program outcomes, the broader context of the program, and future research possibilities.

F. Recommendations

Determine if there are changes (organizational, staff, modification of outcomes) required of the program to meet identified outcomes. Recommendations should be realistic and specific and should have significant impacts.

G. References

Be sure to reference all cited work, including sources of instruments used to collect data.

H. Appendices

Include the following items as appendices: data collection instruments and protocols, data collection plans, report of findings from specific instruments, interim reports, summary of costs for various evaluation activities, consent forms, and resumes of evaluation staff and consultants.

EVALUATOR TIP

Provide continuous feedback to stakeholders through the use of interim reports that incorporate preliminary findings and recommendations.

DISSEMINATE & INFORM

It may seem like a long journey to finally reach this point, but here is where you get to put all of this effort to good use. Not all evaluations will show positive findings, but remember that this is a learning opportunity to understand what worked and what didn't. Although no one wants to highlight negative results, refrain from reporting only on positive findings. Including what did not work adds credibility to your efforts and helps inform the practice of other practitioners. For various reasons, many evaluation reports never see the light of day, so make it a point to get your report disseminated in both traditional and non-traditional venues.

A. Share with stakeholders

It is important that your stakeholders are comfortable with what is in your report and where you plan to disseminate it, so after the report has been written, share it with key stakeholders before disseminating it more broadly.

B. Consider publishing

What have you learned as a result of your evaluation? Perhaps there are key findings that could be of value to others working within the citizen-science realm. With a little bit of work, an evaluation report can be rewritten as a paper for peer review. Below is a partial list of journals that have published papers on citizen-science outcomes:

- *Ecology and Society*
- *Journal of Environmental Education*
- *Public Understanding of Science*
- *Conservation Biology*
- *Science Education*
- *Frontiers in Ecology and the Environment*
- *International Journal of Science Education*

EVALUATOR TIP

Schedule follow-up meetings with evaluation users to assist in the transmission of evaluation results and recommendations into appropriate action or decision-making.

C. Consider non-traditional options

Many other options exist for disseminating your work. If your goal is to showcase your program far and wide, consider these ideas:

- *Upload the report to informalscience.org and citizenscience.org.*
- *Upload your report on your organization's website.*
- *Publish results or part of your results in a local newspaper.*
- *Air your results on a local radio station.*
- *Summarize the report as an easy-to-read flyer and post it in visible places at your organization, local businesses, community centers, and libraries.*

D. Inform your program

With your evaluation complete, you can now make important decisions about your program based on sound evidence. One of the first questions that a summative evaluation helps to answer is: "Did the program achieve its intended goals and outcomes?" If not, your evaluation should provide information to help determine why outcomes were not met. These types of findings can be just as important as those that show positive program impact because they can help clarify where your program needs improvement.

With buy-in from key staff and stakeholders, it is critical to review the evaluation findings and determine what, if any, modifications to the program should be implemented. The evaluation report will likely provide recommendations, some of which will be more feasible than others. Together, your team should prioritize the recommendations based on what is feasible given time and resources, what is most critical, and what is likely to be supported by stakeholders. Program staff should develop a working timeline for implementing and monitoring key recommendations, with ample opportunity to provide feedback on the changes.

The evaluation report may also highlight some unintended outcomes that can be extremely enlightening for future planning. Unintended outcomes should be discussed at length with the project team as they can result in a shift or new emphasis for your program that you had not considered before.

APPENDICES

APPENDIX A: SAMPLE GOALS, OUTCOMES, AND INDICATORS FOR CITIZEN-SCIENCE PROJECTS

Content has been included and modified with the consent of the projects listed here.
Colors are representative of the framework in Figure 3 (see page 10).

EDUCATIONAL GOALS	POTENTIAL OUTCOMES	POTENTIAL INDICATORS	PROJECT NAME
Increase interest in science activities such as monitoring rare plant species.	Participants gain interest in plant conservation and management.	Increase in the number of monitoring hours logged by participants.	Plants of Concern
Increase awareness of environmental topics such as marine habitat preservation.	Monitoring of sites will raise individual awareness of surrounding marine habitat.	Volunteers express increased interest in protecting local marine habitats following participation.	Shorekeeper's Guide
Increase efficacy of volunteers to promote wetland conservation and land stewardship.	Volunteers engage in public awareness of water quality issues and take part in local stewardship practices.	Participants use data collected to create and share reports on wetland health to local community.	Watershed Land Trust Adopt-A-Wetland Program
Empower participants to feel part of the scientific process.	Participation results in increased confidence to successfully collect and submit data.	Participants report improved confidence in their ability to contribute to science, increased reports of "self as scientist."	The Great Backyard Bird Count
Increase motivation by local people to understand and monitor their water resources.	Participants are empowered to understand and engage in science activities and environmental action.	Participants express intention to use information in the database to engage in dialogue with local resource management organizations.	Community Science Institute
Increase motivation for learning about the effects of invasive species across the USA.	Participation results in greater intrinsic motivation for learning about specific science topics - such as the spread of invasive species.	Participants report greater personal relevance to learning about invasive species.	National Institute of Invasive Species Science

APPENDIX A: SAMPLE GOALS, OUTCOMES, AND INDICATORS FOR CITIZEN-SCIENCE PROJECTS (CONTINUED)

EDUCATIONAL GOALS	POTENTIAL OUTCOMES	POTENTIAL INDICATORS	PROJECT NAME
Increase knowledge of scientific/environmental topics.	Participants gain an understanding of firefly biology and habitat.	Participants demonstrate their increased knowledge using online identification tools and exercises.	Firefly Watch
Increase knowledge about the nature of science and science processes.	Participants will demonstrate increased knowledge in two specific areas of scientific problem solving.	Participants complete essay responses for problems regarding causation and correlation.	Spotting the Weedy Invasives
Improve data collection skills.	Participants will be trained to monitor local water quality and collect data.	Participants complete a field training session, and demonstrate gains in sample collection/testing skills.	URI Watershed Watch
Provide an authentic science learning environment to impart science inquiry skills.	Participants will practice rigorous collection and analysis of data across upland, freshwater, and coastal ecosystems, practicing scientific processes and protocols using the same field equipment as scientists.	Participants showcase their data and multimedia “meaning-making” projects via interactive website and public discussion.	Vital Signs
Change participant behavior with regard to the spread of invasive species.	Participants will take part in at least one targeted behavior such as actively removing invasive species from their homes and/or neighborhoods.	Participants will report a change in their behavior regarding invasive species (4 target areas: eco management, persuasion, policy/legal means, and consumer choices).	Spotting the Weedy Invasives
Encourage participants to engage in community coalitions.	Build a network of informed citizen advocates for management and protection of natural resources.	Evidence of active community networks built through participation in group monitoring events.	Water Action Volunteers

APPENDIX B: LOGIC MODEL WORKSHEET

LOGIC MODEL FOR: ____

PROJECT DESCRIPTION & GOALS:

INPUTS	ACTIVITIES	OUTPUTS	OUTCOMES–IMPACT		
			SHORT TERM	MEDIUM TERM	LONG TERM
What we invest:	What they do:	What the deliverables are:	What the short term results are (1-3 years):	What the medium term results are (4-7 years):	What the ultimate results are (8-10 years):

ASSUMPTIONS ABOUT YOUR MODEL:

EXTERNAL FACTORS AFFECTING YOUR PROJECT:

APPENDIX C: PARTICIPANT CONSENT FORM TEMPLATE

You are invited to participate in a research study regarding [brief project description] and conducted through [*institution and partners*]. Please read this form carefully and ask any questions you may have before agreeing to be in the study. You will be given a copy of this form to keep for your records.

Purpose: The purpose of this study is [*describe the nature and purpose of the study in a few sentences*].

Procedures: If you agree to be in this study, you will be asked to [*explanation of what the participant is being asked to do*] regarding [*state the topic*]. This should take approximately [*approximate time commitment*].

Risks and Benefits: We do not anticipate any specific risks resulting from this study [*or acknowledge unpredictable risks if appropriate*]. The study will not have any direct benefits for you, [*or describe any benefits or incentives*] but your participation will help us learn more about [*describe any potential benefits for the researcher*].

Voluntary Nature of Participation: Your decision whether or not to participate will not affect your current or future relations with [*institution administering the study*]. If you decide to participate, you are free to withdraw at any time without affecting those relationships. You may decline to answer any questions that you do not feel comfortable answering.

Confidentiality: This research will not include any information that will make it possible to identify you. All data collected from [*describe data collection procedure, i.e., survey, interview, etc.*] will be kept in a locked file. Only the researcher will have access to this file. This consent form will be stored in a locked file separately from the data and will be destroyed at the end of the study.

Contacts and Questions: The researcher conducting this study is [*researcher name*]. If you have questions later, you may contact him/her at [*researcher contact information*].

If you have any questions or concerns regarding your rights as a subject in this study, you may contact the [*institution IRB name]* at [*contact information for Internal Review Board*].

Statement of Consent: I have been given information about this research study and its risks and benefits and have had the opportunity to ask questions and have them answered to my satisfaction. I consent to participate in this study.

Signature ____ **Date** ______________________

APPENDIX D: COMPARISON OF DATA COLLECTION METHODS

METHOD	DESCRIPTION	STRENGTHS	WEAKNESSES
Survey	Data are usually collected through questionnaires, although sometimes researchers directly interview subjects. Surveys can use qualitative (e.g. ask open-ended questions) or quantitative (e.g., use forced-choice questions) measures.	Surveys can be used to collect a wide range of information and are a great starting point to dive deeper into an issue. They can be inexpensive and easy to administer, and provide anonymity. They also provide a source of generalizable statistical data. Surveys can be administered via telephone, through email, and in person.	If not developed properly, surveys can be laden with multiple sources of error. Often, surveys only scan the surface of an issue. Sampling and statistical expertise may be necessary.
Interviews	Interviews involve direct discussion between the researcher and the participant. Interviews can be informal or structured.	Interviews are comprehensive and adaptable. They provide in-depth detail and unique insights about a topic. Interviews can be held via telephone, through email, and in person.	Interviews lack statistical rigor and may have limited generalizability. They can be time-consuming, costly, and difficult to analyze. Interviewer bias is a concern.
Focus groups	In a focus group, people are asked about their perceptions, opinions, beliefs, and attitudes regarding some topic. Focus groups usually take place in an interactive group setting, typically in person.	Provide an in-depth discussion of concepts and allow the researcher to understand concerns in a local context. The researcher can observe group interactions and notice the dynamics between numerous people within a community.	Others can influence opinions in the group and participants may not be representative of the population. Some participants may be reluctant to speak, while others may dominate conversation. Analysis can be challenging.
Observations	Observational research techniques involve the researcher or researchers making observations of a situation, event, or activity and taking notes or recordings of their observations.	Allows for a unique insight into contexts, relationships, and behaviors previously unknown to the researcher that may be crucial for the interpretation of other data.	It is difficult to record data and the quality of the data depends on the diligence of the researcher. Observations can be time-consuming and interpretation of behaviors may be difficult. Evaluator must be present to make observations.
Tracking and timing	Refers to following and recording visitor behavior, including where visitors go, what they do, and how long they spend at each exhibit in an exhibition. Similar to web analytics for websites.	The researcher can get a better understanding of popularity trends and the exhibits or projects that visitors tend to favor.	Does not provide feedback on the exhibit or allow the researcher to gauge the visitor's perceptions or beliefs regarding the exhibition.
Concept maps	Concept maps include a linking of ideas and hierarchies in a visual, graphic representation. May include word links or directional arrows to map many ideas.	Can be generated online or in-person simultaneously by numerous people. Concept maps provide a permanent record of individual understanding at a particular time, which will show changes in understanding over time.	Researchers must learn how to use and teach the technique and participants must be taught how to construct them, which can be time-consuming. Analysis and interpretation can be challenging.
Card sorts	Concepts of interest are identified and then written onto cards. Participants sort the cards into groupings and then name the categories. The results are later analyzed to reveal patterns.	Participants create categories that are meaningful to them. This technique works well when similarities between items make them difficult to divide clearly into categories and no existing taxonomy has been established. Card sort is low-tech and can be inexpensive to accomplish. Can be done in person or online.	May provide fairly consistent results between participants, or may vary widely. Analysis of the data can be difficult and time-consuming, particularly if there is little consistency between participants. Participants may not consider what the content is about and may just sort by surface characteristics such as document types.
Drawings	Participants draw a picture of something, which is then analyzed by the evaluator.	Drawings allow the participant to communicate their beliefs and perceptions in ways they can't through verbal means.	Lack statistical rigor and can be difficult to analyze for the researcher. Drawings can only be administered when the evaluator is present.
Web analytics	Web analytics looks at the use of a website or parts of a website to find which sections are visited most often.	Useful for understanding and optimizing web usage and understanding trends in those that visit your website.	Doesn't provide information on why visitors make certain choices online. Limited utility for most summative evaluations.

APPENDIX D: COMPARISON OF DATA COLLECTION METHODS (CONTINUED)

METHOD	DESCRIPTION	STRENGTHS	WEAKNESSES
Professional critique	Critique or critical review of a project or exhibition by someone other than the evaluator.	Improvement may be more obvious to someone with special expertise or to someone who looks at it with a fresh eye. It subjects ideas to the scrutiny of others who are experts in the field.	The professional offering the critique can only be an expert in a limited area and may offer poor advice if reviewing a project outside of their area of expertise.
Content analysis	Using already existing documents as a data source. Documents may include reports, statistics, manuscripts, notes, artifacts, and other written, oral, or visual materials.	Low cost, allows for a large sample size, and provides access to historical information that may be difficult or impossible to research through personal contact.	Record keepers may not preserve all pertinent materials but rather selectively save those that are non-controversial or problematic. Documents must be present to examine.
Conversation analysis	Recording conversations for analysis. There may also be observations, but conversation analysis only counts if the conversation is recorded and later examined.	Ideal for use with people speaking different languages. Conversations can be archived, transcribed, and analyzed at a later date. Conversations can be recorded in person, over the phone, or online with permission of the participant.	Data can be taken out of context and harm the participant. Issues may be oversimplified when taken out of context.
Journals/logs	A personal recording of ideas, thoughts, or activities over a time span revealing the perspective of the writer. Includes blogs, diaries, written reflections, and logs.	Journals provide feedback on a specific topic or line of thought on a particular day. Data can provide an understanding of thought evolution over time. Can be examined in person or via the Internet.	May be narrowly restricted to a specific question asked and therefore may focus on a small part of the material covered on a single day. May require determination and consistency from the participant in order to maintain a stream of events.
Portfolio reviews	A collection of a participant's documents or samples of work that encompass the scope and breadth of the activity being evaluated.	Portfolio reviews show graphically the current level of the participant's knowledge/skills, where their current ideas are coming from, and how they arrived at their current level.	Portfolio reviews are labor and time intensive to analyze and interpret and usually require the use of rubrics for analysis. Documents must be present to examine.
Photographic/video data	The use of video or photographic equipment to capture images or record activities.	Ideal for use with people speaking different languages; can be archived, transcribed, and analyzed at a later date. Provide a visual record of an event or situation. Photos and video can be collected in person or online.	Visual quality depends on the skill of the researcher. Data can be taken out of context and harm the participant, and may oversimplify issues.
Literature review	A review of the critical points of current knowledge including the theoretical and methodological contributions to a particular topic.	Provides an overview of the particular subject and allows the researcher to determine what information is already available.	Sources may not be current and the review may not be focused or complete enough on a particular aspect of a topic. Can be time-consuming.
Case study analysis	In-depth investigation of an individual, group, or event. May be descriptive or explanatory.	Case studies can provide a great deal of information about a person or situation and invoke innovation, creativity, and context in situations.	Can be difficult to generalize to general phenomenon or populations because of inherent subjectivity. Can be time-consuming to coordinate.
Examine email/list serve messages	Use of content analysis to analyze email, list serve data, and messages.	Participants in different locations can share ideas. Ideal for sensitive or vulnerable groups requiring anonymity. A low-cost method allowing researchers to examine data from anywhere.	Participants require technical knowledge and access to computers and Internet.
Tests/quizzes	Tests include the use of standards to assess skills, knowledge level, or performance.	Provides insight into what the test taker knows and does not know and how their learning can be strengthened. Results are easy to quantify and compare across groups. Tests can be administered online, via phone, through mail, or in person.	Tests focus on surface learning and memorization, not on the understanding of principles and relationships. Language and vocabulary can introduce cultural biases.
Creative expression	The use of art forms to represent participant's thoughts or feelings through stories, dance, painting, music, and other art forms.	Allows participants freedom in expressing their feelings and emotions. Non-verbal techniques may be particularly effective when dealing with sensitive and vulnerable topics and participants.	Lacks statistical rigor and can be difficult to analyze for the researcher.

APPENDIX E: DATA COLLECTION STRATEGY

	INTENDED OUTCOME	EVALUATION QUESTIONS	INDICATORS	STUDY DESIGN	TIMELINE, PERSONNEL
1					
2					
3					
4					

APPENDIX F: CHECKLIST FOR DEVELOPING SURVEYS

Adapted from Project STAR (http://www.projectstar.org/star/Instrument_Dev/)

Name/Group Number:______________________________________

Circle: First Draft Second Draft Final Survey

1. Instrument Title

- ❑ Clear and concise words that reflect the survey's content are used.
- ❑ Program name/type of program is stated, if appropriate.
- ❑ Type of instrument (survey) is indicated.

2. Introductory Statement/Directions

- ❑ Survey's purpose is stated.
- ❑ Information about how the data will be used is included.
- ❑ Level of confidentiality is stated.
- ❑ General directions on how to complete the survey are stated (e.g., when, where, and how to return the survey).
- ❑ Amount of time needed to complete the survey is stated.
- ❑ Specific directions for completing each section of the survey are stated as needed.
- ❑ Respondent is thanked for completing the survey.

3. Demographics (if applicable)

- ❑ Questions that ask respondent for relevant information about him/herself and his/her background are included (e.g., name, grade, age, teacher's name, organization/agency, gender, ethnicity).
- ❑ Length of respondents' participation in the program is asked, if appropriate.
- ❑ Date of survey completion is noted.

4. Questions

- ❑ Language that respondents understand is used (i.e., avoid jargon).
- ❑ Questions are not "double-barreled" (e.g., "Has your child's interest in school and homework habits improved?").

- ❑ Questions do not contain double negatives.
- ❑ Questions are not leading, value-laden, or biased.
- ❑ Questions are short, clear, complete, and specific.
- ❑ Response format is appropriate to questions asked.
- ❑ Questions collectively provide the information you intended to collect and the information you need.

5. **Format**
   - ❑ Questions are grouped into coherent categories by themes or types of questions or responses.
   - ❑ Question and answer options are on the same page.
   - ❑ Font is legible and big enough to be read easily.
   - ❑ The instrument is attractive but not too "busy."
   - ❑ Icons or graphics are used as clarifiers, if appropriate (e.g., Place a check in the appropriate box.)
   - ❑ There is enough space between the questions.
   - ❑ There is enough space for respondents to complete open-ended questions.
   - ❑ There is space for additional comments or suggestions.

If developing an original survey:

6. **Pilot Testing**
   - ❑ Survey is clearly labeled as a "DRAFT."
   - ❑ Respondents understood the directions, including the tasks required and the answer format.
   - ❑ Respondents understood the wording of the questions.
   - ❑ Respondents understood the terms and concepts included in the questions.
   - ❑ Respondents interpreted the questions as you intended.
   - ❑ Respondents were willing and able to complete the survey.
   - ❑ Additional feedback:

APPENDIX G: BASIC DEMOGRAPHIC QUESTIONS

We would like to know a little more about you so that we can be sure we have reached a broad mix of people. Please answer these few questions about yourself.

1. **In what year were you born? ____________________**

2. **Are you a: MALE or FEMALE?** (please circle one)

3. **Which of the following groups do you MOST identify with?**

- ❑ African-American, Black
- ❑ American Indian, Native American, or Alaskan Native
- ❑ Asian, Asian-American
- ❑ Caribbean Islander
- ❑ Latino or Hispanic
- ❑ Middle Eastern or Arab
- ❑ Native Hawaiian or Other Pacific Islander
- ❑ White, Caucasian, European American
- ❑ Multi-racial (please specify)
- ❑ Decline to answer

4. **What is the highest level of education you have completed?** (check one)

- ❑ Preschool/Kindergarten
- ❑ Elementary/Primary School
- ❑ Middle/Junior High School
- ❑ High/Secondary School
- ❑ Some College (less than four years)
- ❑ College Degree (Bachelor)
- ❑ Post-Graduate Degree (Master/PhD)

5. **What is your combined annual household income?** (Choose one response below.)

- ❑ Less than $30,000
- ❑ $30,000 – $49,999
- ❑ $50,000 – $69,999
- ❑ $70,000 – $89,999
- ❑ $90,000 – or more
- ❑ Prefer not to respond

APPENDIX H: EVALUATION PLAN WORKSHEET

PHASE 1: PLANNING—INVENTORY

A. Describe the project to be evaluated and its audience.

B. Articulate the goals and intended outcomes of the project.

C. Describe the program logic model in terms of inputs-activities-outputs-outcomes-impacts.
(See Appendix B for Logic Model Template)

Inputs:

Activities:

Outputs:

Short-term Outcomes: ____________________

Medium-term Outcomes: ____________________

Long-term Outcomes/Impacts: ____________________

D. Determine if approval by your organization's Internal Review Board (IRB) is necessary for conducting an evaluation.

- ❑ Yes
- ❑ No

PHASE 1: PLANNING—DEFINE

A. State the purpose of the evaluation and what you hope to learn as a result of it.

B. Who are the stakeholders? What do they want to learn from the evaluation and how will the findings be used?

C. Develop and prioritize key questions that you hope will be answered as a result of the evaluation.

QUESTIONS	REQUIRED RESOURCES	TIME REQUIRED	VALUE OF THE INFORMATION	PRIORITY

D. Determine the indicators for the outcomes you intend to measure.

Outcome 1: ______________________________

____

____

____

Outcome 2: ______________________________

____

____

____

Outcome 3: ______________________________

____

____

____

E. Construct a timeline for the evaluation. (Include major milestones.)

MILESTONE	STAFF INVOLVED	DUE DATE
Hold initial meetings with stakeholders		
Identify key people		
Obtain IRB approval		
Draft scope of work and budget outline		
Refine Goals, Outcomes, Indicators		
Develop Logic Model, Theory of Change		
Develop and prioritize evaluation questions		
Determine indicators		
Develop study design and data collection strategy		
Deliver draft evaluation plan to stakeholders, refine if needed		
Obtain existing or develop draft instruments		
Share instruments with stakeholders, refine if needed		
Pilot draft instruments (if applicable)		
Refine instruments (if applicable)		
Begin pre/post data collection		
Gather & clean (pre/post) data		
Analyze (pre/post) data		
Review other pertinent data sources		
Discuss preliminary findings with stakeholders		
Draft and disseminate final report		
Secure data according to data management plan		
Implement evaluation findings		

F. Construct a rough budget for the evaluation

	TIME ESTIMATE	COST ESTIMATE
Staff salary and benefits		
Consultants, experts		
Travel		
Postage/Phone		
Printing/Duplication		
Supplies and equipment		

PHASE 1: PLANNING—DESIGN

A. Determine your overall study design (see **TABLE 3** for strengths and weaknesses of various study designs).

- ❑ Quantitative
- ❑ Qualitative
- ❑ Mixed Methods

B. For each outcome you intend to measure, determine the population to sample from and the appropriate sample size (see www://research-advisors.com for a table of suggested sample sizes).

- Population of interest:
- Acceptable confidence interval:
- Acceptable margin of error:
- Sample size needed:

C. Draft the Data Collection Strategy. For each outcome, include information about the indicator, data collection methods to be used, the source of the data, the sample size needed, and the timeline for data collection.

INDICATOR	DATA COLLECTION METHOD	SOURCE OF DATA	SAMPLE SIZE	TIMELINE

PHASE 2: IMPLEMENT–DEVELOP

A. Articulate the construct of interest and develop draft instruments, if necessary, or document sources for other original work.

Define constructs of interest:

Cite possible existing sources of instruments:

B. Describe the attributes of the instruments and the rationale for selection.

C. Review Appendix F (Checklist for Developing Surveys, if necessary)

PHASE 2: IMPLEMENT–TEST

A. Pilot and/or field test draft instruments and refine as needed based on test results:

INSTRUMENT NAME	PILOT OR FIELD TEST?	AUDIENCE	SAMPLE SIZE	DATE ADMINISTERED	RESULTS

B. Document any changes to the instrument based on pilot and field tests:

PHASE 2: IMPLEMENT–ADMINISTER

A. Describe participant recruitment efforts.

B. Document your data collection efforts:

DATA COLLECTION METHOD	AUDIENCE	SAMPLE SIZE	DATE ADMINISTERED	RESULTS

PHASE 3: SHARE–ANALYZE AND INTERPRET

Make a copy of the original raw data and a working file of the data.

Master file name: ______

Master file location: ______

Working file name: ______

Working file location: ______

QUANTITATIVE DATA (NUMERICALLY-BASED DATA)

- ❑ A. Create a codebook for organizing all your data
- ❑ B. Determine software to use and types of statistical procedures to employ
- ❑ C. Summarize the data using descriptive statistics

QUALITATIVE DATA (TEXT AND IMAGE-BASED DATA)

- ❑ D. Determine the procedure for data analysis
- ❑ E. Determine what type of software to use
- ❑ F. Employ data reduction techniques

MIXED METHODS DATA

- ❑ G. Compare and contrast qualitative and quantitative data
- ❑ H. Synthesize mixed methods data
- ❑ I. Analyze separately

PHASE 3: SHARE–REPORT

- ❑ A. Executive Summary
- ❑ B. Program Description
- ❑ C. Evaluation Methodology
- ❑ D. Findings and Results
- ❑ E. Discussion/Interpretation
- ❑ F. Recommendations
- ❑ G. References
- ❑ H. Appendices

PHASE 3: SHARE–DISSEMINATE

- ❑ A. Share with stakeholders
- ❑ B. Consider publishing
- ❑ C. Inform your program

APPENDIX I: GLOSSARY OF TERMS

Activities—Tasks described in a logic model that use inputs (resources) and directly relate to outputs and outcomes.

Bias—Systematic errors that can negatively influence research results such as measurement or sampling-related errors.

Coding—A procedure to transform raw data into a form that can facilitate data analysis; used often to categorize text-based, qualitative data into common themes, concepts, or phrases.

Construct—A psychological attribute or latent variable that cannot be measured directly, such as happiness or interest, but only through a set of measurable indicator variables.

Convenience sample—A sample acquired based on who is available or where they are located.

Data management plan—A document that outlines the processes for collecting, storing, and analyzing data.

Descriptive statistics—Methods used to describe basic features of a particular set of data including the mean, median, mode, range, and standard deviation.

Evaluation—The systematic collection of information to determine strengths and weaknesses of programs, projects, and products so as to improve their overall effectiveness.

Executive summary—A very brief overview and description of a longer report, such as a final report. The executive summary typically describes the program structure, purpose, and results.

Formative evaluation—A type of evaluation that occurs during project development and provides direction for improving implementation and operation. Findings may result in changes to project structure and/or implementation (also called process or implementation evaluation).

Front-end evaluation—A type of evaluation that occurs during the defining phase of a project to obtain baseline information about an audience. Findings help to inform project goals and objectives that can be aligned with audience needs/interests (also called needs or feasibility assessment).

Generalizability—The extent to which research results from a sample can be applied to the larger population, sometimes referred to as "ecological validity."

Goals—Broad and abstract statements describing a desired result, e.g., "appreciation for science" or "increase interest in technology."

Impacts—Long-term outcomes that are broad in scope, aimed at expanding knowledge and capacity for a particular field of study, and meant to provide benefits to society.

Indicators—Specific criteria for measuring success. Indicators should articulate how you will define and measure success in reaching your outcomes.

Individual learning outcomes (ILOs)—Measurable changes to project participants, including "cognitive outcomes" (the things people know), "affective outcomes" (how people feel), and "behavioral outcomes" (what people do).

Inferential statistics—Methods of analysis that allow researchers to make inferences and test hypotheses about relationships in a sample that are likely to occur in a population.

Informed consent—A procedure for obtaining permission for voluntary participation in a research study, usually by way of a signed form that clearly describes the study and its risks and benefits.

Inputs—Resources dedicated to or consumed by a project; typically things like funding agencies, scientists, staff, volunteers, and technology infrastructure.

Institutional Review Board (IRB)—A committee charged with protecting the rights and welfare of people involved in research. Associated with biomedical service, but behavioral and survey research also fall under the category of research involving human subjects.

Instrument—In evaluation research, a tool used to collect and organize information either through self reports or observation. Examples include survey questionnaires, behavioral rating scales, tests, checklists and inventories, psychometric instruments, and rating scales.

Likert-type scale—Used to ascribe quantitative value to qualitative data, this is a type of psychometric response scale commonly used in surveys to obtain a participant's preferences or degree of agreement with a statement or set of statements.

Logic model—A graphical representation of a project that shows the relationships between each project component and the expected outcomes; helps to articulate programmatic objectives and strategies; and focuses attention on key interventions and intended outcomes. Usually presented as inputs, activities, outputs, outcomes, and impacts.

Outcomes—The changes that a project is intended to produce in individuals, groups, or communities as a result of participation. Targeted and more specific than goals, outcomes refer to concrete and measurable statements and are used to determine if goals were met.

Outputs—Direct products, or by-products, of the stated activities that demonstrate immediate results of activities. Easy to quantify and focus on things done by participants.

Population—The entire target group under consideration that has specified criteria or properties. Entire populations are often impossible to study, so most researchers draw a sample from the population at large.

PPSR—(Public Participation in Scientific Research) Scientific investigation that engages the general public in asking questions, developing research projects, collecting/analyzing data, and presenting findings.

Purposeful sample—A type of sampling method that does not rely on randomness or representativeness, aimed at obtaining information from a specific group.

Qualitative data—Non-numerical data collected in the form of text and images.

Quantitative data—Information that is collected in numerical form and can be analyzed using statistical methods.

Questionnaire—A type of data collection instrument presented as part of a useful set of questions in a survey.

Reliability—Describes the overall consistency of a measure or instrument; reliability is high if similar results are produced across time and across similar groups.

Sample—The subset of a larger group or population that is considered representative of the population.

Sampling—The process of selecting a subgroup that represents the population from which it is drawn. Sampling varieties where there is an equal probability for selection include: simple random sampling, systematic sampling, and cluster sampling. Non-probability sampling techniques include: convenience sampling, quota sampling, and snowball sampling.

Scale—In survey research, a set of questions that attempt to measure different levels of a single construct (or in the case of subscales, multiple related constructs) within a population.

Stakeholders—Persons or organizations with an interest in the project; e.g. funding sources and employers.

Stratified sample—A sample that illustrates particular characteristics of a subgroup; can be random or purposeful.

Summative evaluations—A type of evaluation that occurs once a project has been established. Used to describe project value, outcomes, and to determine effectiveness. Findings help to determine if the project's stated goals and target outcomes have been accomplished (also known as outcome or impact evaluation).

Survey—A methodological process that involves sample design, data collection, and data analysis and interpretation that is aimed at gathering systematic information about a defined population, typically through interviews or questionnaires.

Theory of Change—A technique for outlining how project activities will lead to desired outcomes by formulating "if…then" statements. Theory of Change should describe the target population, desired results, activities, context, and assumptions.

Validity—The extent to which a concept, conclusion, or measurement is well-founded and corresponds accurately to the real world; i.e., an instrument correctly measures what it is supposed to. There are many types of validity including face, content, criterion-related, construct, internal, and external validity.

APPENDIX J: REFERENCES

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APPENDIX K: ADDITIONAL RESOURCES FOR USE IN PLANNING AND CONDUCTING PROJECT EVALUATION

CHECKLISTS, GLOSSARIES, TIPS, AND WORKSHEETS

Evaluation Design Checklists (Western Michigan University)

Study Design and Data Collection Worksheet (CAISE, see page 3)

Research and Evaluation Glossary (Colorado State University)

Quick Tips for Evaluation (University of Wisconsin Cooperative Extension)

CULTURALLY RESPONSIVE EVALUATION

Navigating the Complexities of Research on Human Subjects in Informal Settings (informalscience.org)

Tips for Culturally Sensitive Evaluation (University of Wisconsin Cooperative Extension)

DATA ANALYSIS AND INTERPRETATION

Analyzing Qualitative Data (University of Wisconsin Cooperative Extension)

Using Excel for Analyzing Survey Data (University of Wisconsin Cooperative Extension)

Analyzing Retrospective Pre Data (University of Wisconsin Cooperative Extension)

Understanding Statistics Tutorial (Education Commission of the States)

DATA COLLECTION AND METHODS

Data Collection Overview (NOAA "Designing Education Projects," 2nd ed. 2009, see page 57)

Methods for Collecting Information Tip Sheet (University of Wisconsin Cooperative Extension)

Guide to Sampling (University of Wisconsin Cooperative Extension)

ETHICS

American Evaluation Association Guiding Principles for Evaluators (AEA)

Ethics in Research (Research Methods Knowledge Base)

Does Evaluation Require IRB? (Oregon State University)

EVALUATION REPORTING

Writing an Evaluation Report (University of Illinois at Chicago)

Quality Criteria for Reports (Online Evaluation Resource Library)

Evaluation Report Template (South Australian Community Health Research Unit)

GENERAL EVALUATION GUIDANCE

The PI Guide to Managing Evaluation (CAISE)

The 2010 User-Friendly Handbook for Project Evaluation (NSF)

Planning a Program Evaluation (University of Wisconsin Cooperative Extension)

Visitor Studies Association "Find an Evaluator" Database (VSA)

LOGIC MODELS

Development of Logic Models (W. K. Kellogg Foundation)

Logic Model Worksheets (University of Wisconsin Cooperative Extension)

STUDY DESIGN

Study Designs for Program Evaluation (Project STAR)

Evaluation Designs Common in Measuring Outcomes (University of Wisconsin Cooperative Extension)

National Science Foundation Framework for Evaluating Impacts of ISE Projects (NSF)

Using Comparison Groups (University of Wisconsin Cooperative Extension)

SURVEY DESIGN

Questionnaire Design (University of Wisconsin Cooperative Extension)

Collecting Survey Data (University of Wisconsin Cooperative Extension)

Best Practices for Survey Research (Ithaca College)

Visit www.citizenscience.org/evaluation for tools to measure learning outcomes from citizen-science projects.

The Cornell Lab of Ornithology

www.birds.cornell.edu

Cornell University