

INTRODUCTION

Native bees and honeybees are crucial for sustainable productivity in natural, agricultural, and urban ecosystems, contributing over \$200 billion worldwide in revenue from vegetable, fruit, nut, meat, and dairy production (Gallai, 2009). Colorado is home to 946 bee species belonging to 66 genera (Scott et al., 2011). In addition to the challenges created by pesticides and climate change, rapid urbanization in Colorado and beyond reduces natural habitats with valuable forage and nesting resources for bees. More effort is needed to increase public awareness and engagement with pollinators.

An opportunity exists to build the public's capacity to support pollinator conservation through population monitoring and informal STEM education. One educational approach is community science, which aligns with Extension (Clyde et al., 2018).



Figure 1. A bumble bee (*Bombus* sp.).

Native Bee Watch (NBW), an existing community science training program offered through Colorado State University (CSU) Extension, enables volunteer community scientists to identify and monitor bees in public and backyard gardens.

STUDY GOAL

Redesign NBW from an in-person to fully online program and respond to the research question: How did volunteers perceive the training, support materials, and subsequent bee monitoring experience?

PROGRAM REDESIGN

Key components of the 2020 NBW online community science program:

- Volunteers monitored bees at their residence instead of designated public gardens in Larimer and Arapahoe counties
- Survey123, an ArcGIS data collection tool
- Live and recorded trainings and seminars
- Online quiz to assess insect ID skills
- Volunteer resource portal
- Social media



Figure 2. A volunteer collecting data.

METHODS

Participants and Data Collection. In this qualitative study, we recruited 2020 NBW volunteers who (1) completed a pre-season survey, (2) passed an online photo ID quiz, and (3) submitted data by mid-July. We interviewed participants on Zoom in late summer 2020 with separate protocols for new and past volunteers, as shown in Figure 3. We collected participant demographics from pre-season surveys.

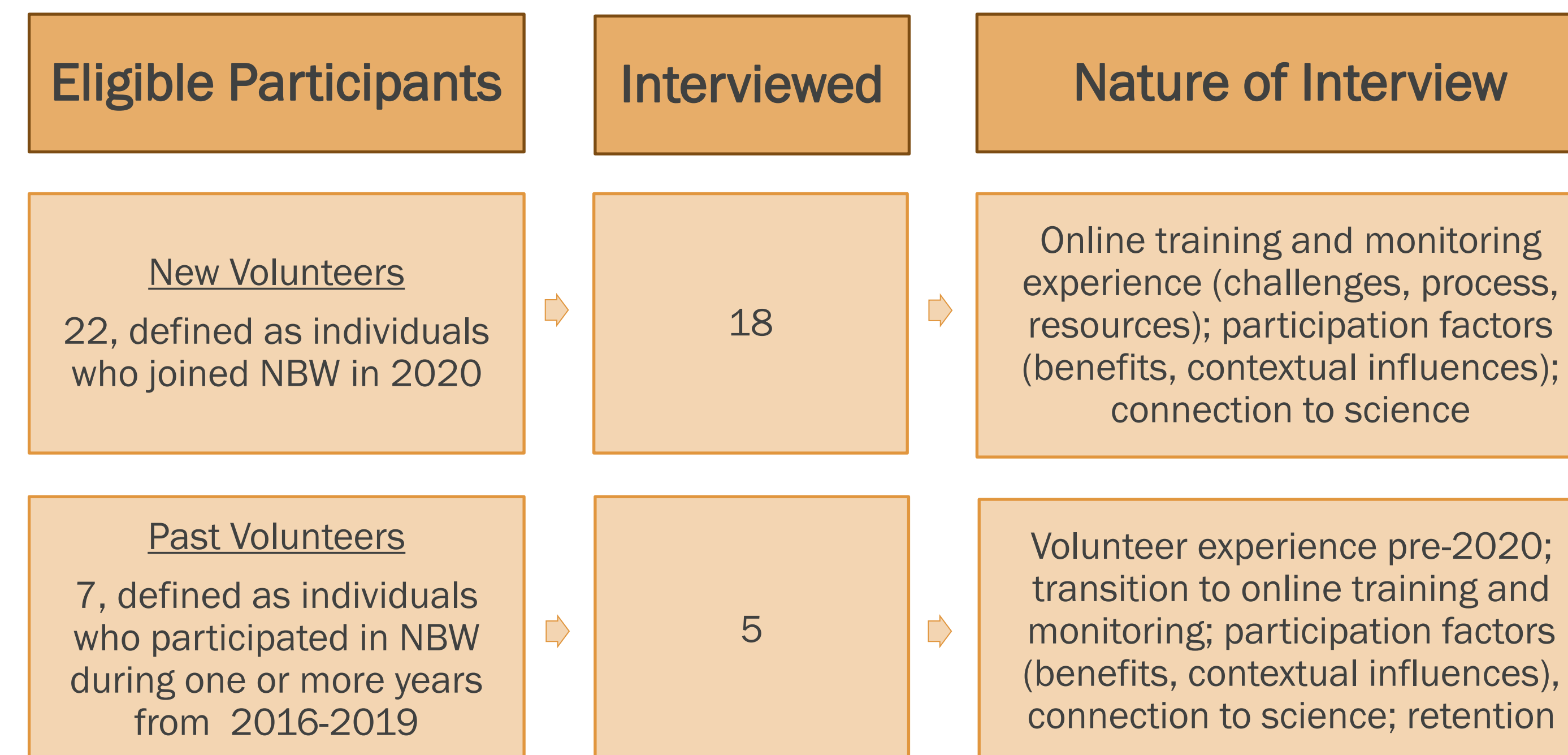


Figure 3. Participant recruitment and data collection procedures.

Participant Demographics. Most participants identified as female (83%), ages 55 years or older (83%), white (96%), and have earned a bachelor's (43%) or master's degree (39%, $n = 23$).

Data Analyses. We transcribed interviews verbatim. Three researchers unitized and applied *a priori* codes; average interrater reliability was 74%. Vilen revised the codes, conducted a second round of coding, and analyzed coded categories and demographic data in Excel.

FINDINGS

Transitioning to an online format expanded access to informal adult STEM learning opportunities across Colorado.

NBW had 80 active volunteers in 2020, an increase of over 200% from the program's historic high of 25 volunteers in 2017.

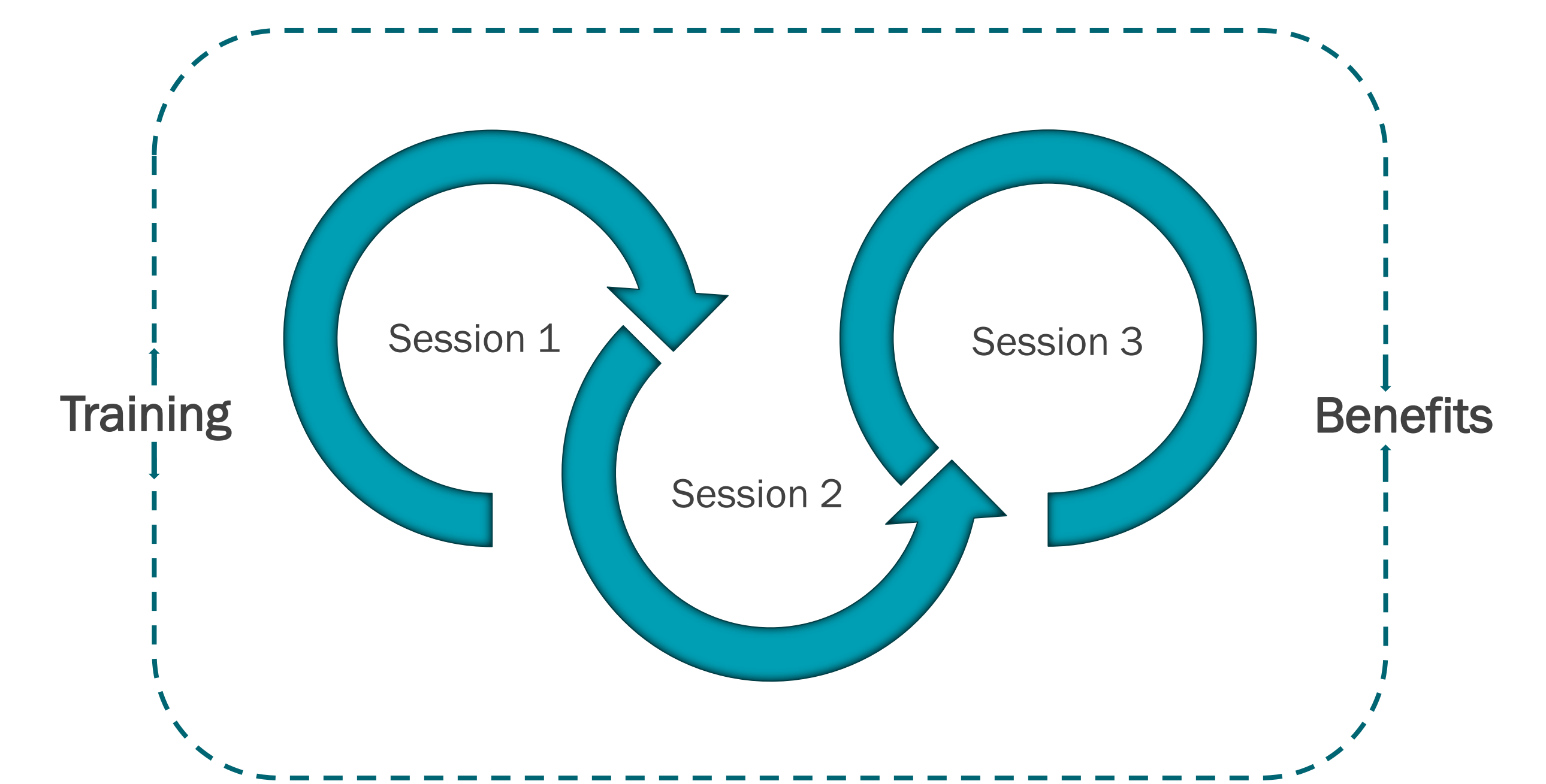
- Past and new volunteers had favorable reactions to the training webinar and shared similar experiences in 2020 (Figure 4), although new volunteers relied more heavily on self-assessment.
- Some past volunteers expressed skepticism about data accuracy and learning bee identification in the online format, which limited the availability of immediate and direct feedback compared to the prior in-person format.

Figure 4. Monitoring is an Experiential, Self-Directed Process

The first time it was confusing, but it was doable. And with practice, it's working. ~ Anne

It's kind of like an open book test and you can go out and take data and then come back and do some further research to get it right...That was my mode of operation...I got more familiar with the species that we were dealing with here in my particular geographic location. And so I was more confident of identifying them...my time doing the research for identification was much reduced as we got into those later of observations. ~ James

Building Confidence and Skills Through Practice and Self-Assessment



Recognizing Challenges, Identifying Resources

Being able to see the bee well enough in the short amount of time you have to identify it. ~ Alan

I wasn't able to transfer and say this is equal to that...too many resources where I got confused because things were described differently. ~ Karen

Having a camera was handy, that sure did help, so that way you get a picture of what you have a question about. ~ Sharon

I have a pretty strong ecology biology background, you know...and so identifying something, even to a species level is something I've done a lot. ~ Erika

CONCLUSION & IMPLICATIONS

This natural experiment illuminates the affordances and constraints of an online community science program.

- Requires a high level of self-direction and ability to self-assess.
- Feedback processes are limited, impacting volunteers' motivation and engagement.

Future directions should focus on developing feedback systems that support (a) volunteers' confidence, knowledge, and skills and (b) scientific data accuracy.

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