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Determining Environmental Extension Programming Effectiveness and Reach Following Assessment of a Natural Resources Webinar Series

Abstract

Extension is important in educating the public about science-based good practices for environmental protection. The “Earth Day, Every Day” webinar series was implemented to address environmental topics and covering actions people can take to address specific issues. Short, free online programming proved to be effective for increasing the adoption of good practices. On a practice-by-practice basis, the intention to implement a practice only moderately predicted actual implementation, suggesting that surveys of asking about intention to adopt may not be sufficient in assessing program impacts. Practices with the lowest adoption rates included some that may be relatively difficult to implement, suggesting that education needs to also include those practices that can be readily adopted by participants. The implementation of practices was also correlated to knowledge about the corresponding topic, suggesting that education and continuing education is important in effecting practice adoption. Relative to the state population,

audience members were overrepresented in the categories of 45 or older, female, and White, indicating the need to reach non-traditional audiences following diversity, equity, and inclusion goals.

Abbreviations: *CE experience* – previous attendance in Cooperative Extension programming; *PNTA* – prefer not to answer; *VDA* – Vargha and Delaney's A; *WMW* – Wilcoxon–Mann–Whitney test

Keywords: Behavior Change**;** Demographics**;** Extension Education; Knowledge Gain**;** Native Plants; Natural Resources; Online**;** Webinar

Introduction

Extension programming in environmental protection in New Jersey has historically focused on traditional audiences through regular, in-person, and, sometimes, service-based volunteer training (Master Gardeners, Environmental Stewards, 4-H clubs, etc.). Free, online Extension programming that is open to the public and focuses on environmental protection has been absent in New Jersey, with a few exceptions, including Kluchinski et al. (2011) and Zemeckis (2021).

New Jersey's intense industrial and urban growth has made it the most densely populated state in the country, leading to many competing uses and users of its natural resources. The state was one of the first to enact legislation on air pollution, land conservation, flood hazards, and hazardous substances. More recently, the state has adopted strict fertilizer and stormwater reduction laws to protect water quality, eliminated plastic and paper bags in supermarkets, and adopted mandatory climate change education for K–12 students. In addition, the climate in the Northeast U.S. is predicted to change dramatically in the next 100 years, as the Northeast U.S. is warming faster than other regions of the country (NJDEP, 2020). The state has enacted aggressive goals of 100% clean energy and a reduction in greenhouse gas emissions of 80% by 2050 (NJDEP, 2019 and 2023). These efforts can only have a lasting effect on environmental protection if the public is educated on these topics. Public, science-based

environmental education is needed to reinforce sustainable practices as new and changing policies are implemented (McCann et al., 2020).

Environmental education is the most effective means to help citizens understand the web of connections between their own health and well-being and that of our society, our environment, and our economy (NEEAC, 2000). The key purpose of environmental education is to convince people to act as environmental stewards within their homes and communities. Numerous studies have shown that to achieve this, more needs to be done than simply providing knowledge about environmental problems and their impacts (Ardoin et al., 2020; Sass et al., 2023). There is also a need to teach people about available solutions and which solutions are the most effective in a particular context (Ardoin et al., 2020). Environmental education should provide students with the necessary skills to implement those solutions and provide adequate support to allow them to overcome situational factors such as economic constraints or social pressures influencing whether people move from passive learners to actively implementing practices (Boyes and Stanisstreet, 2011).

Rutgers Cooperative Extension's mission is to help the diverse population of New Jersey adapt to a rapidly changing society and improve their lives and communities through an educational process that uses science-based knowledge (Rutgers Cooperative Extension, 2023). To achieve this mission, it is critical to provide supporting data about the effectiveness of programming to show Extension's impact on public behavior change.

An "Earth Day, Every Day" online webinar series was implemented based on these needs. Knowledge gain, intention to adopt good practices, and actual adoption of practices were assessed. Although online programming has become commonplace in Extension, questions often arise about the effectiveness of virtual education (Anderson et al., 2020; Vilen et al., 2023). This article examines the effectiveness of short, online programming for impacting environmental behavior change, attracting new, non-traditional audiences, and improving the practices of traditional audiences.

Methods

Webinar series and surveys

The “Earth Day, Every Day” series included 42 live webinars held in the spring and fall from April 2020 to November 2022 by 32 topic area experts, including Extension educators, other university faculty, government professionals, and non-profit staff. Webinars were approximately one hour long on Monday evenings. Each week, a different topic was covered with specific good practices that individuals or communities could adopt to address the issue. In the first two years, topics were chosen based on what an individual could do at home due to COVID-19 restrictions. As restrictions eased, in the third year, the series was expanded to focus more on community-level actions specific to climate change. All webinars were recorded and made available on YouTube (Google, San Bruno, CA) for public viewing. Table 1 summarizes the topics covered, the number of attendees, and the views of the recordings.

Live polls were conducted at the end of each session, where participants were asked up to four self-assessed knowledge gain questions based on program content (scale 1–5; 1=strongly disagree, 5=strongly agree). In total, 105 knowledge gain topics were assessed across all 42 webinars. Participants were also asked about their intention to adopt between two and eight practices per webinar, with 204 practices across all webinars. An online follow-up survey assessed the actual adoption of practices and demographic information. This survey was sent approximately one year after the program to 3,438 participants for 2020 and 2021 programs, resulting in 415 responses consenting to have their information used (13% response). Surveys were approved by the Institutional Review Board at Rutgers University, New Brunswick (IRB ID # Pro2020001422) before participant recruitment.

Webinars and live polls were hosted on either Webex (Cisco Webex, San Jose, CA) or Zoom (Zoom Video Communications, San Jose, CA). The follow-up survey was conducted with Qualtrics software (Qualtrics International, Provo, UT).

Statistical analysis

Statistical analyses were conducted in R (R Core Team, 2022) using the packages *coin*, *DescTools*, *emmeans*, *dplyr*, *FSA*, *ordinal*, *rcompanion*, *stats*, *stringr*, and *tidyr*. Plots were produced using the *ggplot2* package.

For respondent categories of *Age*, *Race*, and *Gender*, responses were counted and compared to proportions of these categories in New Jersey's population (USCB 2002a, 2002b), using goodness-of-fit chi-square analysis by Monte Carlo simulation with 1,000,000 replications. As a post-hoc analysis, 95% multinomial confidence intervals for categories were determined with the Sison–Glaz method (Sison and Glaz, 1995; Signorell, 2022).

The association of previous attendance in Cooperative Extension programming with demographic categories, adoption of good practices, and knowledge gain was assessed using chi-square analysis, chi-square analysis by Monte Carlo simulation, linear-by-linear test for ordered categories (Agresti, 2002; Hothorn et al., 2006), or ordinal regression (Christensen, no date; Mangiafico, 2016), as appropriate.

Live poll responses for instruction and content rating were pooled across all webinars. Self-assessed knowledge gain questions were pooled across respondents and webinars, and responses were not treated as paired within respondent. An increase in knowledge was assessed with the Wilcoxon–Mann–Whitney test (WMW), and effect size was assessed with Vargha and Delaney's *A* (VDA) (Vargha and Delaney, 2000; Mangiafico, 2022). VDA is the probability that observation in *After* will be greater than observation in *Before*, adjusted for ties. It is used as an effect size statistic for WMW.

Responses to the planned adoption of good practices from the live polls were matched to similar topics for actual implemented practices from the follow-up survey. In some cases, multiple planned practices were paired with a single implemented practice. In these cases, results for planned practices were pooled to make a single observation, resulting in 34 good practices.

Results

Webinars, attendance, and YouTube views

As of January 4, 2024, total webinar attendance across all sessions was 5,079, with an additional 5,168 views via YouTube (Table 1).

Table 1. Topics, attendees, and views of recordings for the webinar series.

Year	Season	Number of webinars	Attendees	Recorded webinar views	Topics
2020	Spring	11	2462	1004	Soil compaction, Lawn care, Wildlife habitat at home, Vegetable gardening, Food waste, Reducing plastic waste, Invasive plants in your yard, Exploring your watershed from home, Composting, Ticks and Lyme disease, Harmful algae blooms
2020	Fall	8	550	724	Home energy efficiency, Collecting native seeds, Fall lawn care, Defensive driving for wildlife, Home energy audit, Adapting to coastal flooding, Halloween wildlife, Home recycling
2021	Spring	8	943	883	Native plant gardening, New Jersey marine resources, Deer management, Baby animal wildlife, Eco-therapy, Home stormwater management, Food systems and climate change, Urban forests
2021	Fall	8	403	1165	Spotted lantern fly, Rain gardens, New Jersey's plastics law, Citizen science, Lead in garden soils, Combined sewer overflows, Urban wildlife, Road salts
2022	Spring	1	76	329	The costs of climate change
2022	Fall	6	645	1063	Climate change and storm events, Coastal community resilience, Adapting to climate change, Living shorelines, Coastal flooding and agriculture, Marine debris response

Self-assessed knowledge gain

There were 3,461 respondents that consented for their data from live polls to be used in research (91%). Because there were multiple knowledge gain topics per webinar, there were 7,522 responses to *Before* questions (Table 2).

Across all webinars and knowledge topics, ratings for *After* were significantly higher than for *Before*, with a median response of “Neutral” before and a median response of “Strongly agree” after (n = 14984, WMW $p < 0.0001$, VDA = 0.781).

For all 42 topics, treated individually, with multiple questions in a topic pooled, ratings for *After* were significantly higher than for *Before* ($p \leq 0.05$, *VDA* = 0.583–0.908, mean *Before* = 2.00–4.35, mean *After* = 3.88–4.76) (Table 2).

Table 2. Self-assessed knowledge gain scores (strongly disagree = 1 to strongly agree = 5) from live polls. *p*-values are from Wilcoxon–Mann–Whitney tests, and Vargha and Delaney’s *A* (VDA). Results are sorted by VDA within broad topic areas.

Topic	***n***	**Mean Score Before**	**Mean Score After**	***p*-Value**	**VDA**
Climate Change					
Marine debris response	64	2.03	4.02	< 0.0001	0.908
Coastal flooding and agriculture	114	2.71	4.17	< 0.0001	0.853
Coastal community resilience	237	3.07	4.25	< 0.0001	0.830
Living shorelines	195	3.35	4.52	< 0.0001	0.809
Adapting to climate change	156	3.15	4.11	< 0.0001	0.777
Climate change and storm events	285	3.55	4.14	< 0.0001	0.686
The costs of climate change	72	3.93	4.40	0.0098	0.648
Energy					
Home energy audit	93	2.55	4.37	< 0.0001	0.868
Home energy efficiency	91	2.78	4.33	< 0.0001	0.840

Topic	*n*	Mean Score Before	Mean Score After	*p*-Value	VDA
Food					
Food waste	471	2.95	4.56	< 0.0001	0.858
Food systems and climate change	102	4.04	4.76	< 0.0001	0.739
Insect and Pest Management					
Ticks and Lyme disease	324	3.09	4.42	< 0.0001	0.819
Spotted lantern fly	147	3.25	4.50	< 0.0001	0.746
Native Plants					
Collecting native seeds	140	3.04	4.44	< 0.0001	0.878
Urban forests	148	3.23	4.54	< 0.0001	0.802
Invasive plants in your yard	327	3.32	4.40	< 0.0001	0.790
Native plant gardening	316	3.86	4.58	< 0.0001	0.690
Nature Therapy					
Eco-therapy	138	3.36	4.68	< 0.0001	0.847
Plastics					
New Jersey plastics law	90	2.90	4.53	< 0.0001	0.840
Reducing plastic waste	195	3.57	4.56	< 0.0001	0.819
Home recycling	145	3.86	4.49	< 0.0001	0.701
Soil					
Lead in garden soils	34	2.21	4.29	< 0.0001	0.903
Soil compaction	336	3.14	4.55	< 0.0001	0.869
Volunteering					
Citizen science	63	2.60	4.60	< 0.0001	0.902

Topic	*n*	Mean Score Before	Mean Score After	*p*-Value	VDA
Water					
Exploring your watershed from home	182	2.00	3.88	< 0.0001	0.897
Rain gardens	74	2.53	4.30	< 0.0001	0.883
Harmful algae blooms	179	2.55	4.35	< 0.0001	0.870
Combined sewer overflows	28	2.71	4.61	< 0.0001	0.869
New Jersey marine resources	60	2.88	4.30	< 0.0001	0.821
Road salts	48	3.52	4.75	< 0.0001	0.820
Home stormwater management	162	3.6	4.59	< 0.0001	0.804
Adapting to coastal flooding	78	2.91	4.35	< 0.0001	0.838
Wildlife					
Defensive driving for wildlife	99	2.73	4.67	< 0.0001	0.906
Halloween wildlife	88	3.24	4.59	< 0.0001	0.873
Baby animal wildlife	98	3.07	4.50	< 0.0001	0.826
Deer management	116	3.37	4.53	< 0.0001	0.754
Wildlife habitat at home	421	3.89	4.47	< 0.0001	0.682
Urban wildlife	72	4.35	4.51	0.0428	0.583
Yard Care					
Environmentally friendly lawn care	241	3.00	4.23	< 0.0001	0.844
Composting	323	3.83	4.70	< 0.0001	0.769
Vegetable gardening	802	3.42	4.28	< 0.0001	0.755
Fall lawn care	168	3.92	4.60	< 0.0001	0.720

Intention to implement good practices

Across the 204 good practices included in the live polls, the proportion of respondents intending to implement a given practice ranged from 9% to 96%, with a median of 59%.

Practices implemented, improved, or planned

Out of 34 good practices addressed in the follow-up survey, some practices were implemented by many respondents after attending the series (*n* = 87 to 174 respondents across practices, median for *Adopted* = 40%, with a range of 11%–78%, Table 3). Table 3 lists the good practices taught during the webinar and whether the respondents adopted the action or improved what they were already doing.

Table 3. Practices adopted, improved, or planned by webinar attendees, reported approximately one year after attendance. Practices are sorted by percent adopted or improved.

Rank for *Adopted* or *Improved*	**Practice**	***n***	**Percent *Adopted***	**Percent *Improved what I was already doing***	**Sum of percent *Adopted* or *Improved***	**Percent *No, but planning to***	**Percent *No***
1	Taken actions to reduce your use of plastics [examples]	98	78 %	18 %	96 %	2 %	2 %
2	Left wildlife in the wild, and not intervened unless the animal is clearly injured or orphaned	91	66	19	85	7	9
3	Reduced your food waste at home	174	54	29	83	3	14
4	Cut back on your use of single-use plastics	174	56	28	83	4	13
5	Incorporated native plants into your yard	102	59	25	83	11	6
6	No longer fed deer and/or landscaped with deer-resistant vegetation	94	52	30	82	5	13
7	Used nature walks/ecotherapy to relax	93	65	15	80	11	10
8	Killed a spotted lanternfly or scraped spotted lanternfly egg masses off trees	98	72	6	79	5	16
9	Taken steps to reduce your need for road salt at home [examples]	92	52	24	76	4	20
10	Changed how you recycle materials from your home	174	44	32	75	3	22

Rank for *Adopted* or *Improved*	**Practice**	***n***	**Percent *Adopted***	**Percent *Improved what I was already doing***	**Sum of percent *Adopted* or *Improved***	**Percent *No, but planning to***	**Percent *No***
11	Maintained your lawn using environmental practices	174	44	30	74	7	19
12	Planted native plants in your landscape	174	60	14	74	14	12
13	Explored and adopted new recipes that include more plant-rich foods	93	53	18	71	8	22
14	Created wildlife habitat on your property	174	45	24	69	9	22
15	Started a vegetable garden at home	174	40	29	69	7	24
16	Removed invasive plants from your property	174	49	17	67	14	20
17	Started composting at home	174	31	34	65	9	26
18	Taken actions keep you, your family, and pets safe from ticks	174	49	14	63	7	30
19	Managed your soil to reduce compaction	174	39	23	61	15	24
20	Taken steps to make your home energy efficient	174	37	22	59	17	24
21	Worked to reduce stormwater runoff and protect water quality where you live	90	40	19	59	17	24
22	Kept pets indoors (especially cats) to prevent them from harming wildlife	88	44	15	59	1	40
23	Changed your driving practices to avoid wildlife collisions	174	28	19	47	14	40
24	Collected native plant seeds to plants in your yard	174	32	10	43	16	41
25	Changed your property to reduce stormwater runoff	174	24	18	41	13	46

Rank for *Adopted* or *Improved*	Practice	*n*	Percent *Adopted*	Percent *Improved what I was already doing*	Sum of percent *Adopted* or *Improved*	Percent *No, but planning to*	Percent *No*
26	Purchased seafood harvested or grown in New Jersey]	88	28	12	41	20	39
27	Managed your property to reduce flooding	174	19	15	34	13	53
28	Made a map of your property, identifying trees and determined if they are native	93	22	13	34	33	32
29	Used online tools to explore your local watershed	174	22	5	26	21	53
30	Installed a rain barrel in your home	90	16	10	26	28	47
31	Designed or installed a rain garden in your home or community	91	13	10	23	24	53
32	Conducted a home energy audit	174	13	8	21	23	56
33	Tested your soil for lead or other contaminants	88	16	2	18	27	55
34	Viewed the SciStarter website [URL] to find projects nearby that interest	87	11	1	13	30	57

Comparison of intention to implement practices to practices implemented

We considered “implemented” practices as those either adopted or improved following webinar attendance. The rates of implemented practices were moderately correlated to planned practices (n = 34 practices in the follow-up survey or groups of planned practices in the live polls, p = 0.016, Spearman’s *rho* = 0.423, 95% confidence interval = 0.049–0.70). Across practices, implementation rates had similar medians and ranges as planned practices (n = 34; *Planned*: median = 0.64, range = 0.19–0.96; *Implemented*: median = 0.64, range = 0.13–0.96).

However, certain practices had notable differences in rates of implementation when compared to planned rates. Those practices where the proportion implemented was greater than that of planned, with a difference greater than or equal to 20%, were:

- *Used nature walks / ecotherapy to relax*
  (*Planned* = 30%, *Implemented* = 80%)
- *Started composting at home*
  (*Planned* = 24%, *Implemented* = 65%)
- *Created wildlife habitat on your property*
  (*Planned* = 37%, *Implemented* = 69%)
- *Cut back on your use of single-use plastics*
  (*Planned* = 55%, *Implemented* = 83%)
- *Removed invasive plants from your property*
  (*Planned* = 47%, *Implemented* = 67%)

Those practices where the proportion implemented was less than that of planned, with a difference greater than 20%, were:

- *Viewed the SciStarter website [URL] to find projects nearby that interest*
  (*Planned* = 81%, *Implemented* = 13%)
- *Tested your soil for lead or other contaminants*
  (*Planned* = 65%, *Implemented* = 18%)
- *Changed your driving practices to avoid wildlife collisions*
  (*Planned* = 85%, *Implemented* = 47%)
- *Collected native plant seeds to plant in your yard*
  (*Planned* = 78%, *Implemented* = 43%)
- *Purchased seafood harvested or grown in New Jersey*
  (*Planned* = 70%, *Implemented* = 41%)

Correlation of practices implemented and knowledge

Across good practices addressed in the follow-up survey *(n* = 34), implementation was correlated with knowledge of the topic in the corresponding webinar. *Before* knowledge was positively correlated with percent *Yes*, practice implemented ($r = 0.49$, $p = 0.0036$) and *Practice Improved* ($r = 0.39$, $p = 0.024$), and negatively correlated with *Planning to Implement* ($r = –0.41$, $p = 0.015$) and *No*, not implemented ($r = –0.51$, $p = 0.0019$).

Results were generally similar for *After* knowledge and knowledge gained during the webinar as measured by VDA.

Effect of COVID restrictions and online content

Most respondents reported attending more webinars due to COVID restrictions (*n* = 277, *More* = 64%, *About the same* = 31%, *Fewer* = 5%). Most respondents also reported that they would have attended fewer sessions if held in person (*n* = 278, *Fewer* = 72%, *About the same* = 23%, *More* = 5%).

Previous attendance in Cooperative Extension programming

In 25 of the live polls, respondents were asked if this was their first attendance in a Cooperative Extension program. A minority responded that it was their first experience with Extension programming (*n* = 1,984, *Yes* = 14%, *No* = 84%, *I don't know* = 2%). Across these 25 webinars, the proportion of *Yes* responses ranged from 4% to 30%, with a median of 10%. Similarly, a minority of respondents in the follow-up survey reported not attending Cooperative Extension programs before the webinar series (*n* = 274, *Yes* = 36%, *No* = 64%).

Previous attendance in Cooperative Extension programming (*CE experience*) was associated with a statistically significantly higher knowledge of topics during live polls, but the difference was negligible (*n* = 8,755, *p* = 0.013). For *Before*, mean for *with CE experience* = 3.33; mean for *without CE experience* = 3.32. For *After*, mean for with *CE experience* = 4.52; mean without *CE experience* = 4.48. There was no statistically significant difference in knowledge gain across these two groups (*p* = 0.608).

CE experience was not significantly associated with demographic categories; if respondents would have attended more sessions if they were held in person; or if they attended more because of the COVID pandemic (*p* > 0.05).

CE experience was associated with the lack of adoption of a few practices (incorporating native plants, reducing stormwater runoff, reducing road salt), but there was no overall trend or effect on adoption of practices.

Demographic results from the follow-up survey

The follow-up survey respondents represented all 21 counties in New Jersey (92%), and 8% were from outside the state (*n* = 275).

Most respondents (91%) were 45 or older (*n* = 274, Figure 1). Responses for age categories varied significantly from proportions in the state ($p < 0.0001$) with respondents having significantly higher proportions in the *55–64* and *65–74* categories, and significantly lower proportions in the *<18*, *18–34*, and *35–44* categories.

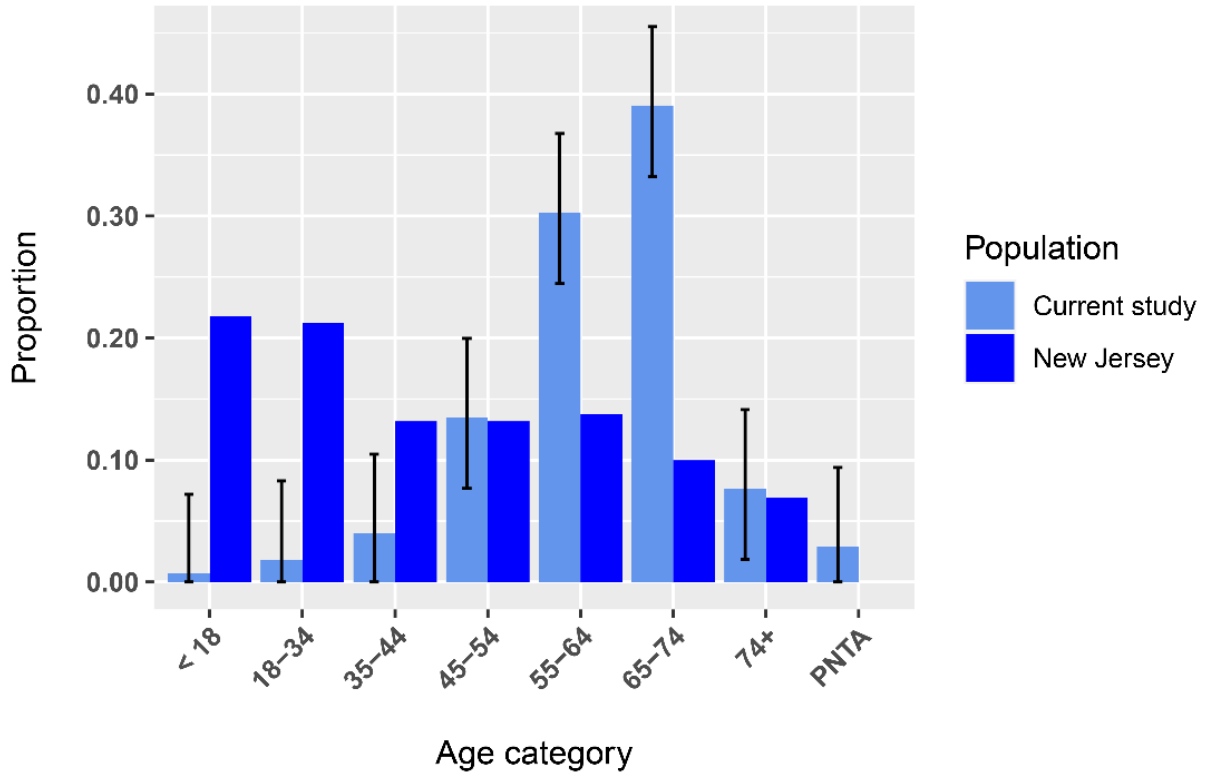

Figure 1. Proportion of responses in each age category compared with proportion from state census data. Error bars represent multinomial 95% confidence intervals by the Sison–Glaz method. USCB (2022a) does not have the PNTA (prefer not to answer) option.

Most respondents (76%) were female (n = 274, Figure 2). Responses for gender categories varied significantly from proportions in the states as a whole (p < 0.0001), with respondents having a significantly higher proportion in the *Female* category and a significantly lower proportion in the *Male* category.

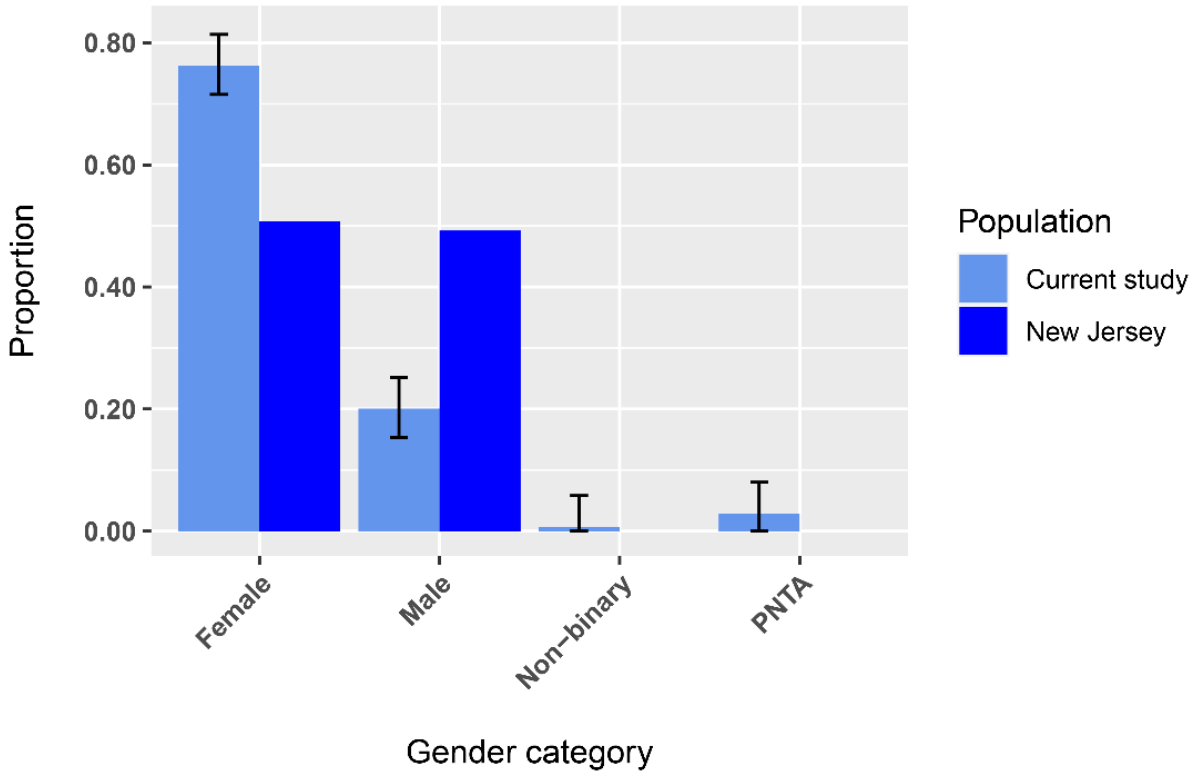

Figure 2. Proportion of responses in each gender category compared with proportion from state census data. Error bars represent multinomial 95% confidence intervals by the Sison–Glaz method. USCB (2022a) does not have the Non-binary or PNTA (prefer not to answer) options.

Considering racial categories, a majority of respondents (78%) were White (n = 272, Figure 3), with 6% of responses reporting Asian and 3% reporting Black. Responses for race categories varied significantly from proportions within the state's population (p < 0.0001), with respondents having a significantly higher proportion in the *White* category and a significantly lower proportion in the *Black*, *Two or more*, and *Other* categories.

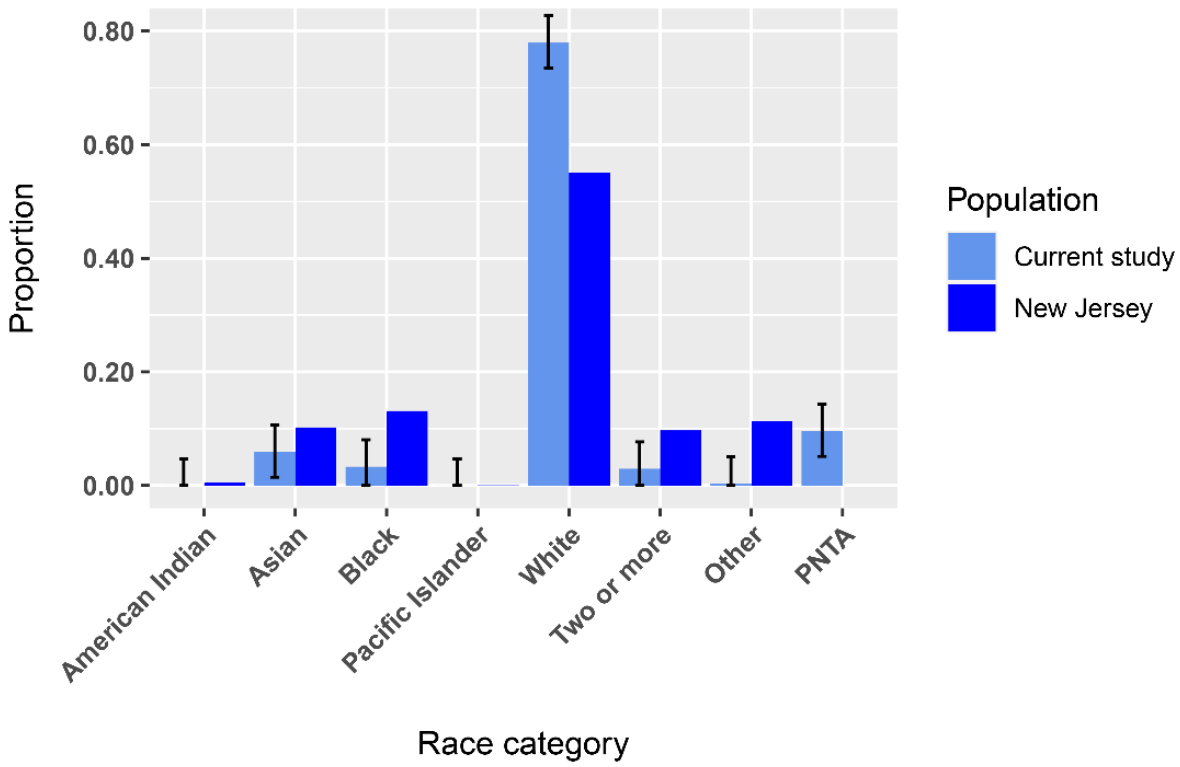

Figure 3. Proportion of responses in each race category compared with proportion from state census data. Error bars represent multinomial 95% confidence intervals by Sison–Glaz method. USCB (2022a) does not have the Non-binary or PNTA (prefer not to answer) options.

The follow-up survey results for age, gender, and race were also compared to the state population who live in owned or mortgaged homes rather than rented homes (USCB, 2022c). While the population in owned homes varied somewhat from the state population, this difference did not affect the results of our analyses.

Discussion

Effectiveness of short, online programming

As Extension resources become slimmer, it is important that we put effort into assessing programming effectiveness so we can determine how best to allocate time and energy to which topics (Khanal et al., 2019). Evaluation results showed that short format, online programming is an effective method for conveying environmental knowledge for those familiar and unfamiliar with Extension programming. For all topics, we saw a statistically significant gain in knowledge. This is compelling as much of our audience had previously attended Extension programs, including, for example, Master Gardeners, who potentially had considerable interaction with Cooperative Extension. It is possible that those with Extension experience in our sample were familiar with traditional topics of agriculture, horticulture, or nutrition programming and may not have been well-versed in the natural resource topics covered in our webinar series.

In some cases, people were relatively unfamiliar with the topic in their *Before* assessment (e.g., *Exploring your watershed from home*, *Marine debris response*, *Lead in garden soils*), and in these cases knowledge gain was relatively large. Where respondents were relatively knowledgeable about the topic in their *Before* assessment (e.g., *Urban wildlife*, *Food systems*, *Costs of climate change*), respondents still reported higher knowledge scores after the program. Still, the increases tended to be more modest.

These observations also suggest that a simple question about prior experience with Extension programming, while having the advantage of brevity on a participant survey, does not capture the nuances about what kind or extent of experience this entails.

Although natural resources and environmental protection programming has historically had lower attendance in New Jersey than horticulture programs, this webinar series reached relatively large audiences, considering both the live audience and those who viewed the recordings.

Likely, restrictions during the COVID-19 pandemic made online programming desirable for some audience segments. However, Komar et al. (2023) noted that audiences were amenable to online and evening content regardless of COVID-19 restrictions.

Of the good practices included in the follow-up survey, many respondents adopted or improved practices. This is an important result suggesting that this kind of programming, while of short duration, did result in behavior change. Historically, more resources have been put into long-format, fee-based Extension environmental education programs in New Jersey, such as the Environmental Stewards program (Rector et al., 2016). Results here suggest that there might be redundancy in programming, at least for foundational concepts, and delivery formats could be made more efficient.

On a practice-by-practice basis, the intention to implement a practice did not predict actual implementation well, given the limitations of the survey design used here, where responses in the follow-up survey were not matched to the same respondents in the live polls. For example, few people viewed the SciStarter citizen science website, perhaps indicating a lack of interest in this topic, despite many respondents intending to do so. This suggests that, while expedient in most Extension education applications, simply asking intention to implement practices immediately after the program may not be the best indicator for behavior change and should not be relied on as a true indication of program effectiveness.

Looking across webinars and topics, it is also notable that prior knowledge of a topic did not necessarily prohibit implementing or improving good practices. For example, our audience had high *Before* knowledge about the importance of not feeding wild animals, the impact of deer on forest health, and that native plants are critical for ecology. Yet incorporating native plants into yards, not feeding the deer, and landscaping with deer-resistant vegetation were in the top five actions implemented or improved. In a broader context, this observation has important implications for Extension education; it suggests that behavior change comes not only from knowledge and an appreciation of the importance of a topic but that repeated exposure or further information may be important in motivating behavior change. Shin and McCann (2018) noted that the

adoption of stormwater management practices by homeowners was related to knowledge about the practices, as well as their attitudes about the relative importance of the topic, as well as any barriers to adoption.

Improving good practices

Asking about the improved practices participants were already doing yielded fruitful information about some practices including home composting, recycling, and environmentally-friendly lawn care. Thirty percent or more indicated they improved these practices. While many claim to be doing these practices, they may often do them incorrectly, as much misinformation exists about these topics. These are areas where incorrect implementation can cause more harm than good, for example, avoiding recycling contamination (USEPA, 2021) and overuse of organic fertilizers that can cause nutrient pollution (Murphy, 2023; Koenig and Johnson, 2011).

Future focus based on knowledge and adoption gaps

Warner et al. (2022) noted that focus should be placed on potential behaviors that have low adoption rates and would result in the largest impact, and that high adoption rates of some studies may result from some practices being relatively easy to implement. This consideration is salient for our study, as some of the top practices adopted or improved included cutting back on use of single-use plastics, leaving wildlife in the wild, reducing food waste, and incorporating native plants into the landscape. The lowest adopted practices were harder to adopt, including conducting a home energy audit, testing soil on the property for lead, and installing a rain garden. It is also possible that repeated education using various outreach methods may be needed on these topics, since these topics were among the greatest differences in *Before* and *After* knowledge assessment, and since knowledge assessed during the webinar was correlated to practice implementation. It is likely that greater familiarity and understanding of a topic leads to greater mental salience of the topic and greater confidence in implementing changes. If we are to align Extension programming to state environmental goals for climate change and energy efficiency, moving forward, these low-adoption practices will need additional focus.

Reaching non-traditional audiences

While one goal of this program was to attract new, non-traditional Extension audiences, much of our audience had experience with Extension programming, and fell into demographic categories like those in other horticulture natural resources programming, namely, with over-representation in older, white, and female groups relative to the state population. Komar et al. (2023) reported similar demographic results in New Jersey for horticultural programming. Our webinar series saw this trend even with topics relevant to urban audiences, such as lead in garden soils, combined sewer overflows, urban wildlife, and urban runoff concerns.

This indicates the need to reach non-traditional audiences and tailor the programming to issues or formats that are more amenable to those audiences. The authors take this issue to heart, especially considering their location in a state with a considerably diverse population and the dedication of their institution to diversity, equity, and inclusion. Successful environmental education programs that target non-traditional audiences, especially in urban communities, have applied a more hands-on approach involving on-the-ground participation, community science, and local partnerships (Janis et al., 2016). Successful examples cited by Carrasco et al. (2022) from Latinx communities in California involved multiple overarching strategies, including partnering with English-as-a-second-language classes for environmental education (Drill et al., 2009). Perhaps our approach would need to expand beyond a state-wide webinar series, integrating community priorities, bilingual resources, and on-the-ground engagement.

Limitations of this study

In addition to comments made in this discussion, a few limitations of this study merit mention. It is important to acknowledge the difference in the number of respondents in the follow-up survey and in the live polls. There were 3,461 usable responses in live polls compared with 415 usable responses from follow-up polls, which was 13% of those receiving the poll. Polls may suffer from selection bias based on those willing to complete the poll, and this may have affected results from follow-up poll. Because the same people often attended multiple webinars, these people may be over-represented

in live polls. It should also be noted that in statistical analyses, because follow-up surveys were completely anonymous, no attempt was made to match live poll responses to follow-up survey responses by the participants.

Conclusion

While technology may make it relatively easy to conduct online webinars and report the number of attendees and audience evaluation of the speaker and content, assessing program effectiveness is critical to assess gaps in understanding, document medium-term impacts, and investigate barriers to implementing high-impact practices. These insights are useful in planning future programming that can best meet objectives for outcomes and impacts, address diversity and inclusion goals, and motivate interest and actions relevant to institutional focus.

Considering general implications for assessing Extension programming, this study found that including follow-up surveys to assess actual good practice adoption was critical since intention to adopt practices did not well predict actual practice implementation. It also found that allowing respondents to select an option of *improving* a given practice was important since many respondents chose this option for some practices. It may be helpful to promote practices that are relatively easy to implement, or those that can be adopted easily and later improved.

Results suggest that repeated or advanced education may improve adoption of practices, since results suggested that implementing good practices was correlated with knowledge of the topic, and that respondents showed an increase in knowledge after webinars even with relatively high previous knowledge or previous experience in Cooperative Extension programs.

Methodologically, it would be ideal to match respondents' answers on live polls to their responses on a follow-up survey. Practically, this may be difficult to achieve if there is a desire to preserve respondent anonymity.

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