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Seeing birds and biodiversity through science and art: An integrated community education program

Bryan S. Wang, Penn State University, Berks, bsw13@psu.edu

David Livert, Penn State University, Lehigh Valley, del11@psu.edu

Sandy Feinstein, Penn State University, Berks, sxf31@psu.edu

Samantha Kavky, Penn State University, Berks, bsk10@psu.edu

Abstract: Sustainability depends on biological diversity and the investment of individuals and communities in maintaining ecosystems. To engage the public in local biodiversity—specifically birds—we developed a program combining science and the arts. The science involved a group field experience, led by area birders guiding observations and providing information on the birds; the arts produced written reflections and visual representations of the birds and birdwatching. The integration of experiences, as manifested in field notes, artwork, and writing, reinforced understanding of, as well as interest in, birds and their natural habitats. In short, the data confirmed that participants gained a deeper appreciation for the natural world when seeing it in the contexts of both science and creative expression.

Keywords: birds, biodiversity, informal STEM learning, STEAM, art-and-science integration

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Bryan S. Wang*, Associate Teaching Professor in Biology at Penn State Berks, has a long-standing interest in integrating science, art, and writing. His published work ranges from articles on protein structure and design to innovative pedagogies, interdisciplinary creative scholarship (with co-authors of this article) to literary fiction (bsw13@psu.edu).*

David Livert *is a social psychologist with a focus on applied social issues. He earned a Ph.D. in Social/Personality Psychology from City University of New York (CUNY) Graduate Center and is currently a Professor of Psychology at Pennsylvania State University, Lehigh Valley. In addition to Livert's publications in scholarly journals, his book* A Psychology of Cooks and Cooking *will be published next year by Lafayette.*

Sandy Feinstein*, Professor of English and Honors Program Coordinator, has published most recently on alchemy in Margaret Cavendish and Marie Meurdrac (*Early Modern Women: An Interdisciplinary Journal*). Her attempts at representing creatures appear in multiple forms, including scholarly articles on early literature, poetry, fiction, creative non-fiction, and an article with two of the co-authors here.*

Samantha Kavky*, Associate Professor of Art History at Penn State Berks, has a research focus on Dada and Surrealism and is co-editor of the on-line* Journal of Surrealism and the Americas*. Recent publications include "Surrealism, War and the Art of Camouflage," in* The Space Between—Literature and Culture 1914-1945.

Introduction

Biological diversity lies at the heart of the many interconnected facets of sustainable societies (Blicharska et al., 2019). The accelerating loss of our planet's biodiversity stems from social and economic changes that have had increasing impacts over the past 50 years (WWF, 2020), and meeting the challenge of maintaining biodiversity requires multidisciplinary approaches and action from governments, businesses, and other institutions—and, thus, interest, engagement, and commitment from the wider public as well (Novacek, 2008).

Effective approaches to fostering public awareness and understanding of biodiversity and threats to biodiversity include those that encourage participants to interact meaningfully with nature, involve community activities that can create a sense of stewardship and empowerment, build social networks, and link the scientific community and the public (McRae & Böhm, 2021). Also, given the immediacy of the biodiversity crisis, education efforts would benefit from targeting populations of all ages (Novacek, 2008). These elements and considerations can be incorporated into science education programs such as nature walks (Zimmerman & McClain, 2016) and citizen science projects like bioblitzes (Lundmark, 2003) and bird counts (Bonney, 2007) that reach broad audiences of diverse ages in informal (non-school) settings (Fenichel & Schweingruber, 2010) to increase appreciation of wildlife and nature.

Integrating the arts into STEM education (e.g., in "STEAM" curricula, Perignat & Katz-Buonincontro, 2019) to combine analytical and aesthetic modes of thinking (Bequette & Bequette, 2012) can increase learning and broaden participation. These programs can tap the learner's interest in art, design, and making; personalize the learning and make it relevant; combine multiple ways of seeing, questioning, and knowing; and emphasize collaboration and growth over individual action and achievement (Conner et al., 2017; Mejias et al., 2021; Vossoughi & Bevan, 2014). Arts integration into education about sustainability offers an opportunity for transformative learning (Bentz & O'Brien, 2019; Bentz, 2020), and students who learn about the natural world through a combination of art and science as social practice (Guyotte et al., 2014; Quigley et al., 2019) increase their understanding of and appreciation for human-environment relationships (Clark & Button, 2011) and are moved to collaborative action (Trott et al., 2020).

This article presents a research study encompassing the design, implementation, and outcomes of an informal education program that combined "science doing" activities—in which participants observed, identified, and described local birds—with "art making" that served as a means for reflection and deepening engagement with birds and birdwatching. The program included a variety of focused activities: a bird walk at a nature center led by experts from a local birding club; a self-study period using printed guides with instructions for additional birdwatching (similar to actions one might take as part of a bird count); prompts for making reflective art and writing about it; and submission of the field notes, artwork, and writing. Participants were also invited to show their artwork in a community art exhibition celebrating birds and biodiversity. Below, we elaborate on the design of the program; illustrate how the program sparked the

audience's interest in, understanding of, and appreciation for birds and nature; and suggest directions and possibilities for developing future programs.

Methods

Community bird walk. A bird walk for the community of Berks County, Pennsylvania, USA was held in early March 2022 at the headquarters of Berks Nature, a non-profit conservation organization, at Angelica Creek Park in Reading, PA. Attendees joined small groups led by members of the Baird Ornithological Club, a local birding organization; on the one-hour stroll over wetland trails, they discussed how to observe birds and identify them by appearance, calls, habitat, and other behaviors (Figure 1). Binoculars were loaned to those who did not own them. During the walk, red-winged blackbirds, American robins, song sparrows, Carolina wrens, Canada geese, a yellow-bellied sapsucker, and a Cooper's hawk were observed.

Figure 1. A group on a bird walk at The Nature Place in Angelica Creek Park, Reading, Pennsylvania. Photo credit: Eli Claman

Birdwatching and artmaking self-study. Following the walk, attendees 18 years or older were invited to complete the integrated art and science program. After consenting to the research study and completing a questionnaire about their experience with birds, birdwatching, making art, and their connection to birds and nature, study participants received a brief overview and a printed guide to watching and studying birds, making artwork that represented their birdwatching experience, and reflecting on the program and writing about it (Figure 2; complete guide at https://sites.psu.edu/berksbirds/guide/). The birdwatching instructions suggested documenting observations in a set of field notes and using illustrated guides and the mobile app Merlin ID

from the Cornell Lab of Ornithology. The artmaking prompts asked participants to "make something that relates to the birds [they] saw and [their] birdwatching experience" and indicated that the art could take any form, "something that's meant to be seen or touched or read—from pictures to poetry to pottery, computer-generated art to crochet to collage." The writing prompts suggested talking about and reflecting on the birds, birdwatching, and making art and then writing about the experience "in as few as 50 words or as many as 500."

Participants were encouraged, verbally and in the written instructions, to spend as much or as little time as they desired on their "bird projects" over the next several weeks and directed to submit any field notes, artwork, and reflective writing they produced and to complete a second questionnaire by the end of the month (26 days after the bird walk). The bird walk and program materials were offered free of charge, and participants were not compensated.

Optional art exhibition. After the submission period, study participants were invited to submit their artwork to an exhibition titled *Bird Call: Studies and Actions in Biodiversity* (Figure 3). While the show was originally conceived as an incentive for study participants, additional pieces were chosen from submissions by community artists and solicited from internationally acclaimed new media artists. The work of the study participants was showcased in a digital projection of a *wunderkammer* (cabinet of curiosities) alongside a description of the research study. This installation formed a centerpiece of the project's celebration of birds and call to action to stop biodiversity loss. More information about the show can be found here: https://sites.psu.edu/berksbirds/.

***Analyzing participant responses*.** Responses to Likert-scale questions from pre- and post-activity questionnaires regarding previous experience with birdwatching and artmaking (pre only), connection to nature and the environment, enjoyment of the various aspects of the experience (post only) and to queries about the number of hours spent on the activity were tabulated in Microsoft Excel. Qualitative data that was collected included field notes, artwork, and written reflections as well as replies to open-ended questionnaire items that asked, "In a few sentences, discuss how your art made you think of the birds," and "in a few sentences, discuss how viewing the birds helped you think about your art." Participant responses were coded (Linneberg & Korsgaard, 2019) both deductively, with a coding framework derived from the descriptions of six strands of informal science learning (Bell *et al*., 2009), and with an inductive approach that identified additional codes, followed by categories and themes that included emotional connection to, and positive feelings about, birds and nature and concern for biodiversity and the environment.

Birds show us the splendor of biodiversity—the range of amazing creatures living on earth—and invite us to learn more about them and the environments they inhabit.

In this project, you'll watch and listen to birds. Then, you'll make something to represent what you saw, thought about, and felt: pictures, poetry, anything that inspires. Throughout, you'll connect with these fascinating animals and the world around you.

The project has three stages:

1. **Go outside and watch birds**. Keep track of the birds you see and hear. (If you haven't done this before, you'll learn how.)
2. **Create something** that expresses your thoughts and feelings about birds and bird watching.
3. **Write a reflection** that describes what you thought about as you watched the birds and what you created.

You don't need to do the steps all at once, and you can spend as much or as little time on the project as you want.

Bird Watching and Field Notes

In this first stage, you'll observe birds and describe them. Bird watching can be as simple as looking at and listening to the birds around you, but if you also want to learn their names and a little more about them, see the Elementary Birding supplement.

Go outside, look, and listen. Take a walk. Stand still for a bit. Look at a neighbor's bird feeder, or the ground, the sky, the trees. Listen for the birds' calls.

When you find a bird, note its appearance: colors, size, and other details. Are there stripes on its wings? Does it have a crest or a round head? What shape is its tail? How about its beak? **Observe its behavior.** What noise does it make? How does it fly, dive, crawl, or peck?

Document your observations in a set of field notes. Make sketches, take pictures, describe what you see and hear.

Keep a list of the birds you can identify or distinguish and where and when you saw or heard them. However, **please don't identify any people**, including yourself, in your notes!

Making Bird Art

This project is not only about watching birds, but about being creative, too. In this stage, you'll make something of your own—you'll make art!—while thinking about what you've seen and done so far.

You can be an "artist-advocate": make something that relates to the birds you saw and your birdwatching experience. Your art may encourage others to better appreciate birds and nature.

Create a piece of art that relates to birds and your birdwatching experience.

Please do not include pictures or anything that could allow someone to identify you or others in your artwork.

The art can be something that's meant to be seen or touched or read—from pictures to poetry to pottery, computer-generated art to crochet to collage.

Whether it's beautiful or strange, plain or complicated, what's important is that your art is meaningful to you.

Reflective Statements

Now reflect on what you've seen and done to gain a deeper perspective on it and further activate your creativity. Jot down notes as you think and talk about the birds you saw, and your experiences with birdwatching and making art.

Then, write about it. Your "reflective statement" could be as few as 50 words long or as many as 500. Again, please don't include information that could allow someone to identify you or others in your statement.

Questions to help you get started:

- What did you think about as you watched the birds and wrote your field notes?
- What did you create and how did you create it?
- What were your intentions in making your artwork? Are you happy with it? What do you wish you had been able to do but couldn't?

Figure 2. Excerpts from the printed guide for the integrated art-and-science bird program. The full guide can be found at https://sites.psu.edu/berksbirds/guide/.

Figure 3. Artwork from study participants displayed in a digital *wunderkammer* as part of *Bird Call: Studies and Actions in Biodiversity*, an art exhibition dedicated to nature conservation. Photo credit: Kevin Brophy.

Results and Discussion

Description of participants. Over 65 people, from young adults to parents and their children to retirees, joined the bird walk event. Of the 24 attendees who consented to enrolling in the program and the research on that day (only those 18+ years were invited into the study), 18 individuals (75%) completed the project and submitted their art and writing during the study period. Participants reported spending an average of 7.1 hours (range 3.0 to 25.0 hours, median 6.0 hours) on the birdwatching, artmaking, and writing and indicated that they enjoyed each component of the program (Table 1). Ten study participants accepted the invitation to show their work in the optional art exhibition.

Table 1. Participants' self-reported enjoyment of various components of the program.

How much did you enjoy…?	Median rating[1]	Mode	Mean
… walking through nature	5	5	4.7
… seeing and listening to birds	5	5	4.7
… describing and photographing birds	4	4	4.1
… identifying birds	4	4	4.1
… planning artwork	4	5	3.9
… making artwork	5	5	4.4

[1] Likert scale: 1=not at all, 2=a little, 3=a moderate amount, 4=a lot, 5=a great deal

Strong initial connection to nature. Responses to the questionnaires showed the study population entered the program strongly connected to nature, birds, and the environment; these feelings and attitudes did not change through the study. When asked, "How do you feel about birds?" 50% responded "I really like birds" (5 points on the 5-point Likert scale) and 50% responded "I like birds" (4 points). The pre-program questionnaire included the short form version of the nature-relatedness scale, which measures subjective connection to nature (Nisbet & Zelenski, 2013). Mean nature-relatedness score was 4.4 (standard deviation 0.6). [In Nisbet and Zelenski's 2013 study, the mean for a group of psychology undergraduate students was 3.00 (S.D. 0.86); for a group of middle managers, 3.39 (0.85); and for a second, larger group of undergraduates, 3.34 (0.96).] An additional series of questions with Likert-scale responses indicated that participants began the program with strong, positive attitudes toward the environment, and that these attitudes remained strong through the integrated program.

Participant submissions. At the end of the program, in addition to the questionnaires described above, participants submitted, through an electronic form, photos or text versions of their field notes, photos of their artwork, and their written reflections. They also responded to prompts that asked, "In a few sentences, discuss how your art made you think of the birds" and "In a few sentences, discuss how viewing the birds helped you think about your art." These documents and responses were analyzed as described below.

Learning about birds. The National Academy of Sciences (Bell et al., 2009) has defined a framework that describes how science learning can involve multiple often overlapping activities. These strands of learning include experiencing excitement, interest, and motivation to learn about phenomena in the natural and physical world (Strand 1, abbreviated here as *developing interest*); generating, understanding, remembering, and using concepts, explanations, arguments, models, and facts related to science (Strand 2, *increasing understanding*); and manipulating, testing, exploring, predicting, questioning, observing, and making sense of the natural and physical world (Strand 3, *engaging scientific reasoning*). The responses submitted for the program demonstrated how pairing the artmaking activity with birdwatching engaged participants in these strands of science learning to foster their engagement with and understanding of birds. For instance, one participant used their artwork, a digital collage, to invoke the "excitement" they associated with the "hide-and-seek" nature of birdwatching; they also drew on observations of where they saw birds during the bird walk to place bird illustrations in the habitat in their composition (Figure 4). Another discussed how drawing helped them "look closely" and observe details about the birds' appearance such as the "intricate feathers" and "beautiful colors," while hypothesizing why birds of different species tended to avoid one another (Figure 5); thus, through the artmaking activity, this participant traced the three strands described above—developing interest, increasing understanding, and using scientific reasoning—to learn about and better appreciate birds. Although the depth of the responses across the study population varied greatly (see below), these kinds of learning were seen throughout the study population (Table 2). Through the integration of art and birdwatching in the program, all participants accessed at least one of these three strands: evidence of developing interest was seen

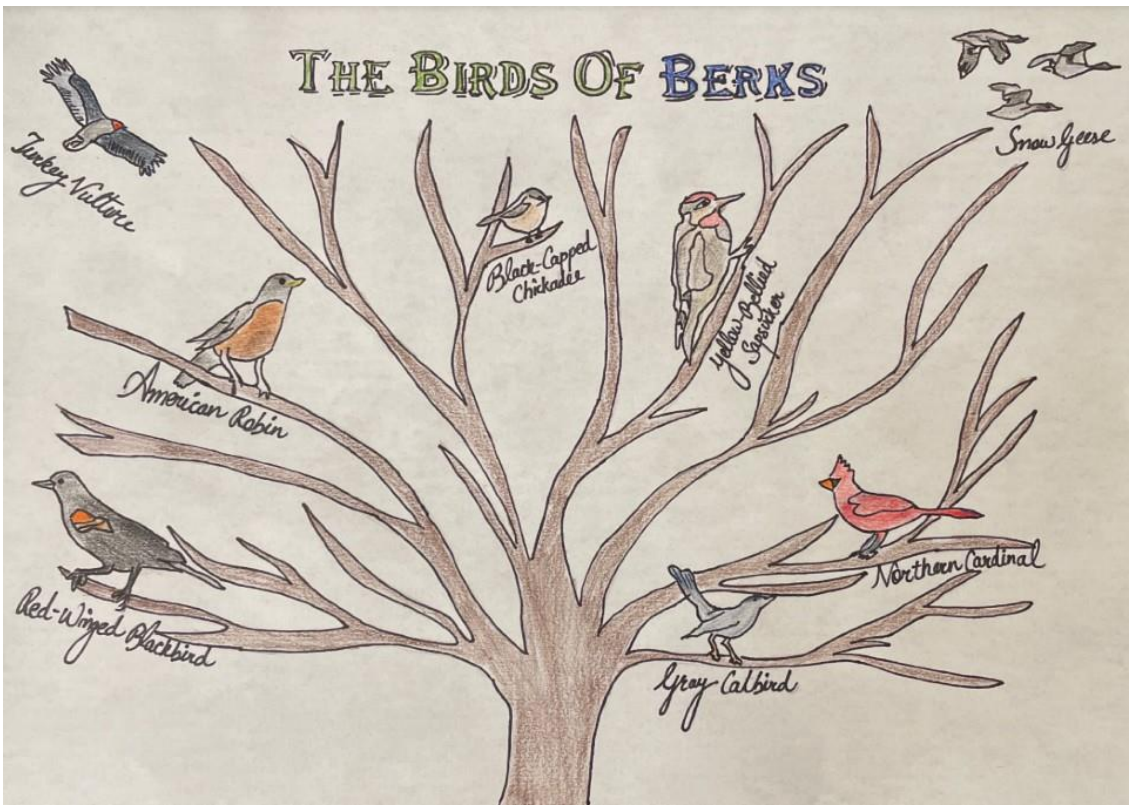
in the responses from 15 of the 18 participants; of increasing understanding for 9 of the 18; and of engaging in scientific reasoning for 10 of the 18.

Connection to birds and nature. The response in Figure 5 also exemplifies how the submitted artwork and writing reflected and reinforced the participants' emotional connection and positive feelings about birds and nature as well as their concern for biodiversity and the environment. This concern stimulated them to reflect on humanity's ethical responsibility to preserve the environment (Figure 5) or, for two other respondents, to "upcycle" 165-year-old wood shingles from their house into a bluebird house and a mosaic (these submissions were made separately, but apparently came from a pair from the same household, Figure 6). A positive affect toward birds was discussed in a number of responses, including: "I'm not much of a [visual] artist but I appreciate the wonders of nature, especially the grand artwork that is birds"; "Being outside in nature is always a good source of inspiration, both for art and just in general for feeling grounded and creative"; and "My art allowed me to reflect on the peaceful feelings that are often present when watching nature just be. Birds have a type of elegance about them when they just exist, going about their normal day. I often find that this is analogous with the rest of nature like trees, shrubs, etc." The restorative quality of birds and nature also was explicitly recognized in the artwork and writing presented in Figure 7.

[In my artwork] I tried to capture the fun of finding the birds… As I watched the birds, I enjoyed finding them, identifying them, and seeing how they reacted to their environment. I created a hide and seek type of silhouette in a graphic editor by placing bird silhouettes on to a silhouette of woods. I tried to place birds that I saw on the bird walk. I also put them in similar positions to where I saw them such as placing them in brush or on branches. My intention in my art was to create a similar sense of excitement in finding the birds that I experienced on my bird walk.

digital collage, anonymous participant

Figure 4. Artwork and excerpt of written response showing evidence of developing interest in birds and increased understanding of birds.



pencil drawing, Safitaj Sindhar

Watching different species of birds sitting atop different trees inspired my artwork… While I was working on the art and trying to draw the birds, I was amazed at how intricate the feathers and how beautiful the colors of these birds are. I never really looked closely at birds, but while trying to draw them, I observed the little things I had not noticed before… It was fascinating to me that different species of birds had their own little niches. No two species sat on the same tree or flew together. Were they fearful of one another? I hope not. So, in my art, I brought my utopian vision to life and created a scene of various species resting on the same tree… While I am pleased with my effort, I realize my limitations and accept that no matter how much we humans try, we cannot replicate the perfect beauty of nature. This experience also made me reflect on the crisis concerning the environment. We, as an advanced species, have asymmetrical power over the course of nature, and it is our ethical responsibility to preserve and conserve the environment.

Figure 5. Artwork and excerpt from written response showing how, through the artwork, the participant developed interest, increased understanding, and used scientific reasoning to learn about and better appreciate birds. The response also indicates how the program tapped and strengthened the participant's emotional connection to birds and nature.

Table 2. Excerpts from written responses indicating how participants developed interest in, increased understanding of, and/or used scientific reasoning to study birds through the artmaking activity. These responses are from participants other than those presented in Figures 4 through 9.

Excerpt from Participant's Writing	Strands of Science Learning in Evidence
"As I was making my project, I was reminded of the colors of the red wing blackbirds that I saw… I have seen them before but not more than a glance and not with binoculars! … I did not get tired of looking through the binoculars… at their beaks when they squawked, at their wings, at their bodies and at their tails. I watched to see them balance there in the wind…It is a common bird to our area but just taking the time to watch them made them memorable and special! I chose to make the red-wing black bird in the style of the late, great Eric Carle"	1 - developing interest 2 - increasing understanding
"Inspired from observations made on the bird walk event. Saw a big flock of geese flying overhead in an arrow-like formation. Painted three flying geese in that formation… [Making art] helped me recall the bird watching experience in greater detail so I can depict it in my artwork. I referred back to some sketches I made while birdwatching so I can capture the experience with some degree of accuracy. Creating my art also made me think more about bird anatomy"	1 - developing interest 2 - increasing understanding 3 - engaging scientific reasoning
"I wanted to include most, if not all of the birds that I saw. Seeing the birds in person also humbled my drawing abilities due to the complexity and beauty of them… [Making art] made me think about their natural behaviors and habitats as well as the variety of species in my area. It also helped me to be able to recognize the species that I included in my art!"	1 - developing interest 2 - increasing understanding 3 - engaging scientific reasoning
"I wanted the art to portray the correct type of bird I saw on the walk"	2 - increasing understanding
"[Making art] made me notice how they live in the world… I thought about how to represent them as living creatures rather than just background objects"	1- developing interest 2 - increasing understanding
"On the March 5 walk I got to see a yellow bellied sapsucker, which I don't think I've seen before. I want to make an art quilt of that bird. But instead I chose to make a Carolina Wren because I learned I'd been mistaking Carolina Wrens for House Wrens… The wren was my mother's favorite bird. But I don't know specifically if it was the Carolina or the House wren. I thought the House wrens were the more gregarious ones, apt to build their nest right in some cranny of your house. I learned on the walk the Carolinas are also very common and live in proximity to humans. The big difference is that striking white eyebrow. So I made that very prominent!"	1- developing interest 2 - increasing understanding

bluebird house, Brad Hartline

I appreciated learning more about our local birds and why they act as they do. While I don't really take them for granted, I don't know as much about them as I would like to. The event was a real help in understanding our flying friends – even the common ones! I am more mindful than before of whom is visiting and why they might be here. I look forward to more events to learn even more about birds… I created a bluebird house out of 165 year old cedar roof shingles from our house. We have a lot of different birds around our house, but no bluebirds. We're going to try to attract them with appropriate housing.

I always enjoy time in nature, and I also appreciate art, particularly primitive style. For my project I used original shingles from our 1857 house. I pictured a simple bird (in my mind a robin). I cut the shingles and simply glued them into the shape of a bird. To further add to the upcycle aspect, I set it on an old kitchen cabinet from our kitchen renovation!

wood mosaic, Steph Hartline

Figure 6. Artwork and written responses from a pair of participants, apparently from the same household, who reused wood shingles in their creations to both celebrate birds and speak to conservation.

digital graphic , Jeff Gernsheimer

When my wife and I went on a bird walk I saw several red winged blackbirds in the wetlands by The Nature Place. They were primarily on bursting cat tails. Also on a 3 mile walk I often take with a friend I saw similar activity in the wetlands near his house. I thought I'd attempt to interpret the scenes in a very simple style and palette with colors that represent the Ukrainian flag since the birds in the marshes gave me comfort in a time where the news, particularly from Ukraine, is so disturbing.

Figure 7. Artwork and written response reflecting positive affect regarding birds.

Outliers. Two members of the study population submitted extensive field notes and written reflections in addition to artwork. These participants—one individual (25 hours) and one mother who completed the project with her young son (19 hours)—spent more than three times the median hours on the project and completed all aspects of the program as instructed in the program guide. They accessed the three strands of science learning described above as well as three additional strands—reflecting on science and the process of understanding natural phenomena and the scientific explanations for them (*reflecting on science*); participating in scientific activities and learning practices with others, using scientific language and tools (*engaging in scientific practices*); and developing an identity as someone who knows about, uses, and sometimes contributes to science (*identifying with the scientific enterprise*) (Bell et al., 2009). They also spoke to pronounced change as a result of the program. The mother described her initial skepticism about the project as well as the transformation she experienced when she went "through the paces" of the program. She spoke to how a walk "done countless times" before was experienced in a completely different way, and how she found herself "more connected to nature, with a newfound awareness and appreciation of birds" (Figure 8). The other individual explained her use of tools like cameras and Merlin ID, how her art "chronicled [her] first day trying to be a 'birder'," and "the excitement of seeing in detail" (Figure 9).

I still consider myself a relative neophyte when it comes to understanding and experiencing nature… And then I had my "nature kid," and like parents everywhere, I tried to adjust and learn so that I can encourage his interest… So, we signed up for the bird walk. Once again, I saw myself as chauffer/chaperone/companion, a conduit for my child's experience, thinking little of the possibility of a unique experience for myself… But then we started the art project, and the field notes, and even this reflection, and it became so much more… when I looked at my work compared to my son's[,] his is bursting with color and energy and excitement…his picture is him. Where I experienced the barrenness of late winter, he experienced the onset of early spring. I asked if he was using a lot of colors just because he likes things to be colorful, and he was shocked I didn't see the reflections on the water, the buds on some of the plants, the green grass.

Strand 3: engaging in scientific reasoning

I brought a notebook, we went on one of our favorite walks. We spotted common birds, nothing exciting, nothing truly notable for a real birder. I started by thinking I would write the birds names or description, maybe a count? Somehow it changed; my field notes stopped being scientific (there goes my A plus), and started becoming about our thoughts, the conversations the birds sparked, the hypotheses we were making. Although we were on a walk we've done countless times since my son's infancy, we experienced it in a completely different way.

Strand 6: identifying with the scientific enterprise

Strand 5: engaging in scientific practices

Strand 4: reflecting on science

Birds have always been part of our background (with the exception of the elusive woodpeckers who we always search for), but never at the forefront of our mind…after all, they have to compete with dogs to pet and kids on bikes. This project changed our awareness, and on walks since then we still find ourselves looking for and discussing birds.

Strand 1: developing interest in science

Figure 8. Excerpts from reflection for a mother-and-son pair showing evidence of five of the six strands of science learning and profound change through the program. (Credit: Linda Bloom)

My art is layered with details too. I combined calligraphy, drawing and sketching, watercolor, photography and haiku. I chronicled my first day trying to be a 'birder.' I did not have an overall plan.	Strand 6: identifying with the scientific enterprise
I drew the three birds from pictures in my bird book, not from life. I had to try out the colors from my two sets of colored pencils to get the correct shades, and make a list of what to use for each bird. There wasn't the right shade of tan for the finch. There wasn't a good shade of brick red either so used watercolors for that.	Strand 2: understanding science knowledge
To fill the rest of the paper and disguise some flaws in it, I planned to paint vignettes of other places I have seen birds (and not always known what they are). I decided I was not a good enough painter to make the places look different from each other, so instead included photos from my past hiking haiku about (mostly) birds.	
So my art is not fine art but it captures my day and hopefully the excitement of seeing in detail.	Strand 1: developing interest in science
I have been on a couple bird walks since doing the art, and can now get a couple more details at a time. I get so interested in looking through my binoculars that I forget to use the Merlin app to identify what I am seeing. My phone doesn't take good enough photos to use the photo id feature, but I read that you can take photos through the binoculars so will have to try that next time. Without that capability I Googled something like 'blue bird nesting box invader' to identify a tree swallow, and used the Bird ID 5 questions – pretty amazing results! I identified a Northern Flicker and a Killdeer that way. Finally a Dark Eyed Junco stayed still enough for me to study! Lots of fun and details to come!	Strand 4: reflecting on science Strand 5: engaging in scientific practices

Figure 9. Excerpts from written reflection showing evidence of all six strands of science learning and profound change as a result of the program. (Credit: Dorothy Delong)

Conclusions and Future Directions

Despite the time needed to complete the program (participants in this study spent between 3 and 25 hours) and the lack of incentives aside from optional participation in a public art exhibition, 75% of those recruited completed the program, and all reported high levels of enjoyment with its various components. Their participation in the artmaking led to gains in science learning, especially Strand 1 (developing interest in science), Strand 2 (understanding science knowledge), and Strand 3 (engaging in scientific reasoning), beyond learning gains from the birdwatching activity itself, as demonstrated in the submitted writing and artwork.

Surveys, including the short form nature relatedness scale, revealed that members of the study population entered with a strong sense of connection to nature and birds as well as high concern for the environment; these attitudes did not change after the intervention. The submitted documents reflected and reinforced the participants' emotional connection and positive feelings about birds and nature as well as their concern for biodiversity and the environment. To explore how this program might more explicitly support behavior changes around conservation, the activities could be paired with environmental education lessons. In a pilot program with youth, discussing topics such as the ecological roles that birds play, threats to birds and biodiversity, and

what individuals can do to preserve wildlife and environments instilled in youth participants a sense of purpose that supported their investment in the birding and the artmaking (unpublished results).

Participants in this study were encouraged to submit their work regardless of the amount of time they were able to spend on the project. The two study participants who spent the most time on the program showed gains in all six strands of science learning in informal settings and spoke to profound changes through the project. Though not the focus here, these responses may provide insight into mechanisms by which the integrated program enhanced learning—*e.g.*, as arts-informed "research" for the participant (Marshal & D'Adamo, 2011). Thus, we plan to explore ways to increase involvement with the program. The high completion rate of this program contrasts with the results of a similar program, run in parallel, that was delivered in a remote asynchronous format; in that format, only 1 of 14 individuals who consented to the study completed it (unpublished results), suggesting that future designs warrant increasing the in-person, communal activities. (Perhaps, after the omicron surge of the COVID-19 pandemic, there was greater appreciation for such face-to-face group experiences.) The program could include multiple birdwatching sessions at different venues, for instance, and in-person artmaking sessions and workshops featuring art instruction and historical and contemporary examples of art inspired by nature observation may further increase the impact of the art component and the community art exhibition. Finally, targeting specific audiences through promotion and incentives, the content of the presentations, the expectations for artwork and writing, etc. may further increase engagement. Through this program and related pilots, we have successfully involved retirees, families with children of various ages, high school and college students, and youth in after-school settings.

At the same time, some aspects of the current program seem key to its effectiveness. First, participants expressed their gratitude for the expertise of the "Bairders" who led the bird walk; such outreach of experts to the audience (or to would-be leaders) can help generate excitement while teaching concepts and skills. While we provided instructions and prompts for all stages of the program—birdwatching, artmaking, reflection, and writing—participants also were given freedom regarding the time spent on the activities and the depth and format of their responses, latitude that may have increased their sense of ownership of the process and their responses. As noted above, building a sense of community, especially through in-person activities, appeared important for encouraging completion of the program; the success of the program (which we titled "Celebrating Birds in Berks" to emphasize ties to the local county) also may draw from and/or contribute to place attachment (Scannell & Gifford, 2017). Above all, we have found that "artmaking" provides a means of seeing and reflecting on—discovering—nature in a way that is complementary to "science doing." Our program has shown that combining the two will lead to deeper engagement and broadening interest in birds, biodiversity, and a better, more sustainable future.

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Bryan Wang

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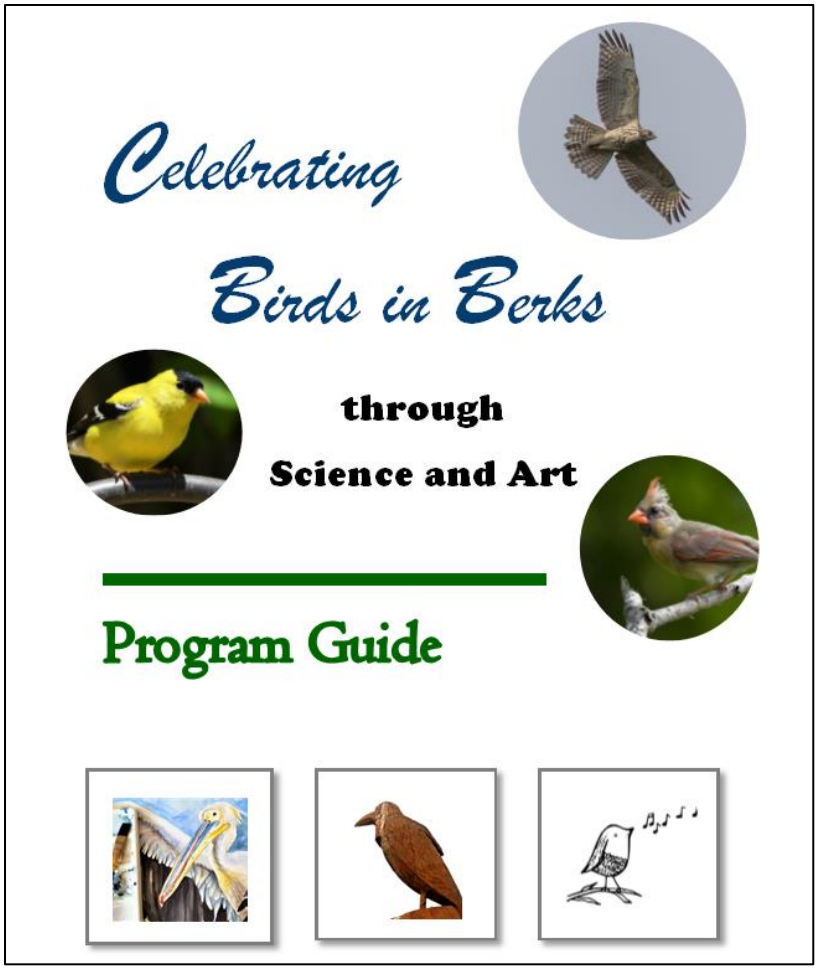
David Livert

Sandy Feinstein

Credit: Theo Anderson

Samantha Kavky



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