Appendix A

Methodology
A two-part market analysis was conducted to identify best practices and innovative strategies.

First, we reviewed 34 top citizen science projects on the platform SciStarter for the year 2020, based on “most joined” and “most contributions” (Hirschon, 2020). Second, we reviewed features of 21 citizen science projects that had dedicated mobile applications, ranked by the number of downloads in the Google Play store.

Few projects/applications exclusively targeted teens or preteens, with the exception being Seek.

Both Seek and Merlin, a bird identification app offered by the Cornell Lab of Ornithology, had over 1,000,000 downloads in the Google Play store. However, neither Seek nor Merlin meet the definition of citizen science apps/projects. No data is collected from users to inform research. Instead, they are both offshoots of citizen science projects, with Merlin using data from eBird and Seek using data from iNaturalist. The applications themselves are used only for end user species identification and education. For this reason, they were excluded from this analysis.

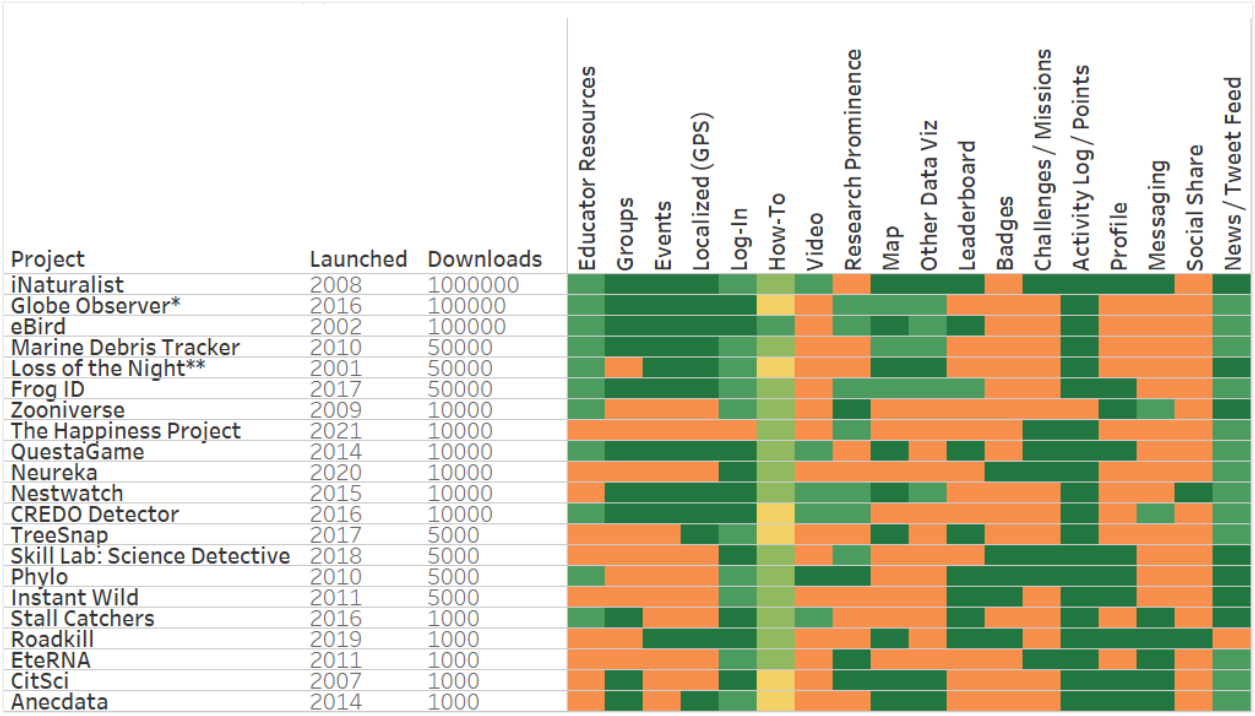
Please note:

- Downloads are not the best indicator of prolonged engagement. Unfortunately, Google Play store downloads were the most consistent measure we had available. A better measure might be active users in a given time frame (e.g. 6 months) or number of contributions per user in a given time frame.
- Many of the top-performing apps fall into the "ecology & observation" double category while the less downloaded ones tend to fall into "games & human computation." This may explain differences in features since users are being asked to contribute to different domains via different protocols.

SciStarter Top Projects
56% of the top projects had dedicated mobile applications for Apple or Android, with the remaining projects relying on web apps or forms exclusively. This indicates that it is not necessary to have a dedicated app to ensure engagement. A majority of the projects (56%) were based on users making observations (such as taking photos or measurements), with the remainder being human computation (assessing existing photos/data, simulating biochemical compounds, etc.)

Top Downloaded Apps
The greatest differentiators for apps with 50,000+ downloads vs. apps with fewer than 10,000 downloads were the ability to form groups, support for educators or group leaders, localization (enabling GPS permissions to localize content seen when opening the app), and events such as competitions, blitzes, or campaigns.

Figure A1. Citizen Science Application Features



* Globe Observer is an mobile application released by NASA's Globe Project in 2016. However, the Globe Project is a well-established citizen science project that was founded in 1995.
** Loss of the Night is a mobile application developed independently that later partnered with Globe at Night, including data sharing. For this analysis, Loss of the Night was analyzed as one project with Globe at Night.

Figure A2. Feature Definition and Key

Feature	Criteria	Key
Educator Resources	Are there any resources for K-12 or informal educators?	Yes | Yes (not in app) | No
Groups	Are users able to participate in public or private groups?	Yes | No
Events	Are there time-limited events?	Yes | No
Localized (GPS)	Are GPS permissions used to localize content?	Yes | No
Log-In	Do users log in with credentials?	Yes | Optional | No
How-To	Is there a tutorial for data collection protocols?	Yes (not in app) | Visual | Text-Only | No
Video	Is there a video for data collection protocols?	Yes | Yes (not in app) | No
Research Prominence	Are associated research publications visible?	Yes | Yes (not in app) | No
Map	Are user-collected data visualized in a map?	Yes | Yes (not in app) | No
Other Data Viz	Are user-collected data visualized in graphs, charts, etc.?	Yes | Yes (not in app) | No
Leaderboard	Can users see the ranked activity of other users?	Yes | Yes (not in app) | No
Badges	Can users earn badges?	Yes | Yes (not in app) | No
Challenges / Missions	Are there specific tasks for users to complete?	Yes | Yes (not in app) | No
Activity Log / Points	Can users see past activity in discrete entries or points?	Yes | Yes (not in app) | No
Profile	Can users create a profile with personal details?	Yes | Yes (not in app) | No
Messaging	Can users communicate with other users? *Includes both direct messaging and message boards*	Yes | Yes (not in app) | No
News / Tweet Feed	Are there communications from the project to users?	Yes | Yes (not in app) | No
Social Share	Are there buttons for users to share on social media?	Yes | Yes (not in app) | No

Appendix B

Parent Survey Data (77 responses) - Taken between Nov 17 to Nov 23 2021

One of our team members worked in a supplementary academic engagement program and the parents of this academy were the primary data source. Google Form surveys for newsletter distribution contained approval from the program director. Most of the parents surveyed were in Belmont, MA for that rationale.

The majority of parents identified themselves as mothers (75%) and most were caretakers for children ages 0-16 years old (average 7 years old). Data showed an even number of female and male children under their care. Outdoor sports (biking) and hiking were listed in parent observations for top five interests for their children, while reading and games were cited as top three interests (see Figure B5 and Figure B6).

Figure B1

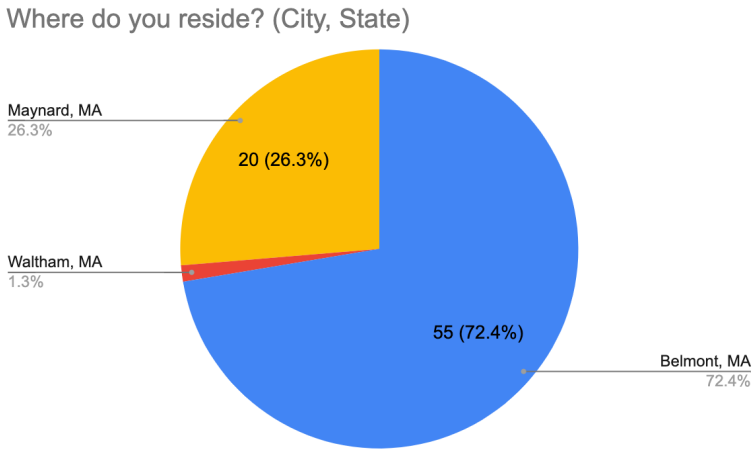


Figure B2

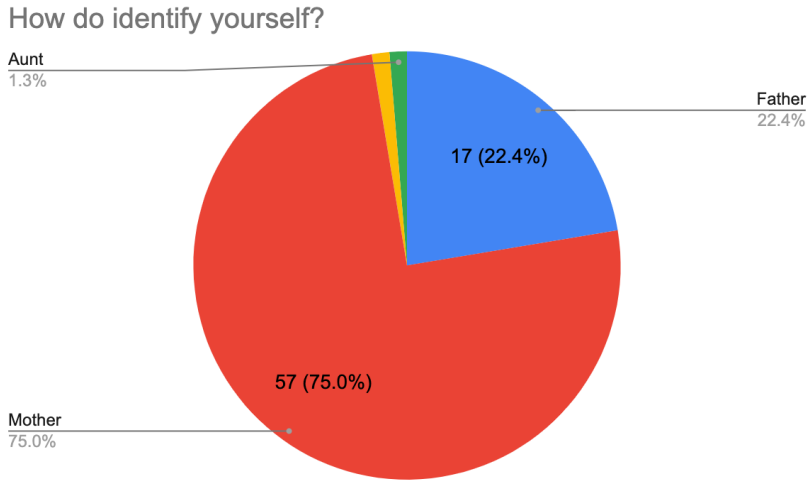


Figure B3

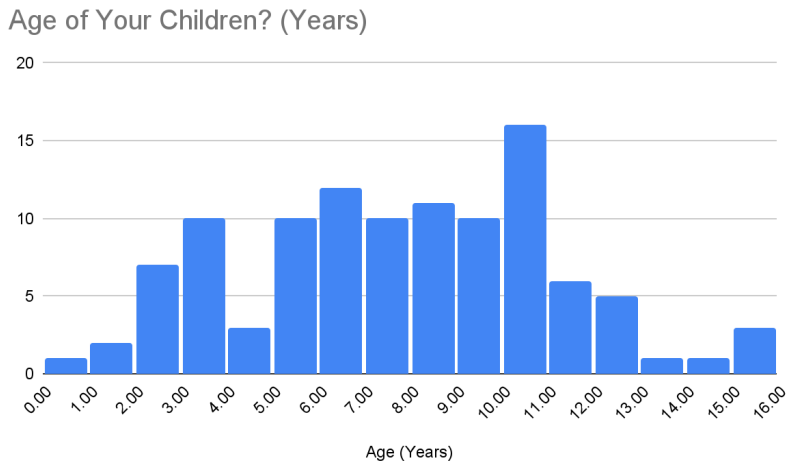


Figure B4

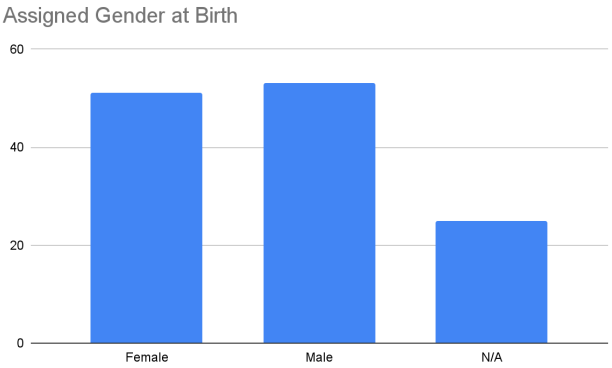


Figure B5

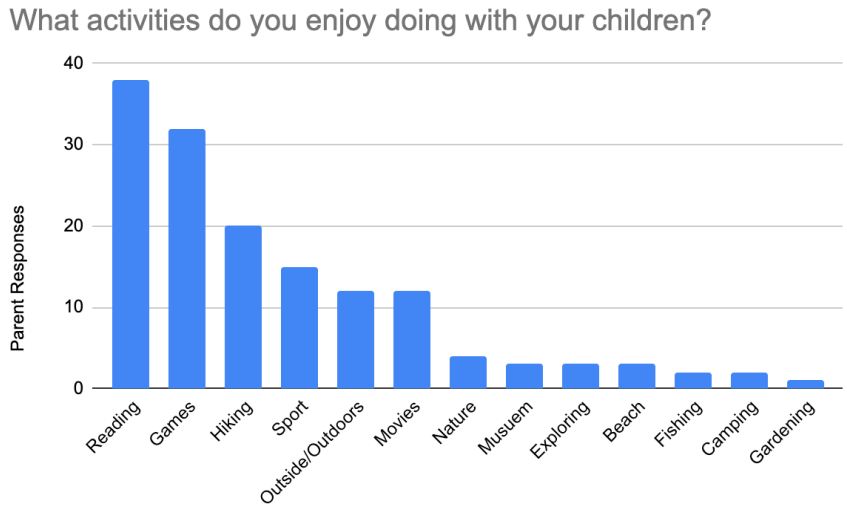


Figure B6

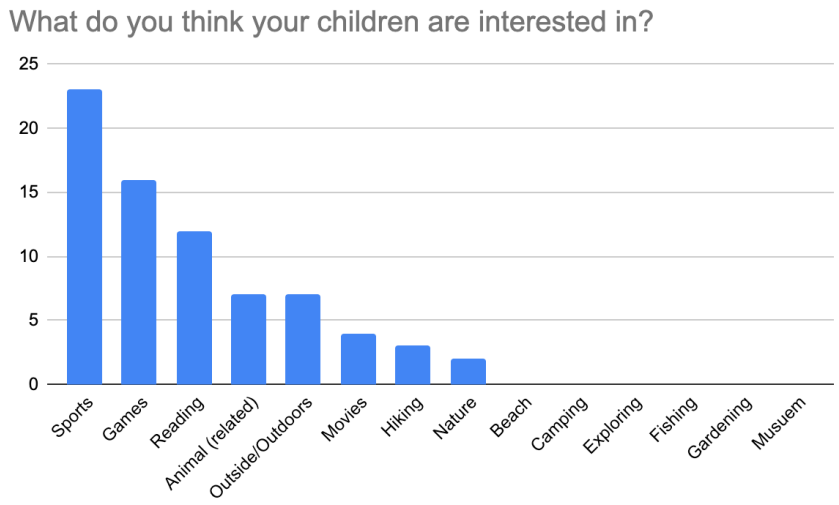
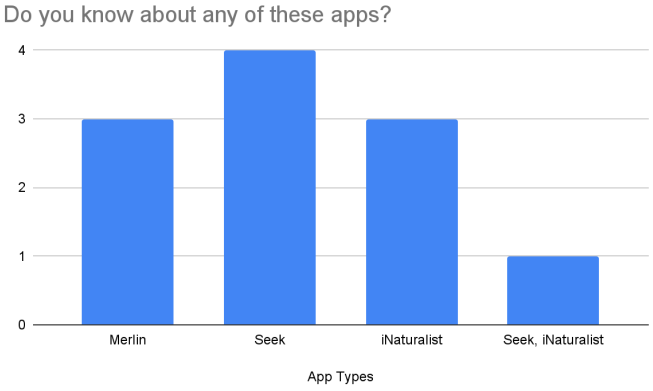
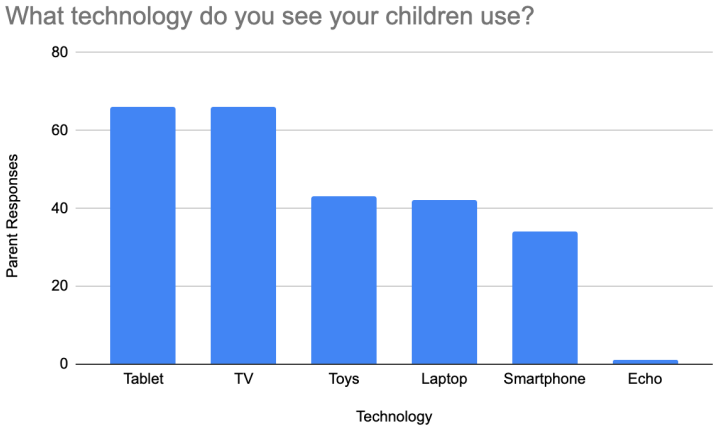


Figure B7



How do you engage your children with nature at home?
Playing outside (walks, hikes), pets, exploring the yard/gardening, scenic watching (seasons, birds, etc.)

Figure B8



How do you decide the technology access for your children?
Pending age appropriateness, time limits on screen time.

What do you think encourages children to learn more about nature?
Exposure and experiencing it outside, school/teachers, friends, natural curiosity/personal connection, making it fun.

Educator Survey Data (1 Response Taken on Nov 11, 2021)

We were able to collect responses from a 9th-10th grade science teacher in Framingham, Massachusetts with 3-5 years of teaching experience. The educator noted that the main technology used in the classroom were laptops and the main educational app used was EdPuzzle. They were knowledgeable about nature-based apps such as iNaturalist but implied that it was not the main technology utilized in the classroom. They also noted that their students engaged in TikTok, Snapchat, Messenger, and Instagram.

How do students engage with science INSIDE the classroom?
"We engage students by presenting the information in multiple modalities with opportunities for investigation and hands-on learning. We conduct a lab for every topic we cover where students get the opportunity to explore and investigate concepts related to the current biology topic. We often have students working through problems within groups to be able to discuss their ideas with each other. We try to bring in examples and activities that relate to students outside of the classroom, including things they may be interested in."

How do students engage with science OUTSIDE of the classroom?
"We don't get much of an opportunity to try and engage our students with science outside of the classroom. At the moment, they are mostly working through and observing science practices and concepts within the classroom. This is somewhat subject to change when we reach our ecology/evolution/environmental units in the spring."

What does "citizen science" mean to you?
"Citizen science means engaging everyone in science found in the environment around them and sharing it with the general population. It means that one does not have to be a scientist or a researcher to contribute to information about the world around them in a way that can assist with the understanding of how our environment/world/ecosystem/setting works."

What do you think engages youth with nature conservation?
"I think that they are really conscious of the fact that we need to help our planet recover from the damage we have done. They are really sensitive and motivated by ways to help our planet that can make an observable change."

Teenager Survey (2 responses Taken on Nov 20, 2021 and permission granted by guardians)

The respondents from the teenager survey data were both from Chicago, Illinois in the 9th to 12th grade range. They both indicated that they do not use any of the widely known nature apps (iNaturalist, Seek) but utilized TikTok and Twitter to share nature-based conversations on social media. The respondents seem to imply a consensus that helping nature is centered around human actions such as not throwing out the trash.

What does "nature" mean to you?
Respondent A:
"Nature means our environment, animals, or the natural things that happen like natural disasters."

Respondent B:
"Nature means to me as the wind blowing, the green grass touching, and the body of waters slowly."

Where did you see "nature" in your life this past month?

Respondent A:
"Tornados, floods."

Respondent B:
"I seen nature outside a lot flowing."

What do you think you can do to help nature?
Respondent A:
"Don't throw out trash out the window, reduce plastic, help clean the environment."

Respondent B:
"Just participate in the communities."