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Using Evolutionary Instruction to Engage Galápagos Elementary Students with Endemic Land Snails

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ABSTRACT: Scientists frequently conduct research in remote field locations, yet in close proximity to local communities. However, too often research conducted abroad involves collecting data and minimum or no engagement with local communities to communicate the broader scientific impacts. To address this deficiency, we worked with Ecuadorian school administrators, teachers, and students in the Galápagos Islands where our research group conducts evolutionary studies on the adaptive radiation of land snails. Despite the wealth of scientific research focused on evolutionary processes conducted in Galápagos, studies have shown that Ecuadorians are less accepting of evolution than other Latin American countries, so our efforts focus on this disconnect. Thus far, our engagement has centered on scientific inquiry and empirical tests of the scientific method while emphasizing the importance of biodiversity in the Archipelago. Herein, we outline our efforts to integrate our scientific work into the classroom and collaborate with teachers to design lesson plans centered on evolutionary biology. We show that building a foundation of evolution-based engagement can increase the scientific understanding of this historic evolutionary playground for local students as we continue cultivating this relationship in the future.

INTRODUCTION

Evolutionary studies are conducted across the globe, yet no location may be as emblematic of evolutionary processes as Ecuador's Galápagos Islands. Made famous by Darwin's visit in 1835, long-term research on the islands continues to advance the field (Grant & Grant, 2014; Parent et al., 2008; Poulakakis et al., 2012). Although international scientists frequently conduct research in locations like Galápagos, all too often they collect their data and leave without significant engagement with local communities and stakeholders. "Parachute" science is a pervasive issue in scientific research originating from the colonial history of earlier scientists from Western countries, with recent efforts calling to avoid these trends and instead authentically and meaningfully collaborate with local stakeholders (Asase et al., 2021; Barber et al., 2014; Stefanoudis et al., 2021). Efforts to engage local communities can also help highlight the scientific and societal importance of the ecosystems in which they live and increase their participation in conserving these unique ecosystems and associated organisms. In previous surveys, only 50% of Ecuadorians accept evolution, placing them 14th out of the 19 surveyed Latin American countries and lower than most European countries (Miller et al., 2006; Pew Research Center, 2014). Thus, it seems the evolutionary lessons from Darwin's finches and giant tortoises have a greater impact outside Ecuador than within its borders.

Ninety-seven percent of the Galápagos land territory is National Park, surrounded by the Galápagos Marine Reserve; together, both form a UNESCO World Natural Heritage site. Increasingly a hotspot of ecotourism, the Galápagos Islands received more than 267,000 visitors in 2022 (Galápagos National Park Directorate, 2022) who were exposed to the unique biodiversity of the islands. Even so, tourists' primary motivations for travel are not usually tied to learning about evolution or Darwin (Mazur et al., 2018). The extraordinary body of evolutionary and ecological research conducted in Galápagos has an even greater reach to international audiences through highly touted documentaries (e.g., BBC's *Planet Earth* and National Geographic's *Galápagos, Islands of Evolution*). Similarly, research efforts routinely engage local workers through training sessions on biodiversity and natural history to educate the park rangers and tour guides (Cotner et al., 2017). However, greater attention is needed to engage Galápagos K–12 teachers and students in promoting biodiversity in the local ecosystem (Stepath, 2009). Limited research has been conducted to understand students' and teachers' knowledge and acceptance of evolution in Galápagos (cf. Cotner & Moore, 2018; Soria Robalino, 2016). Although the islands were largely uninhabited until the 20th century, today approximately 30,000 people live in Galápagos—mostly employed in the ecotourism industry, fisheries, non-governmental organizations (NGOs), or by the National Park. Education in the Galápagos Islands is delivered within a single school district, which oversees 18 schools, 450 teachers, and ~7,000 students distributed across the four inhabited islands: Santa Cruz (~71% of total students), San Cristobal (~21%), Isabela (~7%), and Floreana (~0.7%).

We believe that our roles as scientists and educators should be multifaceted, including teaching and mentoring, communicating with the general public, and involving students to bring evolutionary concepts into everyday life. We are cognizant of our positionality as Western, non-local visitors/researchers from the United States who conduct research throughout the Galápagos Archipelago and also engage the local community and schools in activities associated with our research. Our overarching motivation for this work is to look at ways that we can (a) empower visiting scientists (including ourselves) to involve local communities in scientific research in authentic and meaningful ways, and (b) broaden participation of underrepresented groups in science via engagement with local communities. As such, we have embraced the Four R's framework of relationality, responsibility, respect, and reciprocity (Brayboy et al., 2012) to guide our interactions. The Four R's are an outgrowth of critical and Indigenous research methodologies, and Calderon's (2016) conception of Land as "all places were once Indigenous lands and continue to be" (p. 27).

To expand K–12 opportunities on the Galápagos Islands, our team, consisting of scientists and education researchers/practitioners, has leveraged 20 years of evolutionary research, primarily on endemic land snails, to develop a place-based learning program in collaboration with local educators. Specifically, we use Galápagos endemic land snails to study evolutionary processes of diversification and community assembly (Kraemer et al., 2019; Parent & Crespi, 2006, 2009; Parent et al., 2008; Phillips et al., 2020). With over 65 species currently described, land snails of the genus *Naesiotus* dominate the Galápagos terrestrial malacofauna and form the most species-rich adaptive radiation on the islands. Different *Naesiotus* can be found in all vegetation zones across the archipelago, from ~20 meters in elevation to the top of volcanoes forming the major islands. This assemblage displays remarkable morphological diversity, with shells evolved to match the various abiotic conditions and biotic interactions characterizing their environment (Kraemer et al., 2019; Parent & Crespi, 2009). Their wide distribution across and within the islands, and the fact that large quantities of empty shells can be collected from their environment make them an ideal system for community science and learning.

Here, we describe our use of the Galápagos snail system to develop a sustainable place-based learning approach to engage primarily local students at the Sea View School (SVS, a pseudonym to protect identities of students and staff). Approximately 12 schools, including SVS, are located in and around Puerto Ayora, the most populated town in Galápagos (~12,000 residents). SVS is a private school that serves around 200 K–12 students (~95% Ecuadorian) and offers methodological alternatives to the public schools in Galápagos by implementing project-based and place-based learning models. Although SVS had successfully pivoted toward a project and place-based model of learning, at the time of our visit there was still a need and opportunity to further connect to the scientific research enterprise occurring around and within the school context. In partnership with SVS, our team sought to make an explicit connection between on-the-ground, real-time scientific research being conducted in Galápagos and educational needs as expressed by this local educational partner. Thus far, our educational work has centered on scientific inquiry while emphasizing the importance of the archipelago's biodiversity. Although our focus up to this point has been on working with SVS, our model and future efforts are intent on engaging students, teachers, and the greater Galápagos communities more widely.

Our Approach to Working with Communities. As noted above, the Four R's (relationality, responsibility, respect, and reciprocity) (Brayboy et al., 2012) guided our approach to working with the local communities in Galápagos. The concept of the Four R's dates back to 1991 when Kirkness and Barnhardt (1991) posited the Four R's as respect, relevance, reciprocity, and responsibility. Regardless of the nuances of how the "R's" are organized, the overarching ethic was of interest to us to guide how we thoughtfully engaged the broader community, including students, teachers, administrators, parents, relevant Galápagos National Park personnel, and allied community members.

To clarify and operationalize the Four R's as proffered by Brayboy et al. (2012), we will provide brief definitions of each. Relationality denotes the necessity of investing time in a place and the people of that place to understand the underlying culture, perspective, and rhythms that embody the context. Relationality and knowledge derived from the cultivation of relationships are subjective by nature. Thus, to understand the needs of a context and its people, an investment in relationality serves as an invaluable guide. Regarding responsibility, Brayboy et al. (2012) note that "the link between relationships and responsibilities is critical" (p. 438). As guests to a context, and identifying as allies to the people and other-than-human entities (Smith, 2022) of that place, we have a responsibility to exercise the resources and expertise of our positionality to add value in ways that are appropriate to the needs of the context (i.e., the people and other-than-human entities). Respect speaks to the disposition of curiosity and care for the context in which we conduct fieldwork. We also feel that respect is an important orienting concept that shifts perspective away from a tunnel vision approach of "we are here to collect data and do science" to that of slowing down and paying attention to the context and all that it embodies out of reverence for the opportunity and experience. And finally, reciprocity is the ethic of engagement in mutually beneficial outcomes. Another way of looking at it is to give back in commensurate ways to which we have benefitted from the contexts in which we work for the gain of our research.

METHODS

Programmatic Approach. We began our collaboration by building a relationship and becoming aware of the educational opportunities and challenges associated with SVS. This step involved meeting and getting to know the school director and science specialists within the school. We sought a collaboration in which the needs of the school were at the forefront, and through iterative dialogue, we identified how the expertise of the scientists could enhance the educational experience of the students we ultimately worked with. To effect long-term change, we recognize the importance of incorporating evolution into classrooms (Andrews et al., 2011; Smith, 2017), in accordance with the national standards from Ecuador's *Ministerio de Educación* (2016). We designed lessons to address curriculum blocks within the national curriculum for the selected age group, including 'living beings and their environment', 'the evolution of living beings' and 'biology in action' (Table 1; Ministerio de Educación, 2016). We used these principles to structure our lesson plans.

Currently, scientific research is nearly exclusively carried out by professional scientists through governmental and non-governmental organizations. Although special events and occasional exhibitions provide glimpses to the public and students, scientific research agendas and publications are largely unknown to the community. Science teachers in formal education follow the established curriculum which is largely classroom-based and provides few opportunities to collaborate with or learn from professional scientific initiatives on the archipelago. Scientific research and education follow paths that rarely overlap.

Table 1. *Ecuadorian education standards related to or explicitly teaching evolution. Superior is composed of students ages 12–14 (equivalent to US grades 7–8). Bachillerato is composed of students ages 15–17 (equivalent to US grades 9–10). "Abilities" are designated by the Ecuadorian Ministerio de Educación (2016).*

Grade	Abilities	Curriculum Block	Specific Themes
Superior	C.N.4.2.2 C.N.4.2.3	Human Body and Health	Evolution of Bacteria; Resistance of Antibiotics; Causes and Consequences in Humans; Importance of Vaccination
Superior	C.N.4.1.14 C.N.4.1.16	Living Beings and Their Environment	Evolutionary Changes in Living Beings; Evolution; Biological Diversity; Geological Changes and Impact in Evolution
Bachillerato	C.N.B.5.1.1 C.N.B.5.1.2	Evolution of Living Beings	Abiogenesis; Primitive Atmosphere
Bachillerato	C.N.B.5.5.7 C.N.B.5.1.13	Evolution of Living Beings	Mitosis; Meiosis; Transmission of Genetic Information; Offspring; Cancer Proliferation of Altered Cells
Bachillerato	C.N.B.5.1.11 C.N.B.5.1.17	Evolution of Living Beings	DNA; Genetic Information; Inheritance; Genes; Chromosomes; Gene Alterations
Bachillerato	C.N.B.5.1.14 C.N.B.5.1.16	Evolution of Living Beings	Mendel's Laws; Crossbreeding; Genotype; Phenotype; Generations; Inheritance
Bachillerato	C.N.B.5.1.4 C.N.B.5.1.5	Evolution of Living Beings	Biomolecules
Bachillerato	C.N.B.5.1.21 C.N.B.5.1.22	Evolution of Living Beings	Human Activities; Biodiversity Loss; in situ and ex situ Conservation; Critical, Reflective and Responsible Attitude; Environment
Bachillerato	C.N.B.5.1.6 C.N.B.5.1.7 C.N.B.5.1.9 C.N.B.5.1.18 C.N.B.5.1.19 C.N.B.5.5.2	Evolution of Living Beings, Biology in Action	Evolution; Biological Diversity; Genes; Species; Ecosystems; Endemism; Native Species; Geographic and Climatic Factors; Evolution Patterns; Megadiversity and Galápagos Finches

Our initial efforts in January 2019 focused on inquiry-based learning and developing testable hypotheses as part of a two-day curriculum enrichment with 12 and 13-year-old students. During this experience we discovered that students had limited exposure to scientific material directly related to Galápagos ecosystems, even if their day-to-day lives were spent among the iconic Galápagos finches and marine iguanas. To increase students' exposure to the evolutionary significance of local species, our long-term goals were to (a) engage with local teachers in Galápagos to develop and implement a series of lessons that scaffold learning of evolutionary principles and highlight the evolutionary research we are conducting in Galápagos; and (b) foster a lasting relationship between international scientists and local schools.

Because evolutionary concepts can often seem abstract, clear and concrete examples of evolution are necessary to foster increased understanding and acceptance of evolution (Pobiner, 2016). To engage local K–12 students in the fundamental importance of evolution in their everyday lives, we used lessons from their own backyard via place-based experiential learning (Miller et al., 2015; Sobel, 2004). Students were introduced to basic approaches to scientific inquiry, evolutionary principles, the implications of biodiversity in conservation efforts, and field-based sampling methods. Importantly, a significant broader impact of our educational plan was to demystify evolutionary concepts for students with limited academic exposure to these critical biological ideas and provide the tools to use these principles in their future lives and careers. This educational initiative was integrated with our research goals focused on Galápagos land snails, the development of a local biological system we use to study active evolution, and the training of young researchers and educators in our lab at the University of Idaho, USA.

Curriculum Enrichment. The curriculum enrichment we designed and delivered was facilitated during an archipelago-wide teacher professional development week. We worked with ~75 students aged 9–11 years, split into three groups of 20–25 (hereafter 'subgroups'), each led by one of our team members and two local teachers from SVS, who were able to utilize this experience as a professional development activity to integrate key components of evolution and ecology into their own classrooms. Programming encompassed three days (Table 2), from 8am–1pm, to help students gain familiarity with evolutionary research within the Galápagos Islands.

Table 2. *Description of the learning objectives and activities implemented in our curriculum enrichment for each curriculum block (see Table 1).*

	Learning Objectives	Activities (format)
Day 1 *Living Beings and Their Environment*	Create thoughtful observations through a diversity walk and exploration. Keep track of thoughts, ideas, observations, and data using a science notebook Practice analyzing and interpreting quantitative data to answer an authentic research question.	Diversity walks and science notebook (individual, whole subgroup discussion) Data Nugget worksheet (pairs within each subgroup, whole subgroup discussion)
Day 2 *Evolution of Living Beings*	Increase awareness of current evolutionary research in the Galápagos. Understand the importance of Charles Darwin and how evolution contributes to biological diversity. Explore the inquiry process and start planning a research question, hypothesis, and experimental design.	Scientist presentations (lecture-style with all students) Bird beak challenge (all students in small groups of 4–5) Snail questions brainstorm (whole subgroup discussion)
Day 3 *Biology in Action*	Gather data and analyze it to create a conclusion. Present their findings to their peers in a thoughtful manner.	Data collection and analysis (whole subgroup) Poster preparation and presentation (all students)

Day one of the program focused on practicing data collection and making scientific inferences. In the first session, we discussed how to make thoughtful observations and asked students to observe their surroundings on a biodiversity walk in a park near their school. Students recorded observations in their notebooks by completing the following prompts: "I notice", "I wonder", and "It reminds me of" (see https://beetlesproject.org/) This activity allowed the students to start thinking like a scientist (Figure 1). Next, students worked in pairs to analyze authentic science data as part of a Data Nugget titled 'Coral Bleaching and Climate Change'

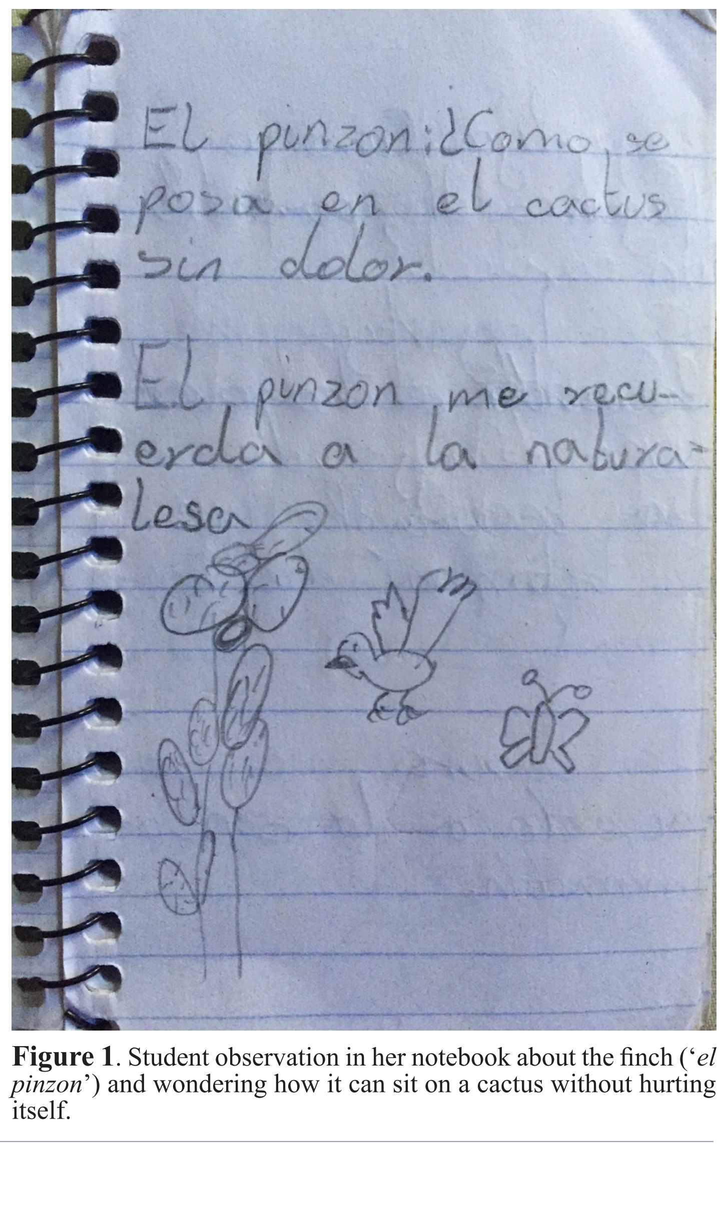

Figure 1. Student observation in her notebook about the finch ('*el pinzon*') and wondering how it can sit on a cactus without hurting itself.

(a worksheet developed by teachers and scientists using real data: Data Nuggets, 2014; Schultheis & Kjelvik, 2015), followed by a discussion about what they learned.

With students now prepared to think more abstractly, day two focused on evolutionary learning and preparing students to create their own inquiry projects. To start the day, two international faculty researchers (one Canadian, one Japanese), presented aspects of their snail research from the Galápagos and Ogasawara Islands (e.g. Chiba, 1996; Parent & Crespi, 2006). These presentations showed exciting examples of evolutionary research and highlighted the value and opportunities that come from the Galápagos context. Students asked the scientists questions and learned about their motivations for pursuing scientific research. Our approach and sequence were intentional in that we started with a student-directed exploration of their local context and prepared them to consider how data can be used to answer questions. Once curiosity was piqued, specifically around land snails as evidence of evolution through abundant shells in the community, we brought in subject experts to drill deeper into the richness of the content related to the local context.

Next, students explored evolutionary ideas through the ‘bird beak activity’, inspired by beak evolution of finches in Galápagos (Janulaw & Scotchmoor, 2003). In small groups, students selected different tools (spoons, tweezers, etc.) to represent a bird’s beak and tested the ability of that ‘beak’ to pick up ‘food’ (different sizes and shapes of beans, seeds, etc.). After multiple trials, students reported their findings and discussed the relationship between beak shape and a bird’s ability to find food and survive in different environments. Finally, we ended the day with each subgroup formulating 50 questions (Stearns, 2009) about snails. We discussed what makes a question testable and whether we could answer the question within our time frame and other restrictions (e.g., only collecting shells rather than live snails, per local restrictions on handling live animals). From the 50 questions exercise, subgroups chose one question to test on day three. Once the question was selected, students discussed their methodology and materials to prepare for the following day.

Day three consisted of students investigating their inquiry-based question about snails by collecting and analyzing data. Because of the vivid signature evolution leaves on island systems, islands are living laboratories and are prime examples where evolutionary change is clear, tangible, and can be directly observed. Snails are an ideal system for young students (Merino et al., 2022), especially in Galápagos with numerous species of land snails, which students can easily classify across wide variations in size, shape, and color. Even when no live snails can be found, they leave behind a trove of shells on the ground or beneath rocks and are locally common, which allows for the use of a central location for extended study by groups of students. We had the opportunity to collect data for this exercise by looking for snail shells on a local coffee plantation (Figure 2). Each subgroup chose similar but unique questions that students found interesting, and were testable within the confines of the plantation.

- Subgroup 1: How many snail species are there on the plantation?
- Subgroup 2: How many colors do the snails have? How many snails are under a rock? How big is a snail?
- Subgroup 3: Does climate affect the snails?

Each subgroup then prepared their results using markers and large sheets of paper and presented them to the entire group of 75 students, teachers, and our team (Figure 3). Students made all the decisions about what to include in their presentations, how to visualize the data, and how to present it orally to the rest of their classmates.

Figure 2. Students searching for snail shells on Day 3.

Figure 3. Students presenting their results on Day 3.

RESULTS

Reflections on Our Guiding Framework. In this work, we sought to address how we as scientists and science educators, interface with communities in which our scientific research is conducted. We recognize that the historical, colonial model cannot be perpetuated if we want to embrace a socially just approach to our multifaceted work. It is important to acknowledge that in efforts such as these, change takes time, often through building relationships and tuning into the needs of the communities and the opportunities therein. Given our longstanding (> 20 years) presence in Galápagos, we have built relational capital within the small communities that supported us to more explicitly interface with the local educational system. From our perspective, the compelling narrative of our efforts can be seen through the filter of the Four R's (Brayboy et al., 2012) noted above (relationality, responsibility, respect, and reciprocity). Below, we unpack how the Four R's have come to bear on our work in Galápagos and served as a guiding framework.

Relationality. When it comes to relationality, it can simply be stated that "showing up" is a critical first step. Along with showing up, investing time in the process of building relationships with the community and individuals has provided our research group in Galápagos with deep connective tissue (Anthony-Stevens, 2017) that has supported our ability to navigate the myriad local, contextual realities of field work and programming. Relationality in remote, rural, and Indigenous communities is critical to understanding the positionality of individuals and how they relate to the nuanced structures of interpersonal relationships in a place. For example, an "insider" in an organization such as a school or governmental agency (e.g., the Galápagos National Park) can provide insight into the "hidden curriculum" of that institution to help facilitate activities that ultimately benefit the community and the expressed interests of that community.

Our research group has been conducting research in the Galápagos Archipelago for over two decades. We have spent ample time within the local communities to get to know the people and the social networks that make up their cultural fabric, participating in social events and engaging with the community by delivering presentations to the general public where discussion is encouraged. Our Galápagos network includes naturalist guides, workers in the tourist industry, park rangers and administrators, fishermen, etc. We make use of this network to take the pulse of the community and identify the most pressing and locally relevant needs. As such, when we sought to collaborate with local schools, we drew from the longstanding relationships with community members to connect us with school personnel to begin the conversation regarding the needs of the school and how our expertise and resources could support curricular objectives, which ultimately resulted in the outreach activities outlined in this article.

Responsibility. For our group, responsibility is acknowledging the historical paradigms of research as an individually oriented pursuit that has all too often not taken into account the needs and sensitivities of the local community. Or, another way to look at it is through the lens of missed opportunities to understand and support the richness of the local context, cultural representations, and educational needs. As such, although we have had our research objectives for the field campaigns while in Galápagos, we have been mindful to invest our time, resources, and expertise where appropriate and applicable to support the expressed needs of the community which was facilitated through our deep commitment to relationality. We also recognize that our positionality as outsiders from an institution of higher education affords us access to resources and expertise that can benefit the community. We seek to identify those opportunities and proceed accordingly.

Thus, we honor the relationality that we have cultivated by taking our responsibility seriously to take the time to connect and listen, without ulterior motives for gain but with a sincere interest in conceptualizing and facilitating something useful for the community, in this case, school partners around evolutionary concepts associated with land snails.

Respect. We are proud to say that the respect associated with our relationships in Galápagos is mutual and ongoing. By showing up and listening, we are demonstrating that the relationships we have cultivated have a significance to us that is felt by our Galapagueño colleagues and friends. For our group, respect is embodied in listening to and honoring the lived experiences and realities of the communities we work with. For example, we recognize that within a community there is a diversity of beliefs and dispositions towards the scientific research we conduct. Rather than impose our academic views of evolution while teaching, we sought to expose students to the empirical, scientifically based evidence while also giving space for beliefs that potentially conflicted or ran counter to the science of our research.

Reciprocity. For our group, reciprocity is embodied in "paying it forward" (Brayboy et al., 2012). From a scientific standpoint, our group's research enterprise studying land snails in Galápagos has immeasurably benefited from access to the sensitive natural and social landscapes of the archipelago. Importantly, over the years, our snail research team has gained a reputation within the community, leading to residents frequently sharing information with us about snail populations, often coming from individuals outside the local research community. As such, we feel it a natural progression of the work to pay it forward by lending our collective expertise to the expressed needs of the community. For example, Galápagos National Park personnel are responsible, in part, for educating through interpretive methods and protecting the sensitive landscape from threats. Thus, our group has on numerous occasions provided up-to-date information on land snails, their habitats, and threats so that park personnel can accurately communicate this knowledge to tourists and policy makers. Therefore, in our work, reciprocity goes beyond educational engagement to foster tangible benefits that directly contribute to the local community's conservation, knowledge, and well-being. To support local conservation efforts, we aim to provide information on land snail populations and biodiversity trends that can be integrated into community-led conservation initiatives. For example, our research findings are regularly shared with local authorities and conservation organizations, providing scientific data that can inform policy-making and ecotourism efforts. By doing so, we help equip the community with scientific insights that underscore the importance of conserving endemic species and their habitats, directly contributing to their conservation strategies.

DISCUSSION

Lessons Learned. Throughout this experience we had to address four main challenges, most of which may be similar to other scientists' experiences when engaging with local communities. First, available classroom spaces lacked electronic devices and WiFi access. We knew and planned for this in advance by designing lessons and activities that relied very little on technology. Second, to appropriately tailor our lesson activities to students' background knowledge, as well as both Ecuadorian and local school standards, we engaged with teachers and administrators throughout the planning stage leading up to our arrival in Galápagos. Third, as expected in another country, language was a barrier. Although SVS is a bilingual school, English ability varied among the students, and not all visiting scientists/educators spoke Spanish fluently. To address this, we prepared materials in both Spanish and English and worked closely with the local teachers in spoken translation as needed. Finally, it is especially important when working with younger students to structure the day with 'brain breaks' and physical activity to keep them engaged during the science-focused activities. This effort was greatly enhanced by the presence of an elementary pre-service teacher on our team who was instrumental in designing the pedagogical approach that considered developmentally appropriate scope and sequencing.

Recommended Framework. Looking beyond our specific efforts in Galápagos, embracing the Four R's (Brayboy et al., 2012) of relationality, responsibility, respect, and reciprocity firmly serves as a framework for us as scientists to consider how we want to engage with the communities associated with our research contexts. As we go into the sensitive and critical habitats associated with the organisms we study, we would be remiss to not take the same care and ethic into how we interact and engage with the human inhabitants. As such, we also highlight some considerations for establishing a long-term approach to engaging with communities as scientists that can have a myriad of positive outcomes, including students learning evolutionary concepts. The most important consideration is the investment of time to foster local relationships. We recommend adequate time be allocated to understand the local context and begin to shift how we think about the impact of our collective scientific work. Getting to know local key knowledge keepers and personnel will invariably lead to a mutually beneficial relationship that can enhance our research through access, coordination, and understanding how our expertise can enhance a need in the community—through formal, informal, or community outreach experiences.

The research we engage in as scientists is complex and replete with specialized language, concepts, and processes. This complexity should not dissuade us from finding avenues to bring our scientific research to life in an intellectually appropriate, accessible way that benefits the focal audience. For example, in our work outlined above, we utilized land snails which are abundant in the archipelago, to serve as a vehicle for exploring evolutionary concepts. Clear avenues for translating science to a particular audience may not emerge immediately, thus, understanding local needs and opportunities through the investment in developing relationships with key stakeholders will be critical in identifying how scientific research can connect to local communities.

When specifically intending to partner with local schools, aligning scientific research to curricular needs and education standards is key (e.g., Warwick et al., 2020). Understanding the curricular needs and standards can also reveal directions to pursue activities that highlight the research and at the same time meet the goals and objectives of the partnering institution(s). The organisms we work with are land snails in Galápagos. Although they are not a charismatic macrofauna, this was not an issue for engaging students in meaningful science activities. Sometimes the less known flora and fauna of a context are more accessible to communities. Snails were an effective organism for the student projects as students excelled when they were able to hold a real organism in their hands without the risks inherent in using more active animals. Being able to use a native species that they can encounter on a daily basis was also beneficial to support the importance of biodiversity in their unique ecosystem. Not all scientific research is as readily accessible (and slow moving) as land snails. Yet this should not discourage investigators interested in more explicitly connecting with local communities. Looking at scientific research from an integrated systems perspective will support finding connections to local opportunities.

Whether we recognize it or not, we impact the contexts where we conduct research. It is imperative that we move away from a parachute model of research toward taking responsibility for the implicit and explicit impacts our research has on communities. Through relationality, responsibility, respect, and reciprocity, we give ourselves the best chance at tuning into what is important to communities and subsequently how our research can support an expressed need.

Future Directions. This project engaged local students in the evolutionary complexity of the Galápagos Islands (a UNESCO World Heritage Site) and successfully laid the foundation for future education and outreach activities of this nature to increase awareness of the resources available in their backyard. We believe that by using the Four R's (Brayboy et al., 2012) to guide our interactions, activities, and collaboration, we were able to effectively lay the foundation for future collaborative efforts with individuals and organizations that implement place-based learning strategies. Our hope is that by providing an improved understanding of diversification in endemic organisms, students will be more committed to the protection and management of Galápagos biodiversity.

We will continue to work with teachers to further their pedagogical content knowledge in evolution (Cotner & Moore, 2018; Ziadie & Andrews, 2018) in order to support them in developing effective lessons for their students. Similarly, we will engage conservation agencies (i.e. Charles Darwin Foundation, Galápagos National Park, Island Conservation) in developing hands-on evolution-based curricula using real-time examples of evolutionary studies in the archipelago, including our own. Our ultimate goal is to support the coordination and facilitation of scientist-school-community collaborations to increase reciprocity and understanding of the natural environment by all inhabitants.

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Author Contributions

The manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript.

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ABBREVIATIONS

NGOs: Non-Governmental Organizations; SVS: Sea View School

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