Broadening the Impact of K–12 Science Education Collaborations in a Shifting Education Landscape

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For more than 75 years, scientists and educators in New Mexico have provided programs that translate research on dryland ecosystems into broader scientific understanding for the public. Kindergarten through twelfth grade (K–12) students and teachers became a primary audience for these programs in the 1990s. Our team from the Jornada Long-Term Ecological Research Program, the US Department of Agriculture Agricultural Research Service Jornada Experimental Range, and the nonprofit Asombro Institute for Science Education navigated changes in K–12 science education to educate more than 200,000 students. The goal of this article is to describe our program's responses to six education trends in order to provide experience-based guidance to others designing and delivering K–12 programs in a shifting science education landscape. We expect our experience will be relevant to others who are trying to scale their outreach programs to larger, more diverse communities while maintaining alignment with changing trends in education at local, state, and federal levels.

Keywords: deserts, ecology, education, K–12 science education, ecological literacy

For several decades, ecologists have challenged each other to get involved in ecology education for kindergarten through twelfth grade (K–12) students by outlining the importance of the endeavor and practical strategies to accomplish it (Feinsinger 1987, Metzgar et al. 1994, Feinsinger et al. 1997a, Brewer 2002; Komoroske et al. 2015). More than 41% of people 25 years and older in the US have not attended college (US Census Bureau 2013), so formal ecological learning for most people occurs exclusively at the K–12 level. Unfortunately, science instruction time, including time for ecology, has decreased in the last decade (Griffith and Scharmann 2008, Milner et al. 2012), making the goal of an ecologically literate public seem increasingly challenging. Ecologists and ecology educators can help K–12 students understand how the ecological concepts they read in their textbooks apply to the ecosystems just outside their classrooms and homes. Ecologists can also communicate the excitement of new discoveries in ecology. It is therefore critical that ecologists and science educators infuse quality ecology education into students' K–12 experiences.

Although many K–12 ecology programs have been implemented in the last several decades (e.g., Bestelmeyer et al. 2015, Monroe et al. 2015), the need still surpasses the number of programs. Long-term, site-based ecological studies have the capacity to help fill this gap. Several studies have documented the value that scientists and policymakers place in long-term ecological studies (Lindenmayer et al. 2012, Hughes et al. 2017). An additional benefit of these studies is the role they can play in educating generations of students about their local ecosystems. In contrast to studies that end in just a few years, long-term projects may extend for decades, spanning the entire K–12 experience of thousands of students in the surrounding region. This provides an opportunity for students to get a front-row seat to ongoing research taking place nearby. As students conduct their own studies, existing long-term research can provide a temporal context, allowing students to examine changes in the system over time. Furthermore, groups of scientists who work on these long-term studies gain a deep understanding of the ecosystem. By forming relationships with the K–12 community and sharing this knowledge, they can help inspire generations of K–12 students who leave school with an understanding of the ecosystem where they live and the ability to make informed decisions about it.

The Long-term Ecological Research (LTER) program has broadened the impacts of long-term, site-based research through a variety of education and outreach programs. Each of the 28 LTER sites has developed curriculum and/or hands-on science activities for K–12 students and teachers (*https://lternet.edu*). Many sites began K–12 programming

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in 1998 when Schoolyard LTER supplemental funding from the National Science Foundation became available. Most sites leverage these small supplements (less than $25,000 per year) with other grants and donations from individuals, businesses, and foundations to create varied programs that deliver locally relevant ecology content and practices.

The key to LTER and other successful education programs is adapting to the changing needs of the K–12 community, as dictated by shifts in local, state, and federal policies, as well as educational trends. In the context of school systems in which little ecology is taught, ecology education programs brought into K–12 schools must be designed to meet the needs of the community. A field trip, classroom activity, or full curriculum designed a decade ago and never updated will likely be out of touch with current needs. Just as the types of research questions that are asked change with a deeper understanding of the ecosystem (Foster 2012), so does the approach taken in transferring that information to K–12 teachers and students.

Jornada outreach and education

In this article, we document a case study of adaptations to local K–12 needs that have informed education programs at the Jornada Basin LTER in New Mexico. Research at the Jornada focuses on key factors and processes that control ecosystem dynamics in Chihuahuan desert landscapes, which are representative of many arid and semiarid ecosystems in the world. The site is located 25 kilometers (km) northeast of Las Cruces, New Mexico, and 95 km north of the US–Mexico border (Havstad et al. 2006). Approximately 210,000 people live in Doña Ana County surrounding the site. Hispanics or Latinos make up 67% of the population, and 51% of the population speaks a language other than English at home (US Census Bureau).

The Jornada Basin LTER K–12 program is led by a local nonprofit organization, the Asombro Institute for Science Education, with significant collaboration and support from the Jornada LTER program and the US Department of Agriculture Agricultural Research Service (USDA ARS) Jornada Experimental Range. Scientists with the LTER and USDA provide background information and help lead field trips, classroom lessons, and teacher workshops. Throughout this article, we will refer to all members of this collaboration as Jornada educators. Our K–12 programs fit into a broader umbrella of Jornada LTER education and outreach, which also includes outreach to land managers, technology development and transfer, data and information accessibility, and media communications.

The primary goal of Jornada's K–12 ecology education programs is to infuse more local ecology education into the K–12 curriculum, thus exposing students to knowledge and scientific practices relevant to their surroundings. We measure success by the number of ecology lessons we bring to students, as well as teacher feedback. Since 1998, we have had more than 240,000 direct K–12 student contacts and provided more than 8500 hours of education through field trips, schoolyard ecology programs, and in-class lessons. Another indicator of success is demand for programs, which has increased from 2385 students reached in 2000 to 22,833 students reached in 2017, primarily because of teachers recommending quality programs to their colleagues.

An additional goal is to increase student understanding of science content and practices. Evaluating achievement of this goal is more challenging, given the short duration of our programs (often 1 to several hours) and our unwillingness to contribute to test fatigue and test anxiety that are prevalent in schools with high-stakes standardized testing. We rely primarily on evaluation tools such as teacher surveys and limited pre- and post-program tests to assess this goal.

Our program has infused ecology into every grade level and received funding from one school district to conduct programs for all students at chosen grade levels. The longevity and extent of our programs stem primarily from our ability to adapt to the changing needs of the K–12 community. Some changes are relatively gradual and are dictated by improved understanding of student learning, whereas others are more abrupt and are influenced by policy shifts at national, state, and school district levels. Regardless of the source, we have chosen to use the word *trend* to describe each change that affects how we deliver K–12 ecology education. Although dozens of trends have affected K–12 science education over the past 20 years, we highlight six trends that have had the largest impact on the Jornada K–12 education programs (figure 1).

Trend 1: Field days for adults and then K–12 students

The foundation of Jornada's K–12 program originated with the USDA ARS Jornada Experimental Range's outreach efforts for livestock producers. When scientists recognized that ranchers were not accessing USDA bulletins that provided a basis for livestock management guidelines (e.g., Jardine and Forsling 1922), they implemented field days to transfer information. Starting in 1938 and continuing into the 1950s, the Jornada hosted 15 Ranch Days that employed several features: (a) summaries of research communicated at field sites, (b) involvement of local university faculty and administrators, (c) attendance of producer associations and elected representatives, and (d) a barbecue lunch. Ranch Days were generally attended by more than 300 people (figure 2), and the events supported research that shows that field days are an effective method of technology transfer and relationship building among researchers and practitioners (Rzewnicki 1991). It is not uncommon for participation in annual field days to decline over time (Long et al. 1995). Jornada's Ranch Day program experienced this decrease in the 1950s, as well as in 1987, when an effort was made to reestablish the event.

Although Ranch Days were ultimately discontinued, they prompted Jornada scientists to recognize that several of the features that made early Ranch Days successful could be used for field trips for K–12 students, an audience that had

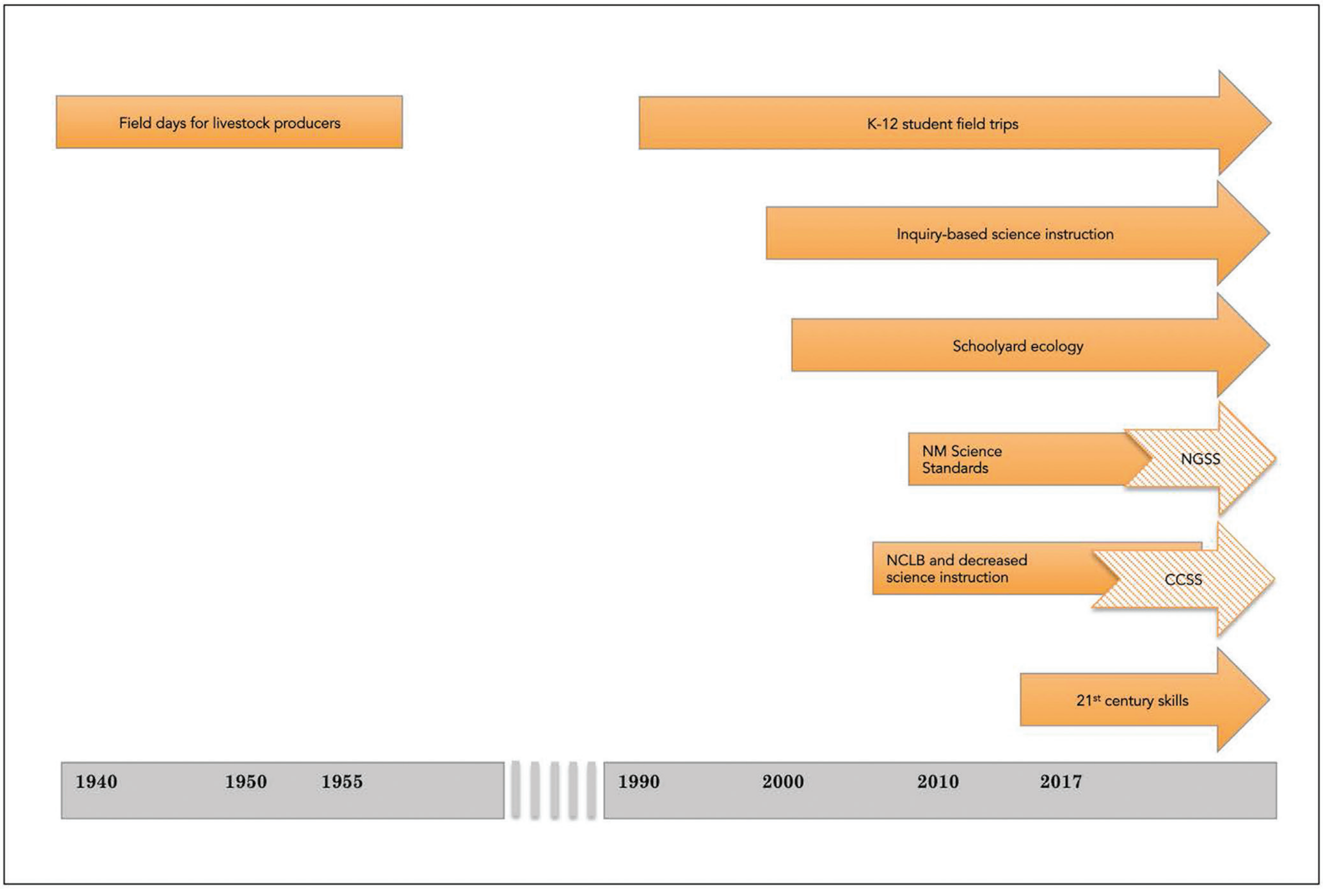

Figure 1. Large changes have occurred in the policies, standards, and trends that dominate science education in K–12 schools. For more than 75 years, scientists and educators in New Mexico have worked through these changes to translate research on dryland ecosystems to broader scientific understanding for the general public. Early efforts took the form of field days for livestock producers. In the last 27 years, efforts have focused on K–12 students and teachers. The six trends that had the largest impact on the Jornada K–12 program are shown, including Next Generation Science Standards (NGSS), No Child Left Behind (NCLB), and Common Core State Standards (CCSS).

been largely ignored by regional outreach efforts. This audience, increasingly urban in recent decades, was seen as inadequately informed about their natural environment. Initially, the Jornada Experimental Range conducted the K–12 field trips, but requests for programs soon exceeded the capacity of scientists. The Jornada reached out to the Asombro Institute for Science Education, the nonprofit that now leads the Jornada Basin LTER K–12 efforts, to collaborate in organizing and running K–12 field trips.

Field trips by K–12 students to nature parks and similar venues can have long-term effects on students' knowledge and pro-environmental attitudes (Farmer et al. 2007, DeWitt and Storksdieck 2008). Jornada's K–12 field trips have persisted for more than 25 years, and more than 1500 students each year visit the research site to learn about the local ecosystem and methods used to study it. The field trips have helped us meet the goal of infusing more ecology education into the K–12 curriculum because many teachers choose this field trip over less science-focused options common in this area, such as the movie theater. The K–12 field trips share a primary characteristic of the Ranch Days for livestock producers; students learn about current research through activities developed with input from research scientists. Because many experiment stations and land-grant universities have similar histories of providing field days for adults, they could use this experience to serve the K–12 community.

Trend 2: Inquiry-based science instruction

The Jornada's development of a formal K–12 field trip program took place in the mid-1990s, when the concept of teaching science through inquiry received a surge in interest with the publication of the National Science Education Standards (National Research Council 1996). The standards explained, "Full inquiry involves asking a simple question, completing an investigation, answering the question, and presenting the results to others" (NRC 1996, p. 122). Although the concept of inquiry-based science instruction was already well established (as reviewed by Haury 1993),

Figure 2. One of the earliest Jornada education and outreach programs was Ranch Day in October 1940. The participants listened to research updates at field sites and socialized with each other and with scientists at a barbecue hosted by the site. More than 300 people were in attendance at many of the early Ranch Days events (USDA file photos accessible at https://jornada.nmsu.edu).

the new standards expanded the vision to include students at every grade level using scientific practices and critical thinking to develop scientific understanding. Inquiry was so central to the standards that Inquiry and the Science Education Standards (NRC 2000) was published 4 years after the standards to answer frequent questions and provide case studies for administrators and teachers.

Inquiry-based teaching strategies were a natural fit for Jornada field trips. We developed activities that involved students in smaller-scale studies using research techniques that scientists use to answer their own questions. For example, third grade students learn about desert animals' use of favorable microclimates by working in groups to measure temperature and humidity at different depths underground in holes we dig to simulate animal burrows. They practice scientific communication by reporting their findings to the group. To gain insight into what scientists are learning about the effects of changing amounts and variability of precipitation on plants, seventh grade students collect and analyze data on plant biomass in control plots and plots covered by 50% rain-out shelters, modeling a research study being conducted nearby (Gherardi and Sala 2013). Teachers choose from a menu of grade-specific stations such as the two mentioned above. New stations are added each year to reflect current Jornada research.

Our program was fortunate to develop the structure of our field trips when inquiry-based instruction was gaining more interest in the K–12 community. This trend became a major focus of every subsequent field trip, schoolyard investigation, and classroom lesson we have developed.

Trend 3: Schoolyard ecology

Budget and time constraints, teacher apprehension, and a lack of administrative support sometimes prevent K–12 students from attending field trips to natural areas (Tal et al. 2014). However, meaningful, inquiry-based ecology education can still take place in schoolyards. The National Science Foundation launched the Schoolyard LTER program in 1998 based on successful projects such as Schoolyard Ecology for Elementary Science Teachers, which developed activities and professional development for teachers that helped them eliminate barriers to engaging students in schoolyard ecology (Hogan and Berkowitz 2000). Scientists and science educators have also provided useful frameworks for the types of questions that could be successfully addressed in schoolyards (Feinsinger et al. 1997a, Feinsinger et al. 1997b). The emphasis on inquiry in the National Science Education Standards (NRC 1996) also resulted in additional support for schoolyards as sites for ecological investigations.

The Jornada K–12 program responded to this interest by developing the Schoolyard Desert Discovery Project between 2000 and 2005. The project includes 36 activities divided into seven topic modules: weather, microclimates, soil, vegetation, arthropods, vertebrates, and biodiversity. Students go into the schoolyard to investigate teacher-driven questions or to test their own questions. Schoolyards vary considerably in their structure, size, and inclusion of natural desert vegetation, so we designed all but a few of the activities to work in schoolyards with minimal natural areas. We added a "Tips for entire class participation" section to each lesson's educator guide to help alleviate teachers' concerns about conducting schoolyard investigations with large classes (Hogan and Berkowitz 2000). Over the years, teachers have contributed ideas that are added to the teacher guides.

We have hosted more than 25 teacher workshops for Schoolyard Desert Discovery, allowing teachers to practice the activities while gaining better understanding of desert ecology. In anonymous, open-response workshop evaluations, teachers often write that the standards-based activities are effective in developing students' critical thinking skills through hypothesis testing and analysis of data. To combat a lack of science resources in many local classrooms, we assembled kits for each module that include all the equipment and consumable supplies necessary to conduct schoolyard lessons. We update the activities regularly to ensure that they still reflect our most up-to-date knowledge of the desert system. Even 18 years after the activities were first developed, teachers still borrow kits to conduct schoolyard lessons with their classes. In addition, Jornada educators continue to use many of these activities in programs that we bring directly into schools.

Trend 4: Adoption of new science education standards

Science education standards explain what students should know and be able to do in each grade. We noticed a large effect on the local K–12 community in 2003 when the New Mexico Public Education Department approved new state science standards. Administrators and teachers immediately adjusted their curriculum to meet these standards. Teachers reluctantly dropped excellent science activities that fell outside the scope of the new standards for their grade level.

In order to meet the needs of the K–12 community, we aligned our education programs to the new standards. In some cases, this meant revising a program to become age appropriate for a new grade level in which the topic was covered. In other cases, it meant developing programs specifically for the science standards, which presented opportunities to add ecology education based on the latest Jornada research. For example, under the 2003 New Mexico science standards, many ecology concepts were part of the seventh grade curriculum (e.g., identify the living and nonliving parts of an ecosystem and describe the relationships among these components). To meet this need, we designed a program that allowed students to go to their schoolyards once a month with Jornada educators to complete an investigation of a topic (e.g., soil, vegetation patterns). At the end of each lesson, students added to a qualitative conceptual model (Dresner and Elser 2009) showing direct and indirect relationships between components of the system. By the end of the year, students had a rich conceptual model that covered seventh grade ecology standards. Schoolyard LTER supplements and grants from other sources funded the program for several years. Our staff was told that teachers reported to their administrators that students' interest in and understanding of ecology increased as a result of the project, prompting school district administrators to contract Asombro to work with each of the approximately 1800 seventh grade students in the district for the past 5 years. Ecology education based on Jornada research is now part of every student's seventh grade experience.

For more than a decade, states used their own science education standards, which were variable in the degree to which they followed the 1996 National Science Education Standards. In 2010, there was a renewed interest in the development of national standards to establish a common foundation of what students need to know to become scientifically literate. The Next Generation Science Standards (NGSS), released in 2013, had the goal of moving away from a wide array of fact-based standards and toward a deeper understanding of fewer concepts that students learn by incorporating science and engineering practices. NGSS were based on The Framework for K–12 Science Education (NRC 2012), which introduced three dimensions: (a) disciplinary core ideas, (b) crosscutting concepts, and (c) scientific and engineering practices. As of July 2018, 19 states and the District of Columbia had adopted NGSS.

Although New Mexico did not officially adopt NGSS until 2017, the largest school district in southern New Mexico began using them in 2015. This gave us the opportunity to meet a district need by creating a lesson designed specifically to address energy, one of the NGSS crosscutting concepts. Traditionally, students learn energy concepts such as food webs and photosynthesis in their life science classes. They learn energy concepts such as potential and kinetic energy in their physical science classes. The NGSS helps students see that all of these energy concepts are intertwined (Nordine 2016). We developed an eighth grade lesson on a charismatic desert species, the kangaroo rat, that allows students to trace transfers and transformations of kinetic and potential energy in food webs, foot drumming behavior, thermoregulation, and photosynthesis. Because of our design of the lesson to align with NGSS, one school district contracted us to deliver the lesson to every eighth grade class (approximately 1700 students) in the 2016–2017 and 2017–2018 school years.

Post-program evaluations showed the teachers' appreciation for the NGSS-aligned programs. For example, one teacher wrote, "I love how the lesson fits right in with my Energy Unit and how it reactivates what they learned in seventh [grade]!" On these same surveys, every teacher ($N = 39$) rated the lessons as *excellent* (97%) or *good* (3%) in correlating with content standards, as well as *excellent* (95%) or *good* (5%) in aligning with science practice standards.

Common standards that are used by multiple states also create an opportunity to develop NGSS-aligned science education activities that meet the needs of K–12 educators in multiple states. We capitalized on this opportunity with the creation of a middle and high school curriculum focused on climate change and the water cycle in the southwestern United States (*https://swclimatehub.info/education/climate-change-and-water-cycle*) for the USDA's Southwest Climate Hub. During the first implementation of the program, 39 participating students showed gains in their understanding of climate change. Before the program, 48% of students were able to name a greenhouse gas, and 52% were able to identify the relationship between global temperatures and carbon dioxide levels. These increased to 91% and 86%, respectively, after participating in the lessons. Rather than aligning each of the module's 10 activities to individual states' standards, we aligned them with NGSS (and also the Common Core State Standards discussed below), making them relevant for all the states using NGSS.

Figure 3. When the local school district recognized that students whose first language was not English were slipping behind their native-English speaking peers, they contracted the Jornada program to develop inquiry-based ecology education programs with student handouts and teacher background information in both Spanish and English. These activities are being used in fourth and fifth grade classes in southern New Mexico to increase the amount of science instruction time. One activity includes students spending several weeks tracking the population size of various arthropod species that hatch from soil collected in playas, ephemeral lakes in the desert.

Trend 5: Reduction in science instruction time in elementary education

Concurrent with changes in science education standards in the early 2000s, large education policy changes had the unintended consequence of reducing science instruction time in elementary schools. The No Child Left Behind Act of 2001 (NCLB) was created to "close the achievement gap with accountability, flexibility, and choice, so that no child is left behind" (US Department of Education 2001). Almost immediately, NCLB drew criticism for its structure and implementation (e.g., Meier and Wood 2004). One of the most challenging aspects of NCLB was the implementation of adequate yearly progress (AYP) goals. Goals were measured, in part, by student achievement on standardized tests, and there were severe consequences for schools not meeting those goals.

For the first 5 years, AYP included students' scores on tests in only two subjects: language arts and math. This resulted in decreased time elementary teachers spent teaching science (Diamond and Spillane 2004, Goldston 2005, Griffith and Scharmann 2008). Some teachers reported that administrators told them to decrease science instruction time to allow more math and reading time (Kim and Sunderman 2005, Milner et al. 2012). Elementary student testing in science began in 2007, but these scores did not contribute to AYP, so emphasis on reading and math, at the expense of science, continued. We saw another reduction in 2010 when New Mexico adopted the Common Core State Standards (CCSS), mathematics and English language arts standards that have been adopted by 41 states and the District of Columbia. NCLB was replaced by the Every Student Succeeds Act in 2015; however, reduced science time in elementary schools remains.

Our response to this decline in science instruction followed the advice of Marx and Harris (2006, p. 475) after NCLB implementation: "Science curriculum, highly suffused with language arts and mathematics, may be science education's best bet for gaining a foothold for ambitious inquiry instruction in elementary schools." We developed Desert Stories, three-lesson modules for second, third, and fourth grade students. Each program covers language arts and math standards from CCSS while centering on an engaging desert ecology story. For example, in the third grade module, students learn about the mutualism between the yucca, New Mexico's state flower, and the yucca moth through two experiments (with data analysis and graphing), a play highlighting the life cycle of the moth, guided reading of a picture book about the mutualism, and a parts-of-speech scavenger hunt with sentences from the book. Teacher responses to these Desert Stories modules have been overwhelmingly positive. On 32 anonymous teacher evaluations ranking programs from 4 (*excellent*) to 1 (*poor*) in 2017–2018, the teachers gave programs a rating of 3.9 for both overall quality and alignment with standards. The teachers reported that they were excited to get science back into their classrooms while simultaneously satisfying the emphasis on reading and math that began with NCLB and has continued with CCSS.

Students whose first language is not English (English Language Learners or ELLs) have been especially affected by the reduction in science time in elementary school. Pressure to increase students' reading proficiency often leads schools to pull ELLs out of nonreading time, such as science time, to work on English language development. One school district recognized the growing gap in science proficiency between ELLs and native English-speaking students and asked us to create Spanish language materials about the desert ecosystem for use in fourth and fifth grade classes (figure 3). The result was a science module containing seven activities corresponding with a bilingual nonfiction science book about the Chihuahuan Desert (Mihok 2014). Activities are aligned with science, language arts, and math. All student handouts are available in both Spanish and English, so teachers can give the appropriate handout to each student. At teachers' request, we included background information in both English and Spanish, thus giving teachers the Spanish vocabulary for the science content. Teachers gain access to the module through workshops in which we preview the activities. The teachers' enthusiasm for the Spanish language materials is evident in their anonymous workshop evaluations (box 1).

Box 1. Sample of comments from open-ended, anonymous post-workshop teacher evaluation about Jornada's Spanish and English science lessons for fourth and fifth grade students.

"Having the lesson plans and materials brings me the joy of teaching back. I don't spend time away from my own kids to find, translate, and prepare. Thank you very much."

"I can't wait to do the activities with my students."

"Excellent Spanish sources and materials!"

"Thank you for thinking of the bilingual students."

"I really like that the information is in Spanish, and the activities are really engaging."

"I especially am thankful that everything is translated. I am so happy that the standards are listed as well."

Trend 6: Twenty-first century learning

While schools were grappling with the implications of AYP, another concept of how to educate students was emerging. This framework for twenty-first century learning (Partnership for 21st Century Learning 2007) was developed by a nonprofit in collaboration with the US Department of Education and businesses. The framework included a set of essential learning and innovation skills: critical thinking, communication, collaboration, and creativity (the 4Cs). The 4Cs were proposed as skills that should be woven into all school subjects.

Although the K–12 ecology programs we had developed in the last decade emphasized critical thinking and collaboration, we saw opportunities to help students with the other two Cs: communication and creativity. We developed a fifth grade program to help students gain communication skills related to their new understanding of ecology. The project was built on research showing the effectiveness of learning by teaching (Aslan 2015) and the benefits of near-peer teaching, in which a student at a more advanced school level teaches a less-advanced student (Campolo et al. 2013). Fifth grade science interns first gain content knowledge by engaging in three inquiry-based lessons taught by Jornada educators. Then fifth graders create their own hands-on lessons about this content or use lessons we developed to teach younger students at their schools. The teaching events have taken various forms, from a Desert Day event during which fifth graders present hands-on activity booths to other classes at the school, to science interns teaching in several classrooms of younger students. In 2017, 433 students participated in science interns, practicing the communication of ecology information through near-peer teaching.

In 2010, we developed the Desert Data Jam to foster the twenty-first century skills of communication and creativity, along with data literacy and critical thinking, in middle and high school students (Bestelmeyer et al. 2015). Desert Data Jam challenges students to use ecological data sets collected by scientists in our region (*www.ecotrends.info*; Peters et al. 2013) and develop creative projects to showcase the results to nonscientists. Creative projects have included models, poems, paintings, videos, infographics, and raps.

The Desert Data Jam is now in its eighth year in New Mexico, and similar Data Jam competitions have been started in Maryland, New York, and Puerto Rico by LTER and other science education providers (McGee and Rodriguez 2017). Students gain a better understanding of the data and then exhibit communication skills and considerable creativity to present the data and patterns in the data in an interesting way. At the end of the project, students write a brief, open-ended reflection on the experience. In a sample of 43 projects in the 2017 competition, 84% of the students reported that using creativity was a highlight of the experience. Example student responses include the following: (a) "The Desert Data Jam definitely helped us understand how you can interpret data in many different ways. It helps to relate it to something you enjoy or understand, so you can comprehend the experiment and the data. The creative project is what helped us the most." (b) "For us, we agreed that the most fun part of this project was making the creative product. It allowed us to express our creative side and show ourselves as a writer and an artist. It allowed us to do something that we enjoy, and yet somehow connect that with this project."

Discussion and recommendations

Most people will never receive formal training in ecology as adults. Their understanding of ecological systems and their abilities to make informed decisions about issues affecting these systems will be shaped by the ecology they learn during their K–12 education. It is therefore imperative that scientists and science educators assist the K–12 community by providing them with ecology education programs that give students the skills and knowledge they need while aligning with standards, policies, and other trends shaping the K–12 system.

Meeting the K–12 community's needs does not necessitate changing the ecological principles that we teach. However, the packaging of the content may need to be modified. For example, the topic of desert plant adaptations takes multiple forms for different age groups at Jornada from a basic introduction to plant adaptations using observations and role playing for lower elementary students to long-term measurements of plant composition in restoration plots for high school students. When schoolyard ecology became popular, we packaged lessons to take advantage of small areas of native plants near schools. When reading and math became emphasized over science, we packaged the topic by creating a fourth grade module that covered science, language arts, and math standards. Students continue to learn science through programs that are supported by teachers and administrators because of their coherence with educational trends.

We recognize that we are in a favorable position to create long-term K–12 ecology programs because of the existence of a local science education nonprofit, as well as a legacy of LTER and USDA scientists with commitment to K–12 education. Similar situations exist at other US and international LTER sites (*www.lternet.edu*), but this still leaves large areas of the world without similar partnerships available. However, even geographically isolated ecologists and science educators can overcome potential obstacles (Komoroske et al. 2015) and assist their local school systems by providing field trip opportunities, guest lectures, and classroom and schoolyard visits to lead ecology education lessons. The first and most important step is to talk with school administrators and teachers and determine their needs. If the school district has adopted NGSS, develop or adapt an ecology education program that aligns with those standards. If elementary teachers are having difficulty fitting science into their reading- and math-focused curriculum, find a quality book related to the local ecosystem (such as titles from the LTER Children's Book Series) and create a lesson that simultaneously covers language arts, math, and science. If a school is unable to take field trips because of budget constraints, help students by taking them outside to discover the excitement of ecology in their schoolyards. The possibilities are nearly endless, but they all must start by asking what the schools need most.

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