Interdependence in the Garden Ecosystem: A Next Generation Science Standards aligned Curriculum.

In this 12-lesson series, students will explore the basic ecological principle of **interdependence** through the lens of common organic farming practices. Over the course of the series, students will explore a variety of questions:

- What does it mean when we say that the garden is an "ecosystem"? What evidence do we have of this?
- How do common farming practices such as cultivating and tilling the soil, companion planting, hand weeding, and composting affect the wellbeing of our crops?
- What role do they play in the garden ecosystem overall?

At the end of the unit, students will apply what they have learned to develop crop planting proposals. Their proposal will include which crops they would like to plant, when they want to plant them, how they anticipate caring for them, and the ecological justifications for their plan. Additionally, students will reflect on and describe the other considerations that might play a role in their planning, such as the cultural relevancy of certain crops to their communities, their aesthetic visions for the garden space, the market value of certain crops, and their visions for how the food from the garden might be used, among others.

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NGSS in the Garden

Gardens are teeming with potential for scientific inquiry. Fascinating phenomena can be found everywhere you look—from how the plants and other organisms grow and interact with one another, to the minerals in the soil and the weather in the sky. It also forms the foundation of many of the farming practices that have defined organic agriculture for millennia. These practices were, after all, developed over many years based on close observations and evidence-based conclusions by the scientist-farmers who developed them. In this curriculum, we use basic organic farming practices as a jumping-off point for better understanding how the garden works. This approach is a natural fit with the Next Generation Science Standards (NGSS).

NGSS was designed to support students in learning not just scientific *facts*, but also the *practices* that lead to scientific knowledge and discoveries. In the garden, the possibilities for NGSS application are endless—asking questions about why certain crops grow the way they do; carrying out an investigation to explore the impact of fertilizer on plant starts; analyzing data on the role of temperature on germination rates in seeds; constructing evidence-based arguments for the benefits of school gardens for student mental health etc., and the list goes on.

Our Approach to NGSS

In this curriculum, we wanted to emphasize the delivery of standards through hands-on garden engagement. All the lessons take place in the garden classroom, and a majority include a gardening activity. When students aren't actively gardening, they are conducting observations or analyzing data collected firsthand in order to better understand how the garden functions as an ecosystem. They apply all this learning to make decisions about how to tend to the plants they're growing, and to develop planting plans in the final lesson of the series.

This curriculum also includes a fair amount of reading and textual analysis. These activities may feel awkward at first in the garden, but we encourage you to take advantage of the unique benefits the garden has to offer. Give students time to find a place they feel comfortable settling in with the material. We have found that offering students opportunities to learn through doing *and* reading (in addition to talking, writing, observing, planning etc.) can help make clear the sometimes complicated ecological concepts they'll be engaging with. Every lesson plan offers teacher notes for support, including resources for supporting student literacy.

The Standards

This lesson series focuses on three main performance expectations from NGSS:

MS-LS2-1. **Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.**

MS-LS2-3. **Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.**

MS-LS2-4. **Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.**

Most lessons in this series touch on learning that supports aspects of all three of these standards, but certain standards are foregrounded in different lessons. For example, in Lesson 3: Cultivation, students begin a unit-long project in which they analyze the impact of growing plant starts in cultivated vs. uncultivated soil, as well as soil that has or hasn't been amended with compost. This is their first introduction to considering the impact of resource availability on living organisms in the garden.

Throughout the unit, they elaborate on their understandings by making observations about the effects of sunlight, soil moisture, soil type, and other environmental conditions on crops in Lessons 4-6. Students also develop their understanding of how interdependent relationships in the garden ecosystem function through investigating biotic relationships in Lesson 7: Biotic Interactions.

Their multifaceted understanding of ecological interdependence forms the foundation for diving into the cycling of matter and flow of energy. In Lessons 9-12, students explore food webs, decomposition, and the basic principles that govern how matter and energy move in a garden ecosystem.

Finally, in Lesson 13: Final Project, students apply all their learning to develop a planting proposal. They support their proposed plan with evidence from their learning and observations, including explanations for how they anticipate the physical and biological components of their plan to support the well-being of the crops.

While these lessons were designed with certain standards in mind, we encourage you to use this curriculum as you see fit! Adapt it to suit your garden, your location, and your students. At best, these lessons should offer a place-based education—emerging from you and your students' real and immediate context.

Curriculum Writers

Molly Rose-Williams, Consultant, and lead writer

Molly is an educator, artist, writer, and audio producer. Her relationship with The Edible Schoolyard started when she was 11, as a middle school student at Edible Schoolyard Berkeley. She went on to become a garden intern in 2014, and then a cooking teacher in the ESY Kitchen classroom from 2015-2018. Since then, she has worked in a variety of educational settings, including as Lead Curriculum Developer for Impact Science's hands-on NGSS middle school science curriculum. In every setting, Molly is committed to developing meaningful and relevant learning experiences that allow students to deepen their connections with their bodies, the places they live, and the land we live on.

Raquel Vigil, Designer, and writer

Raquel is the Director of Learning at The Edible Schoolyard Project and a co-designer of Edible Education at Home. Raquel is an educator and curriculum designer specializing in creative education, food curricula, and land-based pedagogies. She is interested in pedagogy that encourages deep inquiry, critical thinking, and imagination. Raquel holds a Masters in Curriculum and Teaching from Teachers College, Columbia University, and a Certificate in Horticulture from the Center for Agroecology and Sustainable Food Systems.