Theme Four: Nature's Design

Systems, Cycles, Patterns, Relationships, and Adaptations in the Garden System

Theme Four explores the physical and biological sciences of the natural world. "How would nature do it?" is an important question for inventors, engineers, and designers of ideas, products, and processes. These processes hold essential knowledge for creating a more sustainable world. Acquiring that knowledge requires observation and exploration of nature's systems. The school garden is the perfect nexus of the big four: Food, Water, Energy, and the Recycling of Natural Resources. Today we call this "education for sustainability." Themes Two and Four engage students with Next Generation Science and Engineering Practices that examine disciplinary core ideas and crosscutting concepts. The School Garden Curriculum Map provides an instructional strategy to explore ecological interdependence, growth and development of organisms, structure and function, energy and matter, adaptation, and the environmental impacts of human activity.

Nature's Design: Systems, Cycles, Patterns, Relationships, and Adaptations in the Garden System
Theme 4: Curriculum Map – K–2

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
Food	The plant nutrient cycle (Carbon cycle, nitrogen cycle, N-P-K, and minerals in plant growth)	Understand that plants need water, sun, and nutrients to survive and thrive. Recognize that composting recycles nature's nutrients (greens are nitrogen and browns are carbon).	Students tend the classroom garden and learn what plants need to thrive. Students build, care for, harvest and apply compost to the garden K2. 2-7	What do humans, plants, and animals need in order to survive and thrive? How are humans and plants the same or different? K2. 4-2	K.RI.1 K.SL.2 1.RI.10 1.SL.2 2.RI.3 2.SL.2	K.CC.5 1.NBT.1	K-LS1-1 2-LS2-1 SC.K.1.2 SC.1.3.1 SC.2.4.1	1.2.2 HE.K-2.1.2
	The Soil Food Web The Soil Food Web is a complex living system of organisms in the soil and their interactions with each other, the environment, plants and animals	Show understanding of the relationship of organisms in a food web. Recognize that healthy soil grows healthy plants and healthy people. Recognize that soil is a living system full of organisms that transform organic matter into food for plants.	Students grow, harvest, prepare and eat simple snacks from the garden. K2: 3-14 Identify, observe, and record/draw organisms in soil and compost. K2: 2-5 Learn the FBI song. K2: 2-4	Use magnifying tools to observe selected soil samples. How are they the same or different? Create a collection of organisms found outdoors (, insects, living, and nonliving materials). Create a Nature Table in your classroom of found and/or seasonal natural objects.	K.W.2 K.W.7 1.W.7 1.SL.4 2.W.7 2.SL.2	K.MD.3 1.MD.4 2.MD.10	K-ESS3-1 1-LS1-1 2-PS1-1 SC.K.4.1 SC.1.3.1 SC.2.3.1	1.2.2 2.2.2 HE.K-2.5.1
	Growing systems in Hawai'i: • Indigenous, • Conventional • Aquaponics • Hydroponics • Agroforestry • Permaculture • Organic gardening	Understand where our food comes from and that it is grown in different ways.	Share stories about, identify, grow, and taste a few canoe crops. K2: 1-7 Classroom or garden discussion: Where does our food come from, (e.g., garden, farm, farmer's market, the wild, supermarket, ocean, forest, etc.)?	Create a wall chart of pictures drawn by students identifying sources of food in their community. Visit a local food market or farm and write a reflection and/or thank you letter on return.	K.SL.1 K.SL.2 1.SL.1 1.SL.2 2.SL.1 2.SL.3		K-ESS2-2 2-LS4-1 SC.K.1.2 SC.1.4.1 SC.2.3.1	HE.K-2. -2.1 2.2.2 4.2.1

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
			Students tend the school garden and observe where food comes from. Visit a local farm and observe and describe the systems that are seen.	Post the Kamehameha School's Ahuʻupaʻa poster in your classroom and use it for rich discussion, story writing, or poetry around growing and community systems.				
Energy and Matter	Energy cycles in the garden system	Understand the flow of energy from sun to plants to food (Photosynthesis) via storytelling. K2. 4-4 Explore heat sources in the garden environment and identify the source of energy. Explore and describe how the sun warms the land, the water, and the air.	Explore, record, and graph sources of heat in the garden environment with your hand or a thermometer. Explore thermal energy (e.g., heat in compost, body heat after playing and running on the field, dark and light objects - reflected heat, etc.). Plan and conduct an investigation to determine if plants can grow without sunlight. STEM Gather dry wood and show children how to make a safe fire and control it.	Identify through stories, observation, games, & discussion, what plants, animals, and people need to survive and the role the sun plays in the survival of all living things. Observe and be able to describe in a drawing or words how the sun warms the land, the water, and the air (e.g., day and night, temperature differences). Introduce the thermometer as a tool to measure and compare temperature. Explore how fire was used in different cultures and in Hawaiʻi (e.g., cooking with fire in the imu).	K.W.2 K.SL.2 1.W.2 1.SL.4 2.W.2 2.SL.4	K.MD.1 K.MD.2 1.MD.4 1.NBT.3 2.NBT.5	K-LS1-1 1-LS1-1 2-LS2-1 SC.K.1.1 SC.1.2.2 SC.2.6.1	1.2.2

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
	The Food Web, trophic levels and proportional relationships of producers to consumers, carrying capacity and population equilibrium Relationship between producers and consumers and effect on habitat	Identify and name producers and consumers in the garden. Identify and name pests and predators in the garden. Observe, discuss, and give examples of interdependent relationships among plants, animals, and humans in the garden environment. Observe and understand that resources are limited.	Identify and name producers and consumers in the garden and community. Play *The Pest and Predator Game.* K2. 2-13 Define and identify pests and predators in the garden. Create stories that describe their interdependent relationships. K2: 2-24 & 25 Find examples in the garden that illustrate how natural resources can be used or overused (e.g., soil, water, sunlight, mulch).	Draw a simple food web using local plant and animal relationships, and have the children make a copy. Then, let them construct another example using the model. Play the *Food Web Game.* Role-play using the cards. * See Appendix. Read and create stories of the interrelationships with the different organisms of the food web.	K.W.2 K.SL.2 1.W.7 1.SL.5 2.W.7 2.SL.2		K-ESS3-1 1-LSI-1 2-LS4-1 SC.K.3.1 SC.1.3.1 SC.2.3.1	
	Forms and transformation of energy: • potential • kinetic-thermal • chemical Conservation of energy	Observe the effect of sunlight on the Earth's surface. Reduce the warming effect of sunlight on an area. Describe how energy cycles from sun to plant to animal and human. Explore ways that energy can be used to move an object	Using tools and materials, design and build a structure that will reduce the warming effect of sunlight on an area. Observe and compare the temperature of differences of surfaces in the garden (e.g., mulch, soil, rock, grass, etc.). Students use a thermometer to measure and record heat in various areas of the garden. Record in Journal. How would that change over time? What	Students identify the flow of energy through the food chain. Sun-Plant-Animal-Human. Illustrate that cycle. Play a push and pull game like tug-of-war to exemplify the way energy is used to move objects. Use marbles to show how energy can move objects in different directions. Make a paper pinwheel to show the power of wind. Place light and dark	K.W.7 K.SL.2 1.W.7 1.SL.4 2.W.7 2.SL.2	K.MD.1 K.MD.2 1.MD.4 1.NBT.3 2.NBT.5	K-PS2-1 K-PS2-2 1-PS4-3 2-LS2-1 SC.K.1.1 SC.1.7.1 SC.2.3.1	

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
			would influence that change?	colored paper outside under sunlight; test by touching the surfaces which color warms up faster.				
	Chemical and physical changes in the garden system and classroom kitchen	Observe and identify that some changes caused by heating and cooling can be reversed and some cannot. Identify taste and texture differences between raw and cooked vegetables or fruits.	Offer taste tests when available. Identify taste and texture changes between raw and cooked fruits and vegetables.	Reversible changes: heat and cool water or butter. Irreversible changes: cook an egg, freeze a plant leaf, or heat paper.	K.W.7 K.SL.2 1.W.7 1.SL.2 2.W.7 2.SL.2	K.MD.1 K.G.1 1.MD.4 2.MD.10	2-PS1-4 SC.K.1.1 SC.1.1.1 SC.2.1.1	
	Fossil fuels and renewable energy inputs, outputs, and the transformation of energy	Define and identify renewable energy resources in our school, home, or community. Be able to name the renewable energy resources in the garden.	Identify renewable energy sources in the garden and the community.	Discussion: Where does our electricity come from? Where does oil come from? What is solar energy? What is renewable energy? What are examples in our school, home, and community? Show examples of the photovoltaic effect in which solar cells convert light into electricity (solar lights). Discussion: Compare a tractor, a rototiller, and a garden fork to cultivate a garden bed. Compare use of a solar pump vs. an electric pump for a hydroponic system.	K.SL.2 1.SL.2 2.SL.2		K-PS3-1 SC.K.2.1 SC.1.2.1 SC.2.2.1	

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
Water	The Water Cycle and its interrelationship with weather and climate The properties of water	Understand that all living things need water to survive. Recognize that our bodies and the earth are made mostly of water (approximately 75%). Introduce the Water Cycle and the three forms of water.	Water Cycle Relay K2: 2-13 Water-play activities in the Garden. Experiment with various sizes of containers. Water-play table. * See Appendix Sing the *Water Cycle Boogie.* K2. 4-3	Introduce the components of the water cycle and create a water cycle diagram. Experiment and describe the properties of the different forms of water. Create a small terrarium in the classroom with plants, soil, and a small container of water. Experiment using water to show floatation, mixtures, water vapor or frozen form. Check how fast evaporation can work by outlining with chalk the perimeter of a large puddle on a cement or an asphalt surface; see how long it takes for all the water to "disappear" into vapor. Read *Where Does Water Come From?* By C. Vance Cast	K.W.7 K.SL.2 1.W.7 1.SL.3 2.W.7 2.SL.3	K.MD.1 1.MD.2 2.MD.9	K-LS1-1 2-PS1-1 2-ESS2-2 SC.K.1.2 SC.1.2.2 SC.2.1.2	
	Recognize the action of water in living systems	Develop a model or solution that slows or prevents water from making changes to the shape of the land. Discover that water flows down hill. Understand that the forest is an essential	Conduct an investigation and compare plants or seeds grown with and without water. Develop a system for watering the garden (use watering cans) and nursery plants. Learn how to water and when and how much water is needed (e.g., test for soil	Students explore how their family gets water in their home (e.g., bottled water, well, county piped water, rain catchment). Students list all the ways water is used. * See Appendix: Read or tell the story: "Rain Follows the	K.SL.1 K.SL.2 1.SL.1 1.SL.5 2.SL.1 2.SL.5		K-LS1-1 2-ESS2-1 SC.K.1.1 SC.1.3.1 SC.2.1.2	HE.K-2.5.2

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
		component of the Water Cycle.	moisture using a finger as indicator). Identify areas of the garden or school campus that are impacted by water. Discuss and design a solution for the problem. Compare multiple solutions.	Forest."				
	The hydrology of Island drinking water for Hawai'i Island.	Identify where our water comes from, how it is used, and where it goes. Discuss and create ways to conserve water at school and at home. Develop a model to represent the shapes and kinds of land and bodies of water in your area.	Investigate and discuss where the water used in our school garden comes from. Students discuss how water can be conserved in the garden.	Students share ideas about where our water comes from, how it is used in daily life and where it goes. Create a mural or model that illustrates this story. Students create a list of ways they can conserve water at school and at home. Discuss safe drinking water practices.	K.SL.4 K.SL.5 1.SL.4 1.SL.5 2.SL.4 2.SL.5	K.MD.2	2-ESS2-2	7.2.1 HE.K-2.1.5
	Water storage, sources, and management	Identify water sources or potential sources in the garden. Develop the ability to determine when a plant needs water and apply appropriately. Observe and identify water sources and storage sources at home and at school. Eliminate standing water as vector for disease. Fight the Bite. Obtain information to identify where water is	Water hunt, "Where do we find water in the garden?" How do we find water in the garden (e.g., wet vs. dry observations, testing the soil moisture with their finger) Observe and learn to read a rain gauge. Observe the role of mulch and soil in the garden (e.g., organic matter stores water). K2: 4-1 Use wise water	Students look at a map of Hawai'i and identify where water is collected and stored on the Island. Discuss salt vs. fresh water.	K.RI.10 K.SL.2 1.RI.10 1.SL.2 2.RI.5 2.SL.2	K.MD.1 K.MD.2 1.MD.2 2.MD.9	K-LS1-1 2-LS2-1 2-ESS3-3 K-2-ETS1-1 SC.K.1.1 SC.1.1.1 SC.2.1.1	1.2.3 2.2.2 HE.K-2.1.4

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
		found on Earth and that it can be solid or liquid. Students identify a water problem in the garden and develop possible solutions. NGSS - Engineering K-2 STEM	practices to maintain the garden. Eliminate standing water. Students identify a water problem in the garden or school campus and develop possible solutions.					
Natural Resource Management and Conservation	Water conservation and management	Communicate solutions that will reduce the impact of humans on land, water, air, and other living things in the local environment. Understand that water can be reused safely. Understand why it is important to use potable water for washing garden produce.	Students identify a problem concerning waste and create a solution and model to solve it. Students use safe harvesting, washing, and handling practices for preparing garden produce.	Research how people in different environments get their drinking water. Students brainstorm ideas of how to conserve water.	K.W.7 1.W.7 2.W.7		K-ESS3-3 K-2ETS1-1 SC.K.1.2 SC.1.3.1 SC.2.8.2	1.2.1 7.2.2 HE.K-2.1.4 HE.K-2.1.7
	Water quality	Identify sources of clean drinking water at school, in the garden, at home, and in the community. Recognize that rainwater is the perfect source for watering plants.	Children identify sources of clean drinking water on campus and in the garden. Discussion of the importance of drinking water during the day. Students learn how to fold a piece of paper to make a simple clean	Children share their discussions about clean drinking water. Reminding children of the importance of drinking water during the day. Making water available in the classroom.		K.G.3 1.G.2	K-LS1-1 SC.K.1.2 SC.1.3.1 SC.2.1.1	1.2.1 7.2.1 7.2.2 HE.K-2.1.5

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
			drinking cup.					
	Local sources of organic nutrients for soil fertility	Identify organic resource materials in the garden and on campus. Understand organic materials can be reused. Be able to explain how compost is nature's recycling system. Identify how worms and other organisms help recycle organic matter. Understand that food production creates discards that are organic and can be recycled.	Students look for, help gather, and use organic materials on campus that can be used for composting. Construct a composting system using recycled materials from student waste (e.g., paper, fruit and vegetable peelings) from classroom, FFVP, home, cafeteria, etc. K2: 2-7 Students observe and manage worms in the vermicompost bin. They harvest and use vermicompost in growing systems. K2: 2-3	Discuss the value of decomposition as a vital and natural process. Write a story from the point of view of an earthworm. (Read *Diary of a Worm* or The Life Cycle of an Earthworm.) Gather discards from the Fresh Fruit and Vegetable Program and give to the school garden for recycling. Make a compost bucket for collection.	K.W.7 K.SL.2 1.W.7 1.SL.2 2.W.7 2.SL.3		K-ESS3-1 2-PS1-2 SC.K.1.1 SC.1.2.2 SC.2.8.2	
	Recycling, upcycling, and downcycling of inorganic materials	Identify ways that inorganic materials can be reused. Identify waste as human discards. Understand that waste does not exist in nature. Define the 4 R's: Reduce, Reuse, Recycle, and Refuse.	Identify discarded materials from human systems and sort into organic and inorganic materials. Bury organic and inorganic materials and dig them up after 1 week, 1 month, and 6 months. Mark the spot & date. Compare and contrast. Compost, recycle, or reuse as much as possible in the garden. Discuss: Where does our trash go?	Look for ways to recycle inorganic materials in the classroom. Gather and shred used paper and use in the compost or worm bin. Participate in a school wide Zero Waste or Recycling Program. Save and utilize recyclable materials to create, repurpose, and reinvent useful products.	K.W.7 K.SL.4 1.W.7 1.SL.4 2.W.7 2.SL.4	K.G.3 1.G.2 2.G.1	K-2-ETS1-1 K-2-ETS1-2 K-2-ETS1-3 SC.K.1.3 SC.1.2.2 SC.2.8.2	

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
			Why do we have to reduce, reuse, recycle, and refuse? Where are the recycling stations on our island?	Create an art product that uses only recycled materials (Trash Art show). Read Pollution and Waste by Sally Morgan & Rosie Harlow				
	Components of air quality	Understand that human and natural systems impact air quality.	Plants and trees provide oxygen for the air we breathe. The volcanoes emit vog in the island air. People and plants can be affected by vog in different ways. All the air we breathe is the same air that has always been on the earth. Share a story about that idea and discuss.	Track daily weather by recording regularly (at the same time) on a monthly log to include sunny, cloudy, rainy, windy, and voggy days. Use collected data to bar graph and analyze results.	K.W.7 K.SL.4 1.W.7 1.SL.4 2.W.7 2.SL.2	K.MD.1 1.MD.4 2.MD.10	K-ESS2-1 K-ESS3-2 SC.K.1.3 SC.1.1.2 SC.2.1.2	1.2.2
	Carbon footprint and Carbon sequestration.	Understand that plastics are made from oil, and participate in a plastics classroom recycling program. All plastic that has ever been made is still on the earth.	Recycle all plastics that are used in the garden. Wash and reuse plastic pots. Use repurposed containers for seedlings and potted plants (e.g., egg cartons, milk cartons).	Recycle and separate plastics from paper discards in the classroom. Children create posters, stories, poems or drawings that illustrate the opportunities of recycling at school, at home, or in the community. Students discuss recycling solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.	K.W.2 K.SL.1 1.W.5 1.SL.1 2.W.2 2.SL.1		K-ESS3-3 SC.K.1.3 SC.1.1.2 SC.2.8.2	

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
				NGSS				
	Sources and Impacts (air water and soil) of clean energy in the community	Describe human activities at school or home that consume energy. Describe sources of energy for human activities.						
Best Conservation Practices	The individual's role in the conservation of natural resources. Conservation is a set of practices that preserve, restore, and protect natural resources and ecosystem Preserve, repair, and prevent deterioration of the environment, topsoil, water, and natural resources Waste is a system out of balance	Identify and describe natural resources in your community and how humans use them. Identify how resources can be renewable or nonrenewable. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. NGSS Identify invasive species in your geographical area and get to know them. Understand how they move and multiply. Understand how they impact the environment. Repair water damage and soil erosion in the garden environment. Design a Zero waste system for your garden, classroom or home.	Recycle and reuse all natural resources in the garden. Discuss how we impact the land, water, air, soil, or other living things. Identify a problem on campus or in the garden. Brainstorm and design a solution and choose one or more to implement Plant trees on campus. Native Plant identification Garden/Campus walk. Share stories of the native plants in your garden, campus, coastline, or forest. Identify and get to know invasive species in your community. Collect research by reading or asking questions. Identify ways that students can help reduce the impacts of invasive species.	What are natural resources and what is conservation? What causes an extinction of a plant or animal species? What would happen if there were no trees on our island? Discuss the impact of humans on the natural environment. What are native plant species? What are some alien and invasive plant species? How can we protect the native habitat? Identify ways that we can recycle discards in our classroom or at home.	K.W.8 K.SL.2 1.W.8 1.SL.2 2.W.8 2.SL.2 K.W.8 K.SL.2 1.W.8 1.SL.2 2.W.8 2.SL.2		K-ESS3-1 K-ESS3-3 SC.K.1.2 SC.1.2.2 SC.2.8.2 1-LS3-1 2-LS4-1 SC.K.1.3 SC.1.5.2 SC.2.8.2	5.2.1 5.2.2

Strand	Topic	K–2 Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA Standards	Common Core Math Standards	NGSS Standards	NHES
		STEM	Get to know alien invasive species in your garden, school, and community. Plant more native species in your school garden or campus and learn their Hawaiian names and stories. Plant the state flower Hibiscus Brackenridgei Ma'o Hau Hele. Create a wildlife garden section in your school garden to attract pollinators and predators.					

Nature’s Design: Systems, Cycles, Patterns, Relationships, and Adaptations in the Garden System
Theme 4: Grades 3–5

Strand	Topic	Learning Outcome	Garden Activities	Classroom Extensions	Common Core-ELA	Common Core-Math	NGSS	NHES
Food	The plant nutrient cycle (carbon cycle, nitrogen cycle, N-P-K, and minerals in plant growth)	Identify and understand which nutrients are important for plant growth (e.g., nitrogen for leafy growth, phosphorus for flowers and roots, etc.). Recognize that composting recycles nature’s nutrients (greens are nitrogen and browns are carbon). Identify nitrogen-fixing plants, observe physical characteristics and their role in the nitrogen cycle, bringing nitrogen from the air into the ground. Provide examples of how healthy soil grows healthy plants which, when eaten, can lead to healthy people.	Discuss and draw a model of nutrient cycling. Create signs and labels to place in the garden to mark carbon and nitrogen sources. Disease detective: learn to identify nutrient deficiencies on plants by reading clues (e.g., yellowing leaves, spots on leaves, etc.).		3.RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 4-LS1-1	
	The Soil Food Web: A complex living system of organisms in the soil and their interactions with each other, the environment, plants, and animals	Understand and explain that the Soil Food Web includes fungi, bacteria, and invertebrates (FBI). Provide examples that FBI and the soil food web contribute to healthy soil and more nutritious food.	Explore FBI in soil: categorize, draw, look under microscope or magnifying lenses.		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1	

Strand	Topic	Learning Outcome	Garden Activities	Classroom Extensions	Common Core-ELA	Common Core-Math	NGSS	NHES
	Growing systems in Hawai'i: Indigenous, conventional, aquaponics, hydroponics, agroforestry, permaculture, organic gardening	Compare and contrast properties and qualities of various food growing systems (e.g., yield, size, inputs, ecological impact, nutrition profile, etc.). Identify canoe-crop growing systems and experiment with growing those crops in other systems (e.g., aquaponics).	Grow food crop in two to four different systems; compare and contrast properties and qualities (e.g., yield, size, inputs, ecological impact, nutrition profile, etc.).		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 3-SR-3	
Energy and Matter	Energy cycles in the garden system	Understand and explain the transfer of energy from sun to plants to animals. Identify in the garden examples of energy transfer and flow.	Make observations of plants and animals in the garden; compare survival needs and relationships.	Create a model to illustrate and be able to explain photosynthesis and compare and contrast to animal respiration.	3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 4-PS3-2 4-PS3-4 4-ESSE-1	
	The Food Web: Trophic levels and proportional relationships of producers to consumers, carrying capacity, and population equilibrium Relationship between producers and consumers and effect on habitat	Identify producers and consumers in the garden, including humans. Investigate the relationship between producers and consumers: which population has more, how do they affect the garden systems, when are the populations out of balance and in balance. Provide examples from the garden,	Make observations of plants and animals and their role as producer and consumer.		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 4-PS3-2 4-ESSE-1	

Strand	Topic	Learning Outcome	Garden Activities	Classroom Extensions	Common Core-ELA	Common Core-Math	NGSS	NHES
		including the soil food web, energy transfer through the trophic levels.						
	Forms and transformation of energy Conservation of energy (potential, kinetic-thermal, and chemical)	In the garden, identify examples of energy types: kinetic, potential (e.g., water-storage tank), thermal (, sun), chemical (, sugar in fruits). Observe in the garden to provide evidence that energy can be transferred by light and heat (e.g., sun - corn - cooking - human).	Conduct a garden energy identification walk. Experiment with moving water in the garden using pipes, bamboo, buckets. Identify how energy is transformed as the water moves. Discuss energy transfer after eating lunch or a garden snack.	Design and develop a device or tool that converts energy from one form to another (e.g., solar oven, wind turbine, water turbine).	3.RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 4-PS3-2 4-PS3-4 4-ESSE-1	
	Chemical and physical changes in the garden system and classroom kitchen	Observe and identify that some changes caused by heating and cooling can be reversed and some cannot. Identify the physical changes (e.g., texture, color) that occur with varying cooking times. Identify the chemical changes (e.g., taste of the same ingredient), during different stages of fermentation.	Observe and discuss changes in the food before and after processing. Compare and contrast texture, color, taste, smell.		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3.LS1-1 4-PS3-2 4-ESSE-1	
	Fossil fuels and renewable energy: Inputs, outputs, and the transformation of energy	Identify renewable energy resources in the garden, school, home, or community.		Discussion topic examples: Compare a tractor, a rototiller, and a garden fork to cultivate a garden bed; use of a solar pump				

Strand	Topic	Learning Outcome	Garden Activities	Classroom Extensions	Common Core-ELA	Common Core-Math	NGSS	NHES
		Compare and contrast one renewable energy resource with fossils fuels. Evaluate impact on environment and human labor to build and maintain.		vs. an electric pump for a hydroponic system.				
Water	The water cycle and its interrelationship with weather and climate The properties of water	Understand and explain the water cycle know the terms precipitation, condensation, and evaporation. Understand that all the water we have now is the same water since the Earth was formed.	Label all parts of the water cycle. Illustrate how weather cycles impact the water cycle. Identify on a map a local watershed, including drinking water source and wastewater treatment systems. Have a class discussion.		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 4-ESS2-1 5-ESS2-2	
	Recognize the action of water in living systems	Provide examples for water as diluter, solvent, transporter, insulator, diffuser (water in any of its forms). Make observations and measurement to provide evidence of the rate of erosion by water.	Make compost tea. Students observe how the color shade of the tea gets lighter and lighter the more water you add (diluter, transporter). Experiment with putting worm castings directly into the soil versus making tea (transporter, diffuser).		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 5-ESS2-2 5-ESS3-1	
	The hydrology of Hawaiʻi Island Drinking water for Hawaiʻi Island	Recognize the unique features of the hydrology of Hawaiʻi as presented in place-based stories. Identify drinking water sources for school and home.	Identify on a map a local watershed, including drinking water source and wastewater treatment systems. Have a class discussion. Conduct tests on irrigation water or		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 3-ESS2-1 4-ESS2-1 5-ESS2-2	

Strand	Topic	Learning Outcome	Garden Activities	Classroom Extensions	Common Core-ELA	Common Core-Math	NGSS	NHES
			stream water for pH, nitrogen, phosphate, and salinity.					
	Water storage, sources, and management	Identify water systems in the garden. Understand school garden water systems as identified with public water systems. Eliminate standing water as vector for disease.	Create a water usage or best practices plan for the garden. Design an irrigation system.		3-LS1-1 3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-ESS2-1 5-ESS3-1	
Natural Resource Management and Conservation	Water conservation and management	Make observations and measurement of water use to support the argument for water conservation.	Explore various types of wastewater on campus, including garden greywater. Design as system to use garden greywater.		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 5-ESS3-1	
	Local sources of organic nutrients for soil fertility	Understand organic materials as an output and input for other organisms. Identify discarded materials from human systems and sort into organic and inorganic materials. Sort organic materials into green and brown layers. Integrate into compost systems. Identify that healthy disposal of discarded materials from human systems depends on	Create a compost pile using paper and prunings (layering brown and green waste).		3-LS1-1 3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		5-LS2-1 5-PS1-4	

Strand	Topic	Learning Outcome	Garden Activities	Classroom Extensions	Common Core-ELA	Common Core-Math	NGSS	NHES
		worms and other organisms that recycle matter and natural materials. Identify byproducts from food growing, production, transportation, and consumption.						
	Recycling, upcycling, and downcycling of inorganic materials	Identify uses of discarded materials from human systems. Identify human discards that could be composted, recycled, or reused. Understand that “waste” is made of natural resources. Identify how “waste” can be a useful material. Understand and incorporate 4R’s into daily life.	Explore using a composting toilet on campus. Audit of discarded materials in the classroom trash. Make recycling signs for campus recycling center. Set-up recycling center for garden area. Read Hawai‘i Recycling Guide. Take copy home and discuss.		3-RI.1 3.RI.2 3.RI.3 4.RI.1 4.RI.2 4.RI.3 5.RI.2 5.RI.3		3-LS1-1 5LS2-1 5-PS1-4	
	Components of air quality	Identify human activities that produce air pollution. Describe natural systems that increase air quality.	Talk about cigarette smoking as air pollution, and potential for water and soil pollution. Identify photosynthesis as nature’s air-quality filter.					
	Carbon footprint and carbon sequestration	Obtain and combine information about the carbon footprint of personal and family activities. Identify how to offset the footprint through	Identify carbon sources in the garden. Compare and contrast with carbon sources in the classroom and/or home. Discuss how to recycle					

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Comment [1]: Complete standards?

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Comment [2]: Standards?

Strand	Topic	Learning Outcome	Garden Activities	Classroom Extensions	Common Core-ELA	Common Core-Math	NGSS	NHES
		garden activities (e.g., composting, planting trees/carbon sequestration).	these carbon sources (e.g., composting, artwork, etc.).					
	Sources and impacts (air water and soil) of clean energy in the community	Identify systems that produce clean energy. Identify that human energy consumption impacts air, water, and soil quality.	Describe solar, wind, and methane gas collection as clean energy sources. Identify and describe how petroleum gas causes air pollution.					
Best Conservation Practices	The individual's role in the conservation of natural resources Conservation is a set of practices that preserve, restore, and protect natural resources and ecosystems	Identify human activities that consume or pollute natural resources. Identify human activities that restore, preserve, and/or protect natural resources. Identify and participate in local historical, cultural, and/or archaeological conservation practices. Identify and participate in non-regional historical, cultural, and/or environmental conservation practices.	Identify plastic-bag pollution and its effect on birds, ecosystems, and marine life. Discuss Hawai'i as the first state to ban plastic bags. Pick up litter on campus. Examine ahupua'a map. Discuss the use of ahupua'a names in everyday language. Connect use of ahupua'a names to conservation practice.					

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Comment [3]: Standards?

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Comment [4]: Standards

Resources: Groundwater - USGS Ground Water in Hawai'i

Nature's Design: Systems, Cycles, Patterns, Relationships, and Adaptations in the Garden System
Theme 4: Curriculum Map – Grades 6–8

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
Food	The plant nutrient cycle: carbon cycle, nitrogen cycle, N-P-K, and minerals in plant growth	Recognize the components of nutrient cycles and their interrelationships. Healthy/vital soils = healthy/vital foods = healthy vital bodies. Know where, how and why to apply soil amendments such as compost and mulch to ensure that soils and foods are nutrient rich. Understand and use nitrogen-fixing cover crops as a part of the cycle of building soil fertility in the garden.	Research and plant cover crops that enhance soil fertility. Use these nitrogen-fixing cover crops as a green manure when preparing a bed for planting. Examine the roots of nitrogen-fixing crops, identify the nitrogen nodules on roots and describe the symbiotic relationship of the plants with the soil bacteria.				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-ESS2-1: *Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.*	
Food	The Soil Food Web: a complex living system of organisms in the soil and their interactions with each other, the environment, plants and animals	Compare and contrast soils rich with fungus, bacteria, and invertebrates (FBI) with soils that are not. Identify the abiotic components in soil that support the soil food web (i.e. carbon, water, air). Recognize that the health of the soil food web impacts the health of the soil. Healthy/vital soils = healthy/vital foods = healthy vital bodies	Design a side-by-side experiment using at least two beds with different kinds of amendment. (no compost or compost) . Observe and record data from control and treatment beds. Interpret the data and present results. Design an experiment using three distinct parts of the garden (compost, path, bed). Lay a transect line, randomly sample along the transect lines using a quadrat.		CCSS ELA-Literacy.SL.8.4: *Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.*	All 6.SP 7.SP.A.1 7.SP.A.2 7.SP.B.3 7.SP.B.4 8.SP.A.1 8.SP.A.2 8.SP.A.3 8.SP.A.4	MS-LS2-4: *Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.* MS-ETS1-2: *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
			Observe and record quantitative and qualitative data such as plant and insect diversity within each quadrat. Analyze and interpret the data. Present findings using graphs, illustrations and oral arguments.					
	Growing systems in Hawaiʻi: Indigenous, conventional, aquaponics, hydroponics, agroforestry, permaculture, organic gardening * See Appendix: *Native Planters*	Experiment with several different types of growing systems and soil mediums. Keep records of properties and qualities including taste, cost, human labor to build and maintain the systems. Examine characteristics of canoe crops and how they are well-adapted to the environment in Hawai`i.	Design and implement one or more types of growing systems. Collect data. Compare with other growing systems. Evaluate for health and production of biomass.			All 6.SP 7.SP.A.1 7.SP.A.2 7.SP.B.3 7.SP.B.4 8.SP.A.1 8.SP.A.2 8.SP.A.3 8.SP.A.4	MS-ETS1-1: *Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.* MS-ETS1-2: *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.*	
Energy and Matter	Energy cycles in the garden system	Understand that the sun is the source of energy for all things on the planet. Photosynthesis provides the basis for the food chain. Compare and contrast organisms in the garden and other ecosystems.	Design an experiment where students analyze the effects of different amounts of light on germinated seedlings. Plant 2 rows of lettuce or root crops some with shade-cloth others without. Compare and contrast the difference. Measure temperature in compost and graph heat over stages of	Estimate, calculate and record volume.		All 6.SP 7.SP.A.1 7.SP.A.2 7.SP.B.3 7.SP.B.4 8.SP.A.1 8.SP.A.2 8.SP.A.3 8.SP.A.4	MS-LS1-6: *Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.* MS-LS1-5: *Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
			decomposition. Infer heat is a byproduct of the processes of cellular respiration of bacteria. Observe how ambient temperature affects the movement of macroorganisms in the garden.					
Energy and Matter	The Food Web trophic levels and proportional relationships of producers to consumers, carrying capacity and population equilibrium Relationship between producers and consumers and effect on habitat	Investigate proportional relationship between producers and consumers and how they dictate carrying capacity in garden systems. Understand consumption of energy along the food chain. Food is made up of energy and matter that are passed from one organism to another. A higher population of consumers is possible when consuming lower on the food chain. For example: eating chicken eggs vs. eating a chicken; (in a year a chicken will lay 300 eggs, vs. 1 chicken body providing 6-8 meals). Analyze the impact of invasive species on diversity of ecosystems and recognize its impact on carrying capacity. Evaluate the	Identify producers, consumers, tertiary consumers and decomposers in the garden. Observe, count and record number of plant species in two distinct locations in the garden - one with invasive species and one without. Evaluate population diversity and analyze abundance. Observe and collect data of volume in a compost pile over time. Relate findings to availability of resources. Discuss carrying capacity for fungi, bacteria, and invertebrates (FBI).	Play "Oh! Deer". Keep track of population size on a graph. Follow up questions to consider: Which species do/do not follow dynamic equilibrium? http://www.riverventure.org/charleston/resources/pdf/population study game.pdf Respiration in yeast activity. • Activate yeast and sugar; • use digital Vernier probes to analyze the pH of the gas generated to show evidence of carbon dioxide and respiration. • Students blow air through a straw into BTB solution (pH indicator) to demonstrate carbon dioxide's ability to turn liquids acidic.		7.G.B.6 8.G.C.9	MS-LS2-2: *Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.* 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.*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
Energy and Matter		interdependence of organisms on environmental resources and how they affect population size.						
	Forms and transformation of energy, conservation of energy • potential • kinetic (thermal) • chemical	Recognize that humans are an intrinsic part of energy transfer in the garden. Identify energy transformation in the forms of potential, kinetic (thermal), and chemical in the garden. Assess changes in matter (garden products) that occur as a result of processing (e.g., by cooking, fermenting, making compost teas).	Kinesthetic activity: “Plants build the sugars up, humans break them down.” Use cooking as a model for evaluating and measuring the kinetic energy of objects. Higher temperature = greater kinetic energy. Fill different colored hand-washing tubs with water at the beginning of class. Leave them in the sun and compare the temperatures at the end of class.				MS-LS1-7: *Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.* MS-PS3-4: *Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.*	
	Chemical and Physical Changes in the Garden System and Classroom Kitchen	Examine ingredients from the garden before processing or cooking and make predictions about physical and chemical changes. Examine finished product and check accuracy of predictions about physical and chemical changes in the ingredients.	Design an experiment for solar heating of water, use different colored materials as an independent variable and compare temperature from beginning and end of class. Boiling and freezing of substances to demonstrate changes of states of matter and the relationship between kinetic and	Design solar ovens and dehydrators.			MS-PS3-3: *Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* MS-PS3-4: *Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
Energy and Matter			thermal energy. Observe sun, wind and water patterns in the garden and link to potential energy sources. Use solar ovens to cook foods. Mixtures: Create a mixture of salt and pepper. Emulsify salad dressing. Physical change: cutting foods. Chemical: Oxidation of fruits and vegetables.				*temperature of the sample.*	
	Fossil Fuels and Renewable Energy Inputs, outputs, and the transformation of energy Examples: Compare a tractor, a rototiller, and a garden fork to cultivate a garden bed. Use of a solar pump vx. And electric pump for a hydroponic system. (Discussion Topic)	Identify where Hawai'i's energy comes from. Critique different models for generating electrical energy: renewable, fossil fuels, nuclear, etc. Critique may include: cost, human labor to build and maintain the systems. * See Appendix: Kokua Foundation's nutrition lesson skit.	Compare a tractor, a rototiller, and a garden fork to cultivate a garden bed. Compare use of a solar pump or an electric pump for a hydroponic system. (Discussion Topic)	Compare and contrast organic lettuce from your garden and pre-washed and bagged organic lettuce. Look at appearance, cost , human labor, miles travelled, fossil fuel involved, freshness and taste.			MS-ETS1-2: *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.* MS-ESS3-4: *Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.*	
Water	The Water Cycle and its interrelationship with weather and climate The properties of water	Recognize the cyclical pattern of air and water movement on Earth and identify these patterns in the garden. Observe water in the	Research water sources in garden. Collect rainwater. Keep a rain gage and log of rainfall in your garden. Note seasonal trends. Compare your			7.SP.B.3 7.SP.B.4	MS-ESS3-1: *Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
		garden and contemplate that this water is the same water as when Earth began. *See Appendix: "The Earth is an Apple."	numbers to the best data you can find for your area. Notice what parts of the water cycle you can witness, find evidence in your garden.				MS-ESS2-4: *Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.*	
	The action of water in living systems.	Use water in the garden as diluter, solvent, transporter, insulator, diffuser. (water can be used in any of its forms)	Create an example of watering through capillary action over time using a string and bucket. Use water as a diluter when applying worm or compost tea and soil amendments.			6.RP.A.1 7.RP.A.3	MS-ESS2-4: *Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.* MS-ESS3-3: *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*	
	The hydrology of Hawai'i Island drinking water (This is a topic for discussion in the garden)	Investigate freshwater resources for your garden and how they are a result of the island's' geological processes and formations (e.g., Where does your water come from?). Assess the renewability/future availability of this resource in the garden.	Identify the role plants play in the water cycle, using transpiration bags as evidence. Observe wind patterns in the garden and identify seasonal trends. Keep a rain gage and log of rainfall in your garden. Note seasonal trends. Compare your numbers to the best data you can find for your area.	Construct and use models and labs to demonstrate the effects of Earth's rotation and convection currents on wind and weather patterns. (Model of Earth's water cycle) Identify water sources and illustrate the path for our drinking water.			MS-ESS2-4: *Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.* MS-ESS3-1: *Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.*	
	Water Storage, Sources, and Management	Recognize water sources in the garden. Evaluate where water	Construct and implement various irrigation systems and record effects on				MS-LS2-5: *Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
		is needed in the garden and design irrigation systems. Eliminate standing water as vector for disease: * See Appendix: "Fight the Bite." Department of Health	garden ecosystems (e.g., soil salinification, plant growth). Compare irrigation systems efficiency in terms of water conservation (e.g., drip irrigation or overhead watering).				MS-ETS1-1: *Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.* MS-ETS1-2: *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.*	
Natural resources management and conservation	Water conservation and management	Know that fresh water is a finite resource. Recognize that each individual has a role to play in water conservation. Understand impacts of community conservation efforts. Understand the garden is part of an entire watershed. Recognize appropriate use and limitations of greywater and county water.	Identify practices at school and at home that conserve water. Utilize grey water in garden systems for plants. Examine impacts of home and garden practices on water systems. Create a catchment system to mitigate effects of treatment of county water (chlorine off-gassing).	Measure water quality in various areas in the school community. Assess impact of water quality on salt and freshwater ecosystems. Label storm drains: Drains to Ocean potable non potable run off Identify point and nonpoint sources for pollution in the community.		6.RP.A.3.B 7.RP.A.2.B 8.EE.B.5	MS-ESS3-4: *Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.* MS-ETS1-1: *Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.* MS-ETS1-2: *Evaluate competing design solutions using a systematic process to determine how well they*	

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<tr><th>Strand</th><th>Topic</th><th>Learning Outcomes</th><th>Garden Activities</th><th>Classroom Extensions</th><th>Common Core ELA</th><th>Common Core Math</th><th>NGSS</th><th>NHES</th></tr>
<tr><td rowspan="2">Natural resources management and conservation</td><td></td><td></td><td></td><td></td><td></td><td></td><td>meet the criteria and constraints of the problem.</td><td></td></tr>
<tr><td>Water Quality</td><td>Analyze water systems in the garden and design improvements for greywater use.

Maintain a water system using potable and non-potable water correctly (e.g., use potable water for processing garden products).</td><td>Utilize grey water in garden systems for plants.

Examine impacts of home and garden practices on water systems.

Create a catchment system to mitigate effects of treatment of county water (chlorine off-gassing).

Know that water is a vector for contaminants and examine inputs and outputs in garden water systems.

Recognize the potable and non-potable water sources in your garden. Understand the distinctions between potable and non-potable water, and the health implications.

Experiment with water quality.

Compare and contrast how different water sources impact garden (e.g., rain water vs. municipal in garden uses).</td><td>Investigate how and where water is treated, processed and reused in your geographical area.

Investigate the safe uses of greywater in the garden.

Assess impact of water quality on salt and freshwater ecosystems.</td><td></td><td>6.RP.A.3.B

7.RP.A.2.B

8.EE.B.5</td><td>MS-ESS3-3:
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ETS1-1:
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2:
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.</td><td></td></tr>
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Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
	Local sources of organic nutrients for soil fertility	Identify and utilize local resources for soil fertility(e.g., use paper as carbon for compost). State the difference between the bi-products of organic vs. inorganic materials as they decompose. Know how to build a layered compost with organic matter from the garden and paper recourses. Identify paper as a carbon source. Identify green plants as nitrogen. Build aerobic compost piles using correct proportions of carbon and nitrogen in layers. Recognize weeds can be used as a source of nitrogen in compost.	Collect, weigh and record discarded organic materials (e.g., shredded paper, foods) from school and apply to compost system. Examine debris from the garden plants and identify how it is used in the garden ecosystem. Identify and explore sources of organic nutrients on your school campus and within your community that can be used for building soil fertility systems (e.g., mulching, composting). Use these resources. Apply diverse types of mulch to the garden. Design, create and maintain a zero waste system that uses paper to make soil, soil to grow food and food to feed school community. Use the slogan, "Feed the Soil and the Soil Feeds You."			6.SP.B.4 6.SP.B.5.A 6.SP.B.5.B 6.SP.B.5.C 6.SP.B.5.D	MS-ETS1-1: *Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.* MS-ETS1-2: *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.* MS-ESS3-3: *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* MS-ESS3-4: *Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.* 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-LS1-5: *Construct a scientific explanation based on evidence for how*	NHES: 3.8.1, 3.8.3, 5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.8.5, 5.8.6, 5.8.7

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
							environmental and genetic factors influence the growth of organisms.	
Natural resources management and conservation Natural resources management and conservation	Recycling, upcycling, and downcycling of inorganic materials	State the difference between the bi-products of organic vs. inorganic materials. Recognize that inorganic materials have different rates of decomposition and persist over time. Think critically about results and impacts of consumer choices, including the bi-products from consuming food, processing and packaging, recognizing that "Zero Waste" as a goal.	Collect, weigh and record discarded organic materials (ex: shredded paper, foods) from school and apply to compost system. Compare and contrast the volume, mass, and reusability of packaging from various sources. Design, create and maintain a zero waste system that uses paper to make soil, soil to grow food and food to feed school community. Use the slogan, "Feed the Soil and the Soil Feeds You." Compare and contrast the volume, mass, and reusability of packaging from various sources. Make and label decomposition timeline of discarded products with real examples. Reuse and repurpose materials in the garden. Make and use a 4R (Refuse, reduce, recycle, reuse) or Zero waste system	Analyze food byproducts (eg. packaging) from various sources such as the grocery store, farmers market and garden. Design a 4R (Refuse, reduce, recycle, reuse) or Zero waste system for your garden			MS-ETS1-1**:** *Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.* MS-ETS1-2**:** *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.* MS-ESS3-3: *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* MS-ESS3-4: *Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.* MS-LS2-3**:** *Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.*	NHES: 3.8.1, 3.8.3, 5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.8.5, 5.8.6, 5.8.7

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
			for your garden				MS-LS1-5: *Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.*	
Natural resources management and conservation	Components of air quality	Identify how the garden can be a solution for human energy consumption practices impacting air quality.	Observe systems in the garden that produce clean energy (e.g., photosynthesis, solar pumps, weed mat).	Using a pH indicator solution, such as BTB, have students use straws to blow carbon dioxide into the solution. Pour the solution into test tubes. Place a sprig of Elodea in each test tube and leave overnight underneath painter's lamps. Leave at least one test tube with only solution and no Elodea as a control. Check the next day. Solution should show that it has become less acidic (oxygen replaced carbon dioxide, changing the solution from yellow to greenish-blue).			MS-ESS3-3: *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* MS-ESS3-5: *Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.*	
	Carbon footprint and Carbon sequestration	Understand, describe, and interpret the carbon footprints of human activities and their impact on air quality.	Identify practices in the garden that impact the carbon footprint.				MS-ESS3-3: *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* MS-ESS3-5: *Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
Natural Resources Management and Conservation	Sources and impacts (air water and soil) of clean energy in the community	Define carbon footprint. Explain garden systems that sequester carbon. * See Appendix: "Carbon footprint survey"	Build compost piles to sequester carbon.				MS-ESS3-3: *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* MS-ESS3-5: *Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.*	
Best Conservation Practices	The individual's role in the conservation of natural resources Conservation: a set of practices that preserve, restore, and protect natural resources and ecosystems	Interpret data from the garden about renewable and nonrenewable resources. Recognize garden systems that preserve, restore, and/or protect non-renewable resources (e.g., saving water). Identify various sources of mulch. Compare and contrast local and non-regional historical, cultural, and/or archeological conservation practices.	Collect and interpret data from the garden about renewable and nonrenewable resources. Design garden systems that preserve, restore, and/or protect non-renewable resources (e.g., saving water). Identify, collect and use sources of mulch. Compare and contrast local and non-regional historical, cultural, and/or archeological conservation practices in your garden.				MS-ESS3-3: *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* MS-ESS3-5: *Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.*	
Best Conservation Practices	Preserve, repair, and prevent deterioration of the environment, topsoil, water, and natural resources Invasive species	Understand "Zero Waste" as a goal. Design a 4R system for your garden (Refuse, reduce, recycle, reuse).	Implement a 4R or Zero Waste system in your garden.				MS-ETS1-2: *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.*	

Strand	Topic	Learning Outcomes	Garden Activities	Classroom Extensions	Common Core ELA	Common Core Math	NGSS	NHES
	Waste is a system out of balance	Design and implement a "Zero Waste" system for your garden. Identify the impacts of invasive species. Recognize that there are management practices for invasive species.	Manage and dispose of invasive species in your garden and on your school campus.	Make public service announcement or flyer for your community about an invasive species in your area and how to manage it (e.g., tiny fire ant, or coqui frog).			MS-ETS1-1: *Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.* MS-LS2-5: *Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*	

K-2 NGSS Standards

Grade K	Grade 1	Grade 2
Forces & Interactions: Pushes and Pulls K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushesand pulls on the motion of an object. K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.	**Waves: Light & Sound** 1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. 1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated. 1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light. 1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance	**Structure & Properties of Matter** 2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. 2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. 2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive. K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.	**Structure, Function, & Information Processing** 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. 1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. 1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.	**Interdependent Relationships in Ecosystems** 2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. 2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. 2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

<table>
<tr>
<td>Weather and Climate

K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface.

K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time.

K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.</td>
<td>Space Systems: Patterns & Cycles

1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.

1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.</td>
<td>Earth's Systems: Processes that shape the Earth

2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.

2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.</td>
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<tr>
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<td>K-2 Engineering Design

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.</td>
</tr>
</table>

3-5 NGSS Standards

Grade 3	Grade 4	Grade 5
1. Motion and Stability • Standard 3-PS2 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. • Standard 3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. • Standard 3-PS2-3 Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. • Standard 3-PS2-4 Define a simple design problem that can be solved by applying scientific ideas about magnets.	**1. Energy** • Standard 4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object. • Standard 4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. • Standard 4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide. • Standard 4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	**1. Matter and its Interactions** • Standard 5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen. • Standard 5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. • Standard 5-PS1-3 Make observations and measurements to identify materials based on their properties. • Standard 5-PS1-4 Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
2. From Molecules to Organisms: Structures and Processes • Standard 3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	**2. Waves and their Applications in Technologies for information Transfer** • Standard 4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. • Standard 4-PS4-2 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. • Standard 4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.	**2. Motion and Stability: Forces and Interactions** • Standard 5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down.
3. Ecosystems:	**3. From Molecules to**	**3. Energy**

Interactions, Energy, Dynamics • Standard 3-LS2-1 Construct an argument that some animals form groups that help members survive.	**Organisms: Structures and Processes** • Standard 4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. • Standard 4-LS1-2 Use a model to describe that animals' receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.	• Standard 5-PS3-1 Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
4. Heredity: Inheritance and Variation of Traits • Standard 3-LS3-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. • Standard 3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.	**4. Earth's Place in the Universe** • Standard 4-ESS1-1 Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.	**4. From Molecules to Organisms: Structures and Processes** • Standard 5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water.
5. Biological Evolution: Unity and Diversity • Standard 3-LS4-1 Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. • Standard 3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. • Standard 3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can	**5. Earth's Systems** • Standard 4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. • Standard 4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.	**5. Ecosystems: Interactions, Energy, and Dynamics** • Standard 5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

survive well, some survive less well, and some cannot survive at all. • Standard 3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.		
6. Earth's Systems • Standard 3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. • Standard 3-ESS2-2 Obtain and combine information to describe climates in different regions of the world.	**6. Earth and Human Activity** • Standard 4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. • Standard 4-ESS3-2 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.	**6. Earth's Place in the Universe** • Standard 5-ESS1-1 Support an argument that the apparent brightness of the sun and stars is due to their relative distances from Earth. • Standard5-ESS1-2 Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
7. Earth and Human Activity • Standard 3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.		**7.Earth's Systems** • Standard 5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. • Standard 5-ESS2-2 Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
7. Engineering Design • Standard 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. • Standard 3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely		**Earth and Human Activity** • Standard 5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

to meet the criteria and constraints of the problem. • Standard 3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		

6-8 NGSS Standards

1. Matter and Interactions	• Standard MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures. • Standard MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. • Standard MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. • Standard MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. • Standard MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. • Standard MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
2. Motion and Stability:Forces and Interactions	• Standard MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. • Standard MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. • Standard MS-PS2-3

	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. ● Standard MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. ● Standard MS-PS2-5 Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
3. Energy	● Standard MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. ● Standard MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. ● Standard MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. ● Standard MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. ● Standard MS-PS3-5 Construct, use, and present arguments to support the claim that when the motion energy of an object

	changes, energy is transferred to or from the object.
4. Waves and their Applications	• Standard MS-PS4-1 Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. • Standard MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. • Standard MS-PS4-3 Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.
5. From Molecules to Organisms: Structures and Processes	• Standard MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells. • Standard MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. • Standard MS-LS1-3 Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. • Standard MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. • Standard MS-LS1-5

	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. ● Standard MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. ● Standard MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. ● Standard MS-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
6. Ecosystems: Interactions, Energy, and Dynamics	● Standard 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. ● Standard MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. ● Standard MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. ● Standard MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. ● Standard MS-LS2-5

	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
7. Heredity: Inheritance and Variation of Traits	• Standard MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. • Standard MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
8. Biological Evolution: Unity and Diversity	• Standard MS-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. • Standard MS-LS4 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. • Standard MS-LS4-3 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. • Standard MS-LS4-4

	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. • Standard MS-LS4-5 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. • Standard MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.
9. Earth's Place in the Universe	• Standard MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. • Standard MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. • Standard MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system. • Standard MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.
10. Earth's Systems	• Standard MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

	● Standard MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. ● Standard MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. ● Standard MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. ● Standard MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. ● Standard MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
11. Earth and Human Activity	● Standard MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. ● Standard MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. ● Standard MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

	• Standard MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. • Standard MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
12. Engineering Design	• Standard MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. • Standard MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. • Standard MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. • Standard MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Patterns and Cycles in the Garden
June 9, 2016

Nature's cycles have to do with how the earth renews itself. The living things within an ecosystem interact with each other and also with their non-living environment to form an ecological unit that is largely self-contained. Sometimes this renewal process is gradual and gentle. Sometimes it is violent and destructive. Nevertheless, ecosystems contain within themselves the resources to regenerate themselves. Examples:

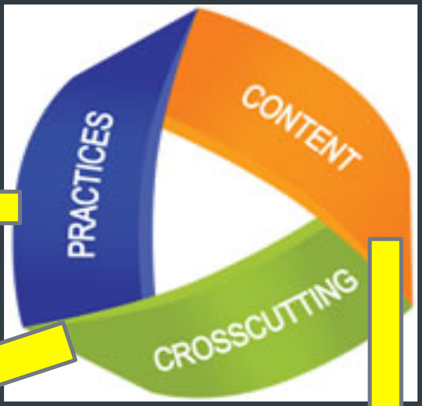
- Seed to seed
- Egg to egg
- Water cycle
- Carbon cycle

Patterns in nature are visible regularities of form found in the natural world. These patterns recur in different contexts and can sometimes be modeled mathematically. Natural patterns include symmetries, trees or fractals, spirals, flows or meanders, waves, bubbles or foams, tessellations, cracks and stripes.

Please observe and draw 3 to 4 cycles and/or patterns found in the garden. Label each drawing.

Cycle or Pattern:__________________	Cycle or Pattern:__________________
Cycle or Pattern:__________________	Cycle or Pattern:__________________

NGSS: 3 Dimensions Intertwined (a focus on how and why as well as what)



1 Scientific and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

2 Crosscutting Concepts

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

Disciplinary Core Ideas

Physical Sciences
PS1: Matter and its interactions
PS2: Motion and stability: Forces and interactions
PS3: Energy
PS4: Waves and their applications in technologies for information transfer

Life Sciences
LS1: From molecules to organisms: Structures and processes
LS2: Ecosystems: Interactions, energy, and dynamics
LS3: Heredity: Inheritance and variation of traits
LS4: Biological evolution: Unity and diversity

Earth and Space Sciences
ESS1: Earth's place in the universe
ESS2: Earth's systems
ESS3: Earth and human activity

Engineering, Technology, and Applications of Science
ETS1: Engineering design
ETS2: Links among engineering, technology, science, and society

NGSS Lesson Planning Template

Grade/ Grade Band:	Topic:	Lesson # _____ in a series of _____ lessons
Brief Lesson Description:		
Performance Expectation(s):		
Specific Learning Outcomes:		
Narrative / Background Information		
Prior Student Knowledge:		
Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
Possible Preconceptions/Misconceptions:		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:		
EXPLAIN: Concepts Explained and Vocabulary Defined: **Vocabulary:**		
ELABORATE: Applications and Extensions:		
EVALUATE: **Formative Monitoring (Questioning / Discussion):** **Summative Assessment (Quiz / Project / Report):**		
Elaborate Further / Reflect: Enrichment:		

Materials Required for This Lesson/Activity			
Quantity	**Description**	**Potential Supplier (item #)**	**Estimated Price**

Why Teach Engineering and Design?

From Engineering is Elementary (a program of the Museum of Science, Boston)
If you've ever watched children at play, you know they're fascinated with building things—and with taking things apart to see how they work. In other words, children are natural-born engineers. When children engineer in a school setting, research suggests several positive results:

Building Science and Math Skills
Engineering calls for children to apply what they know about science and math—and their learning is enhanced as a result. At the same time, because engineering activities are based on real-world technologies and problems, they help children see how disciplines like math and science are relevant to their lives.

Classroom Equity-- Research suggests engineering activities help build classroom equity. The engineering design process removes the stigma from failure; instead, failure is an important part of the problem-solving process and a positive way to learn. Equally important, in engineering there's no single "right" answer; one problem can have many solutions. When classroom instruction includes engineering, all students can see themselves as successful.

21st Century Skills-- Hands-on, project-based learning is the essence of engineering. As groups of students work together to answer questions like "How large should I make the canopy of this parachute?" or "What material should I use for the blades of my windmill?" they collaborate, think critically and creatively, and communicate with one another.

Career Success-- Classroom engineering activities often require students to work in teams where they must collaborate and communicate effectively. In the 21st century, these skills will be critical for career success in any field.
Research also shows that when engineering is part of elementary instruction, students become more aware of the diverse opportunities for engineering, science, and technical careers—and they are more likely to see these careers as options they could choose.
This finding is important at a time when the number of American college students pursuing engineering education is decreasing. Early introduction to engineering can encourage many capable students—but especially girls and minorities—to consider engineering as a career and take the necessary science and math courses in high school.

Engaged Citizens-- Finally, consider some of our nation's most pressing policy issues—energy, healthcare, the environment. Engineering and technological literacy will be critical for all American citizens to make informed decisions in the 21st century.

What Does the Engineering Design Process Look Like?

It looks messy! There are lots of nice diagrams out there, but if you're really doing what engineers and scientists do, it won't follow a neat path.

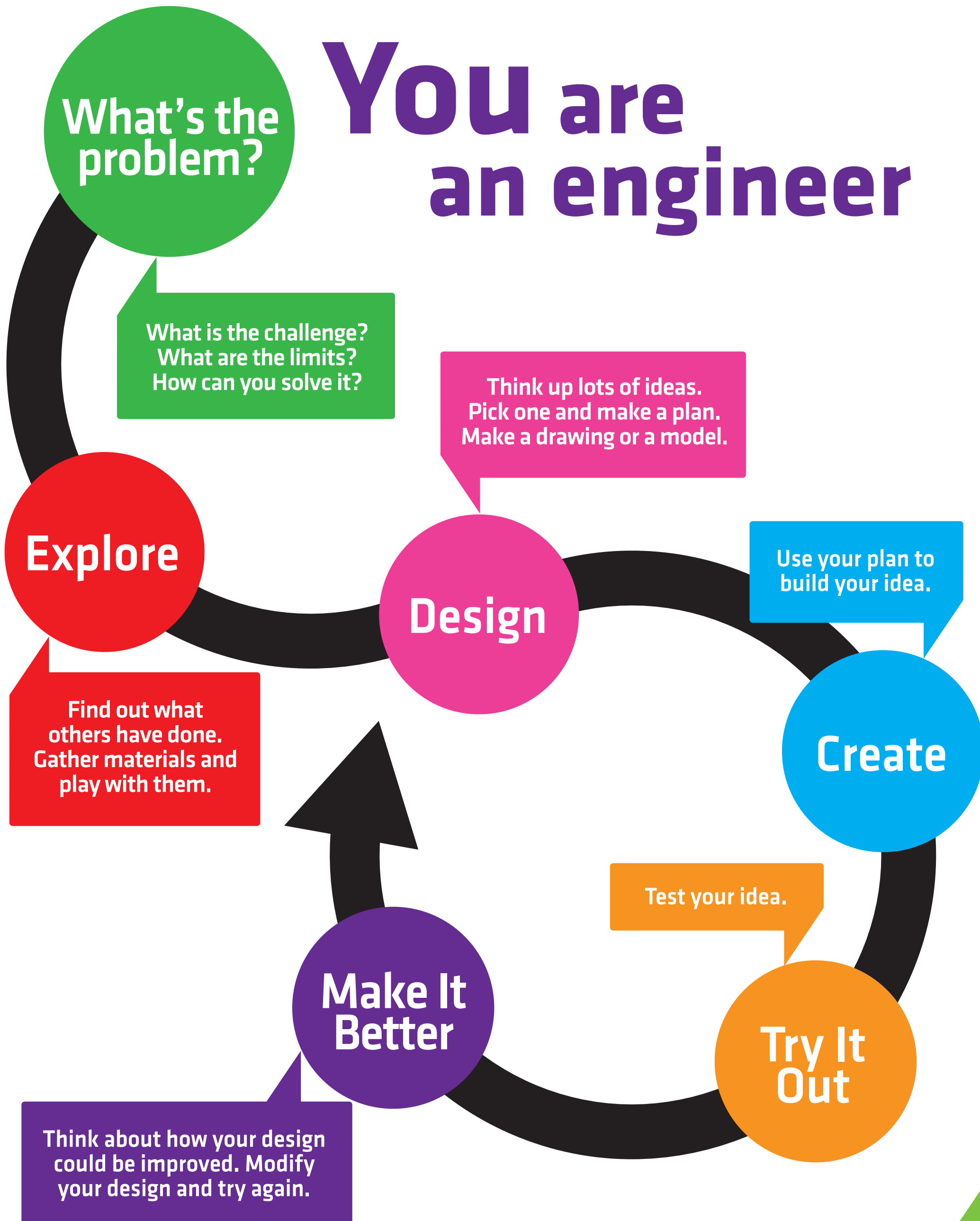
From Engineering Buddies
This process is different from the Steps of the Scientific Method, which you may be more familiar with and is more linear. If your project involves designing, building, and testing something, you should probably follow the Engineering Design Process.

The steps of the engineering design process are to:

- **Define the Problem:** The engineering design process starts when you ask the following questions about problems that you observe:
  - What is the problem or need?
  - Who has the problem or need?
  - Why is it important to solve?
  - [Who] need(s) [what] because [why].
- **Do Background Research**: Learn from the experiences of others — this can help you find out about existing solutions to similar problems, and avoid mistakes that were made in the past. So, for an engineering design project, do background research in two major areas: Users or customers and Existing solutions
- **Specify Requirements:** Design requirements state the important characteristics that your solution must meet to succeed.
- **Brainstorm Solutions:** There are always many good possibilities for solving design problems. Good designers try to generate as many possible solutions as they can.
- **Choose the Best Solution**: Look at whether each possible solution meets your design requirements. Some solutions probably meet more requirements than others. Reject solutions that do not meet the requirements.
- **Do Development Work:** Development involves the refinement and improvement of a solution, and it continues throughout the design process, often even after a product ships to customers.
- **Build a Prototype:** A prototype is an operating version of a solution. Often it is made with different materials than the final version, and generally it is not as polished. Prototypes are a key step in the development of a final solution, allowing the designer to test how the solution will work.
- **Test and Redesign:** The design process involves multiple iterations and redesigns of your final solution. You will likely test your solution, find new problems, make changes, and test new solutions before settling on a final design.
- **Communicate Results:** To complete your project, communicate your results to others in a final report and/or a display board. Professional engineers always document their solutions so that they can be manufactured and supported.

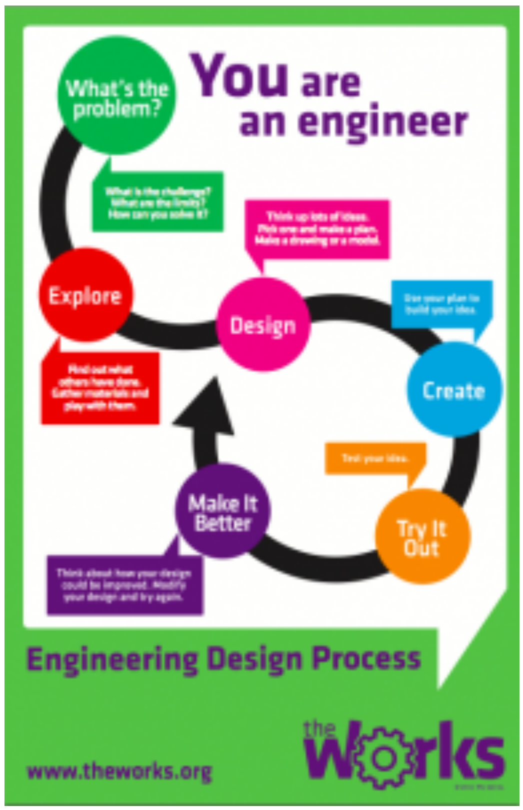
- Engineers do not always follow the engineering design process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change to your design. This way of working is called **iteration**, and it is likely that your process will do the same!

You are an engineer



Engineering Design Process

www.theworks.org


You are an engineer
What's the problem?
What is the challenge? What are the limits? How can you solve it?
Think up lots of ideas. Pick one and make a plan. Make a drawing or a model.
Explore
Design
Use your plan to build your idea.
Find out what others have done. Gather materials and play with them.
Create
Test your idea.
Make It Better
Try It Out
Think about how your design could be improved. Modify your design and try again.
Engineering Design Process
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STEM Unit Criteria Checklist	Does the unit incorporate the following components	
Application of Science Inquiry Process (hands-on) o Learning experiences guide students to discover, investigate, and demonstrate knowledge and skills fundamental to the scientific inquiry process. o Learning experiences engage students in the scientific inquiry process which includes: ● Exploration ● Development of a Research Question ● Research for background Information ● Development of testable hypothesis ● Writing an experimental design ● Complete data analysis ● Summarizing to draw conclusion ● Determining implications and next steps		
Technology Integration o Learning experiences engage students in a variety of 21st century technologies: ● Students use digital media and environments to communicate and collaborate ● Students use digital tools to gather, evaluate, and use information		
Engineering Design Process o Learning experiences help student to demonstrate knowledge and skills fundamental to the engineering design process: ● Ask ● Imagine ● Plan ● Create ● Experiment ● Improve		
Standards for Mathematical Practice o Learning experiences help students to: • Make sense of problems and persevere in solving them • Reason abstractly and quantitatively. • Construct viable arguments and critique the reasoning of others. • Model with mathematics • Use appropriate tools strategically • Attend to precision. • Look for and make use of structure • Look for and express regularity in repeated reasoning		
Alignment to Standards and/or Benchmarks o Learning experiences are aligned to grade level standards and/or benchmarks.		
Assessment Alignment to Standards and/or Benchmarks o Formative and summative assessments are aligned to target standards and/or benchmarks.		
STEM Integration o STEM learning experiences are designed to help students connect knowledge and skills from Science, Technology, Engineering and Mathematics.		

o STEM content and skills are integrated to support the performance task where students apply all of their learning.		
Quality of STEM Experiences o Learning experiences challenge students to develop higher order thinking skills through processes such as inquiry, problem solving, and creative thinking.		
Connections to STEM Careers o Learning experiences provide awareness of connections to STEM careers.		
Nature of STEM Assessments o Students are expected to demonstrate accurate content knowledge and skills through performance-based products and projects.		
STEM Competencies o Community Contributor: The understanding that it is essential for human beings to work together o Complex Thinker: The ability to demonstrate complex thinking and problem solving o Quality Producer: The ability to recognize and produce quality performance and quality products o Effective Communicator: The ability to communicate effectively o Effective and Ethical User of Technology: The ability to use a variety of technologies effectively and ethically		

*Adapted from Ohio STEM Learning Network and Dayton Regional STEM Center: A Framework for Quality STEM Education