NGSS Connections

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Rain Garden Design Challenge
Grade Level: Middle School

Performance Expectations: Students' ability to complete the following performance expectation(s) will be supported by participation in this activity.

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-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.

MS-ETS1-4: Develop a model to generate data for testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Dimension	NGSS Code or citation	Corresponding student task in activity
Disciplinary Core Idea	ETS1.A Defining and Delimiting an Engineering Problem • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the design solutions will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.	During the lab process, students design their models within the constraints of materials, and sometimes cost. For example, they must use all four soils available, build within the space allotted in the model, and occasionally "spend" only $100 in materials.
	ETS1.B Developing Possible Solutions • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.	Students design, build and test their first rain garden model. They then discuss their findings with the class and use the class data to redesign, then build and test their new models.

	• There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • Models of all kinds are important for testing solutions.	Students evaluate their designs according to amount of water absorbed and the improvement in water clarity after passing through the rain garden model. Students use simple models of one soil type per model before designing and building their four-soil models of rain gardens.
	EST1.C Optimizing the Design Solution • The iterative process of testing the most promising solutions and modifying what is proposed based on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	Students test each individual soil type for absorption and clarity, then use the data collected to combine the four soil types into a rain garden model.
Practices	Developing and Using Models • Evaluate limitations of a model for a proposed object or tool. • Develop and/or use a model to predict and/or describe phenomena.	Students use a model to test which soil type is better at absorbing and cleaning water. Students develop and use a model to determine the best combination of soils to absorb and clean water.
	Planning and Carrying out Investigations • Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meets the goals of the investigation. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	Students design their rain garden models and collect data on volume of water absorbed and cleanliness, and use this data to evaluate how well their model met the design goal.
	Analyzing and Interpreting Data • Analyze and interpret data to provide evidence for phenomena. • Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy	Students use the data from their first design to inform their redesign of their rain gardens. Students also discuss the limits to the visual references we use in evaluating the rain garden designs.

	of data with better technological tools and methods (e.g., multiple trials).	
Crosscutting Concept	Scale, Proportion, and Quantity • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.	Students use a small rain garden model to decide the best design to use for a large rain garden. They then observe our real (and large) rain gardens outside.
	Systems and System Models • Students learn that models are limited in that they only represent certain aspects of a system under study.	Students use their small rain garden models to design and test their designs. They do not plant plants in their rain gardens, so recognize that they did not test this aspect of their rain garden designs.

Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurements and observation.

Science is a Way of Knowing

- Science is a way of knowing used by many people, not just scientists.

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Scientific Knowledge is Open to Revision in Light of New Evidence

- Scientific explanations are subject to revision and improvement in light of new evidence.

Connections to Common Core State Standards

English Language Arts/Literacy

RST.6-8.3

RST.6-8.4