Scientific Endeavor
Module 1

Module 1 Description:

Humans are naturally curious about the world in which we live. Our whole lives are spent exploring, questioning, and searching for meaning. The lessons presented in Scientific Endeavor seek to demonstrate how we use science and engineering practices to systematically answer questions about and interact with the natural world. Whirligig Lollapalooza highlights the connections between science and engineering as students explore the behavior of a homemade whirligig and search for an optimum design. Measuring Up and Measuring Up Too seek to increase our understanding of experimental error and the role of numbers in communicating that error. A Picture is Worth a Thousand Words expands on one of the most important communication tools a scientist uses: the graph. And Up Close and Personal familiarizes students with proper observation and data collection technique when using the microscope.

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP when applicable.
- model methods of student-centered inquiry.
- differentiate between accuracy and precision.
- represent data using appropriate graphs.
- demonstrate proper observation technique when using a microscope.
- develop a rich understanding of the philosophy of rigorous instruction in the classroom.

Visual Patterns
Module 2

Module 2 Description:

Part and parcel with our inquisitive nature is the ability to detect patterns. From the shape of leaves to the passage of day and night, we can see patterns everywhere. Each lesson in Visual Patterns, allows students to explore how patterns can be used to classify and organize and lead to the discovery of relationships among phenomena. Moon Watch examines the lunar cycle and familiarizes students with the phases of the Moon. Mineral Masters asks students to apply their knowledge of mineral properties in their classification. Extraterrestrial Enigma is an open-ended activity that engages students in the classification of fictional alien creatures. Students will arrange colored cards and model a process analogous to the creation of the periodic table in It's in the Cards. Lastly, Catch the Wave helps students learn about the regular, repeating undulations known as standing waves.

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP when applicable.
- explain the phases of the moon while addressing common misconceptions.
- predict the moon's appearance based on the position of Earth, Sun and Moon.
- model the process of classification using physical characteristics.
- describe the usage and model the generation of a dichotomous key.
- simulate the creation of the periodic table by searching for patterns in colored cards and arranging them.
- derive the fundamental wave equation and generate the harmonics for standing wave patterns.
- develop a rich understanding of the philosophy of rigorous instruction in the classroom.

Mathematical Patterns
Module 3

Module 3 Description:

Nature is not so obvious as to reveal all of its secrets to the naked eye. Some mysteries are solved through further inspection and mathematical analysis. The lessons in Mathematical Patterns explore this idea that some patterns are best described in a numerical context. Making the Grade introduces students to slope - an important data analysis tool - in a physical context. Walk the Line is a kinesthetic learner activity that has students physically moving themselves to understand how motion and position-time graphs are related. Beetle Races provides an opportunity for students to tell the story of their beetle's journey using motion graphs and multiple representations. The more advanced data analysis tool of linearization is explored in Happiness is a Straight Line. Finally, students use motion sensors to manipulate carts and tracks in Ramped Up! to further develop the concept of acceleration (the rate of a rate of change).

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP when applicable.
- explain how rates describe mathematical patterns.
- calculate and use slope to describe physical slopes.
- manipulate objects to illustrate different types of motion.
- create multiple representations to describe the motion of a beetle.
- model linearization as an analytical tool.
- demonstrate that acceleration is a rate of a rate of change.
- develop a rich understanding of the philosophy of rigorous instruction in the classroom.

Lures for Learning
Module 4

Module 4 Description:

This is the fourth module of any science training series. Unlike the other training modules, it is presented to a mixed audience of middle school and high school teachers. Participants will explore various types and levels of inquiry through hands-on, minds-on activities. The importance of carefully and strategically aligning both content and science process skills and practices is stressed by highlighting the connections in each of the activities. Building successful students starts in the middle grades and progresses throughout the high school years. This vertical emphasis is accomplished by allowing the participants to have the opportunity to explore the process of inquiry, together, through selected activities from middle grades through physics. This also allows participants to examine their own curriculum and determine the best way to integrate lessons obtained at training within their various grade levels or subjects.

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP.
- demonstrate an understanding of the importance of inquiry strategies that allow students to investigate, explore, discover, and reach conclusions about scientific phenomena.
- perform relevant activities and participate with in-depth discussions that illustrate and promote rigor in the science classroom.
- analyze their curriculum and identify areas in which inquiry could be used to better challenge students and improve their critical thinking skills.
- demonstrate an understanding of the need to align both content and science process skills to the learning of science.
- develop a rich understanding of the philosophy of rigorous instruction in the classroom.

Cause and Effect
Module 5

Module 5 Description:

Identifying patterns only whets our appetite to know more about the world surrounding us. By investigating cause and effect relationships we gain an understanding of how the universe works and come closer to making accurate predictions about how it will behave. In A Force to be Reckoned With, students will manipulate mass and force and observe their relationship with acceleration. Reason for the Seasons helps students generate an explanation of the differential heating that causes seasonal climate variations. Acid Raindrops Keep Falling on My Head is an investigation into the causes and formation of acid rain. Tragedy in the Making demonstrates the effects of unrestricted utilization of our natural resources. Are You Meeting the Kyoto Protocol? is a simulation illustrating the environmental impact of everyday living in terms of carbon dioxide production.

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP when applicable.
- verify the direct relationship between force and acceleration and the inverse relationship between mass and acceleration.
- describe how the transfer of thermal energy is affected by the incident angle of radiant energy.
- explain how the byproducts of industrial manufacturing can become pollutants and contribute to acid precipitation.
- develop an understanding of the complexities of managing natural resources.
- predict the effects of modern living on the production of pollutants and the environment.

Scale, Proportion, and Quantity
Module 6

Module 6 Description:

Literature is not the only field in which perspective alters our understanding. Scientific inquiry is likewise affected by point of view. Our understanding of the universe is limited by our ability to imagine and attach meaning to extremes: that which is orders of magnitude larger or smaller than our experience. The activities in this module underscore the importance of scale – especially with respect to time and size – in comprehending how the world works. pHundamentals helps students discover how pH is determined and measured. Hot water is used in Temperature Scales to understand the relationship between Fahrenheit and Celsius temperature scales. In Speed students will measure distance and time of a traveling object to quantify motion. Archimedes' Principle is an inquiry activity designed to aid students in understanding the relationship between mass, volume, and density. Lastly, in Sands of Time students create a model to visualize the expanse of geologic time.

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP when applicable.
- explain how pH is calculated.
- describe the logarithmic nature of the pH scale.
- convert between Fahrenheit and Celsius temperature scales.
- quantify motion by calculating speed.
- use mass and volume to describe the physical property of density.
- construct a model to derive meaning from geologic time scale.

Systems and Models
Module 7

Module 7 Description:

Sometimes understanding is best achieved when we study the parts that make the whole. In complex systems, it may be useful to observe the system in isolation. Some systems cannot be observed directly because of scaling issues – often time or size – and must be simplified through the use of models. Undiscovered Country is an activity in which students determine the shape of an object through indirect observations analogous to the processes and logical thinking Rutherford used in furthering our knowledge of the atom. Students explore the basics of electrical systems in Short Circuits. Multiplicity models the process of eukaryotic growth at is most fundamental level. Beyond the Black Hole sees students model an imploding star and the concomitant increase in density. Finally, Lost in Space has students build a scale model of the solar system to gain understanding of its vastness.

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP when applicable.
- use and describe the process of making indirect observations.
- construct circuits in series and parallel.
- summarize the process by which eukaryotic cells multiply.
- calculate the increasing density of a “collapsing star”.
- attach meaning to stellar distances by modeling the scale of the solar system.

NATIONAL MATH + SCIENCE INITIATIVE

Middle Grades Science

Energy and Matter
Module 8

Module 8 Description:

In science, as in life, change occurs as the result of hard work. When studying systems from a scientific perspective, the "work" is accomplished through the transfers of energy and matter within the system. In addition to identifying the changes within a system, we must understand the system in its context and therefore how energy and matter enter and leave. Running the Stairs helps students understand how energy usage is quantified as power. The conversion of gravitational potential energy to kinetic energy is explored in Rollercoaster. Meltdown is a lab activity where students observe the transfer of energy during a phase change. Burn After Eating quantifies the conversion of matter to energy through calorimetry. Cool Chemical Reactions allows students to observe the removal of energy from a system and the conservation of mass during an endothermic chemical reaction.

Learner Outcomes:

Participants will

- describe what the Science and Engineering Practices look like within the context of a lesson.
- identify and relate each lesson to Common Core State Standards and Next Generation Science Standards.
- review and make connections to the Big Ideas of AP when applicable.
- describe power as the rate of energy consumption.
- use conservation of energy to describe the conversion of energy from potential to kinetic.
- describe the transfer of energy during phase changes.
- demonstrate the conservation of mass and energy through calorimetry.
- discuss how mass is conserved during a chemical reaction.

NATIONAL MATH + SCIENCE INITIATIVE

Middle Grades Science

Models and Reactions
Module 9

Module 9 Description:

This module will explore activities from life and Earth science as well as chemistry and physics middle grades level topics. The activities include the use of models or address different types of reactions in science. The topics addressed include photosynthesis, the solar system, thermodynamics, and waves. Participants will perform activities to better visualize and apply these topics in the middle grades classroom.

Learner Outcomes:

Participants will

- develop a rich understanding of the philosophy of rigorous instruction in the classroom.
- review and make connections to the Big Ideas of AP where applicable.
- examine the Science Practices used with each lesson.
- identify and relate each lesson to Common Core State Standards, Next Generation Science Standards.
- demonstrate a deeper content-based knowledge about mitosis, space, thermodynamics, and waves.

NATIONAL MATH + SCIENCE INITIATIVE

Misconceptions and Magnets
Module 10

Module 10 Description:

This module will explore activities life and Earth science and middle grades level chemistry and physics topics that are often misunderstood by students. Misconceptions will be addressed in life, Earth, chemistry and physics units. Magnets and magnetic fields will also be addressed with a direct tie to planets.

Learner Outcomes:

Participants will

- develop a rich understanding of the philosophy of rigorous instruction in the classroom.
- review and make connections to the Big Ideas of AP where applicable.
- examine the Science Practices used with each lesson.
- identify and relate each lesson to Common Core State Standards, Next Generation Science Standards.
- demonstrate a deeper content-based knowledge about biological diagrams, the circulatory system, misconceptions, outgassing, magnets, and magnetic fields.

NATIONAL MATH + SCIENCE INITIATIVE

Middle Grades Science

Adaptations and Changes
Module 11

Module 11 Description:

This module will explore activities from life and Earth science as well as chemistry and physics middle grades level topics. Adaptations, black holes, acceleration, and chemical reactions will all be explored. Participants will spend the day completing hands on activities, taking advantage of data collection devices and probeware.

Learner Outcomes:

Participants will

- develop a rich understanding of the philosophy of rigorous instruction in the classroom.
- review and make connections to the Big Ideas of AP where applicable.
- examine the Science Practices used with each lesson.
- identify and relate each lesson to Common Core State Standards, Next Generation Science Standards.
- demonstrate a deeper content-based knowledge about adaptations, black holes, chemical reactions, and acceleration.

NATIONAL MATH + SCIENCE INITIATIVE

Middle Grades Science

Effects and Effectiveness
Module 12

Module 12 Description:

This module will explore activities from life and Earth science as well as chemistry and physics middle grades level topics. Current topics such as the greenhouse effect and global commons will be discussed and studied. Participants will also study heating curves and the effectiveness of levers.

Learner Outcomes:

Participants will

- develop a rich understanding of the philosophy of rigorous instruction in the classroom.
- review and make connections to the Big Ideas of AP where applicable.
- examine the Science Practices used with each lesson.
- identify and relate each lesson to Common Core State Standards, Next Generation Science Standards.
- demonstrate a deeper content-based knowledge about global commons, phase changes, levers, and rocks.