ARIZONA SCIENCE CENTER

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EDUCATOR GUIDE

FORCES OF NATURE

EXHIBIT GALLERY
STANDARDS
PRE-VISIT ACTIVITY
BOOKING TRIP

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INTRODUCTION

This Guide introduces concepts and activities for teachers to use with their students centered around the All About Me gallery at the Arizona Science Center, Phoenix, Arizona. This guide is divided into standards aligned activities based on grade level. There are three types of activities in this guide. The first type introduces students to concepts found in All About Me and provides them with background experiences that will enhance their field trip and understanding. The second type of activities are those that students can perform during a field trip. These may include handouts, interactive notebooks or information challenges for the gallery. The final type of activity allows for review and reflection of the experiences following the field trip. This curriculum guide encourages the use of the 5 E's of inquiry by encouraging students, teachers, and chaperones to **Engage, Explore, Explain, Elaborate, Evaluate** as they explore All About Me.

FORCES OF NATURE EXHIBIT GALLERY

Cloud Spinner: Use a spin-browser to change the speed and direction of videos that show cloud formation and movement.

Concepts: Meteorology, Air Pressure, Condensation

Grand Canyon: Visitors can use a topographical map to analyze different faces of the Canyon, as well as its weather, history and more!

Concept: Concepts: Geology, Hydrology, Erosion

Immersion Theater: The focal point of Forces of Nature is our extreme weather simulator! Step inside and experience the heat of a volcano or the torrential rain of a hurricane.

Concepts: Weather, Volcanology, Plate Tectonics

Magic Planet: This huge globe can be projected upon with hundreds of different "skins" of the Earth's surface. See our planet at night or the variation of gravity by location, or the current weather patterns across its surface.

Concept: Climate, Ecosystems, Earth Sciences, Geology, Geography

Make a Vortex: A specially constructed table produces thick clouds of "fog" that are forming into swirling vortex rings by the visitor.

Concepts: Concepts: Vortices, Meteorology

Make Waves with Wind: Guests use an overhead fan's changing speed to influence the height and spread of water waves in a glass bowl.

Concepts: Waves, Oceanography

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Plates on the Move: A shaky table is used as a surface to build sturdy structures with Keva planks. See whose structure stands up to "earthquakes" the best!

Concept: Plate Tectonics, Structural Integrity

Rock Recycler: Look into a virtual world to see robots change one type of rock into one of the other two types! Use a flowchart to predict how your rock will end up.

Concept: Rock cycle, Geology

Rift Zone: Gaze down into a basin filled with fine silica sand, and watch as the changing pressure underneath creates rifts similar to those found on the Earth's surface.

Concept: Geology, Plate Tectonics

See the Heat: A heating rod, suspended in room-temperature water, turns on and causes visible movement as the warmed liquid rises to the surface.

Concept: Plate Convection Cycles, Fluid Dynamics

Seasons: A geared turntable demonstrated the relationship between the Sun, Moon, and Earth. Earth's tilt is made obvious as the sun's light illuminates different halves of the Earth unequally, demonstrating the seasonal variation in a hands-on way.

Concept: Astronomy, Climate, Orbital Mechanics

Sculpt with Wind: Guests use a side-blowing fan to create elegant formations in blowing sand.

Concept: Plate Erosion, Deposition

SRP Faces of Science Kiosks: Three display cases showcase individual scientists (geologist, meteorologist, hydrologist) along with examples of their work and tools.

Concept: Plate Science Fieldwork

SRP Water Energy Center: This workstation presents tabletop activities that excite and engage guests as they explore hydrology and water conservation phenomena. It also features staff-led interactives at certain times.

Concept: Plate Water Conservation, Dams, Hydrology

Stream Table: : Watch trickling water carve an endless variety of banks and meanders through sand and rock!

Concept: Erosion, Deposition

Take a Closer Look: Use mounted magnifying glasses to inspect eighteen samples of all three types of rock- igneous, sedimentary, and metamorphic. Notice the huge differences even between rocks of the same type!

Concept: Rock cycle, Geology

Eye of Inheritance: Visitors learn how to combine eye color genes from a mother and father to their child. This display only uses two eye colors: brown and blue.

Concepts: Genetics

Fever: A display showing the difference between a healthy individual and an individual with a fever.

Concept: Immune Response

Food Is Fuel: This exhibit demonstrates how much work it takes to burn off varying amounts of calories from different foods using a bicycle peddler. The time it takes to burn off the calories is measured by hour of exercise.

Concept: Nutrition and Digestive System

Food Quiz: How well do you know your foods? This is a quiz about what nutrients are found in certain foods.

Concepts: Nutrition and Digestive System

Gas Em Up: A similar exhibit to Vital Network, this display includes the lungs and traces the path of oxygenated and deoxygenated blood through the lungs and the body.

Concept: Respiratory and Circulatory Systems

Heart Beat Drum: Visitors hear their pulse played by a drum.

Concept: Circulatory System

Heart Surgery Theater: Watch as Arizona Heart Center's Dr. Dietrich performs an open-heart bypass surgery. This exhibit also includes a display of the tools heart surgeons use.

Concept: Circulatory System

Immune Response: This display demonstrates how antibodies produced by the body's immune system are unique to invaders that cause disease.

Concept: Immune Response

Just Joints: This display demonstrates the different types of joints in the body.

Concept: Skeletal System

Load Bearing Bones: A display illustrating how bones absorb stress from load-bearing exercises.

Concept: Skeletal System

ESSENTIAL QUESTIONS

These four questions provide the framework for guiding learning through Forces of Nature.

What is air made of? What causes trees to move and waves to form on ponds?

When considering natural disasters such as hurricanes, tornadoes, and earthquakes; what role does friction play?

How do forces inside the earth take a sandstone and form lava?

Consider a flowing stream, what forces are involved with erosion?

EDUCATOR RESOURCES

Watch a BrainPop on the forces of erosion - Erosion - BrainPOP

Dynamic Earth - Interactive resources for earth science - Earth's Structure

The Story of Plate Tectonics - This Dynamic Earth--Contents [USGS]

National Oceanic and Atmospheric Administration - Educator Resources - NOAA Education Resources

National Weather Service - National Weather Service

Rock Cycle Simulation - The Rock Cycle

History of Water use in Phoenix - Canal history

Explore Black Holes with the Hubble Telescope - Black Holes

NASA Resources on Seasons, Atmosphere, Solar System, and Space - What causes the seasons

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STANDARDS BY GRADE LEVEL

THIRD GRADE

STRAND 6	CONCEPT 2	PO 1	Identify the layers of the Earth: crust, mantle, core (inner and outer)
STRAND 6	CONCEPT	PO 2	Describe the different types of rocks and how they are formed: metamorphic, igneous, sedimentary
STRAND 6	CONCEPT 1	PO 3	Classify rocks based on the following physical properties: color and texture

FOURTH GRADE

STRAND 6	CONCEPT 2	PO 1	Identify the Earth processes that cause erosion.
STRAND 6	CONCEPT 2	PO 2	Describe how currents and wind cause erosion and land changes.
STRAND 6	CONCEPT 2	PO 3	Describe the role that water plays in the following processes that alter the Earth's surface features: erosion, deposition & weathering
STRAND 6	CONCEPT 2	PO 4	Compare rapid and slow processes that change the Earth's surface, including: rapid (earthquakes, volcanoes, floods) and slow (wind, weathering)

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STANDARDS BY GRADE LEVEL *(5th grade not available)*

SIXTH GRADE

STRAND 6	CONCEPT 2	PO 1	Identify the Earth processes that cause erosion.
STRAND 6	CONCEPT 2	PO 2	Describe how currents and wind cause erosion and land changes.
STRAND 6	CONCEPT 2	PO 3	Describe the role that water plays in the following processes that alter the Earth's surface features: erosion, deposition & weathering
STRAND 6	CONCEPT 2	PO 4	Compare rapid and slow processes that change the Earth's surface, including: rapid (earthquakes, volcanoes, floods) and slow (wind, weathering)

PRE VISIT ACTIVITY "THE SPEED OF WIND"

by Casey Crowley

OVERVIEW/DESCRIPTION

This activity focuses on how anemometers are designed to measure the speed of wind. Students will work in groups to design, build and test an anemometer made out of everyday materials and learn about some practical applications for anemometers. Students must also develop a way to measure and chart the rotations of their anemometers.

BACKGROUND

An anemometer is a device that is used for measuring wind speed, and is usually found at weather stations. They can also be used to determine if a location is feasible for wind turbines, the wind speed of tornados and hurricanes, and to test the aerodynamics of airplanes. The term is derived from the Greek word anemos, meaning wind. The first anemometer was invented by Leon Batista in 1450 and later improved upon by Leonardo da Vinci.

STEM CONCEPTS

- Wind and Weather
- Engineering Design
- Graphing
- Energy
- Averages
- Teamwork

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5 E'S OF INQUIRY

Engage:

How do scientists measure wind speeds during tornados and hurricanes?

Show this movie clip from "Twister" https://www.youtube.com/watch?v=2dQgjrrEeHA

Did anyone notice the device attached to the truck at the beginning of the scene? Restart the clip and pause at 12-13 seconds. Ask students what they think this device is and what does it do?

Explore:

Divide students into groups of 2-3. Explain that each group must develop their own working anemometer from everyday materials. They must also devise a way to measure and record the relative speed of the wind as indicated by their anemometer. Show students the materials available to build their anemometers.

Explore: (continued)

Groups should develop and draw a plan for their anemometer and create a materials list before gathering their materials. As the groups build their anemometers, they may need to rethink their plan and request other materials. If they do so, they must revise their drawing and materials list. They will also need to devise a way to count revolutions and chart their results as wind speeds change. Note: you may wish to make the "wind" available during the building phase so they can test their anemometer during the building phase prior to the final classroom test. Teacher tips: In order to measure the relative wind speed, students will likely measure the number of revolutions of their anemometer, so you may need to guide them to color one of the wind catchers differently than the others so that it is easier to count revolutions. Also, the top portion must freely spin without resistance, therefore using a straw or pointed object on which the top piece will spin is ideal.

Each group will briefly present their design to the class, discussing how they came up with the design and what modifications they had to make as they built it. Then they will test their design as the other groups observe. Students should make note of what worked and didn't work in each design. The groups should do 3 tests at each wind speed (low, medium, high), for a total of 9 tests. The 3 tests should be averaged to give a relative wind speed for each speed. Results can then be charted as the students see fit.

Explain:

Have students discuss what design features of their anemometers seemed to work best and any other observations they want to share. Show students some photos of real anemometers that illustrate how they have evolved over time (see resources) and compare and contrast them to the anemometers they built. Is there an energy conversion happening when an anemometer "catches" the wind? What type of energy is the wind being converted into?

Elaborate:

What other uses do you think there might be for anemometers? (Examples: weather stations, feasibility tests for wind turbine locations, airports, to determine high wind forces on bridges and tall buildings, aircraft testing, testing ventilation systems, etc.). Why is it important to know the speed of the wind in certain situations?

If your anemometer was used to test a location to see if it would be a good site to install a wind turbine, do you think that three tests would be enough to generate a reliable average? Why or why not? If not, how many tests do you think would be adequate? What other features might an anemometer for this purpose need to have?

Evaluate:

Each group will self-evaluate their designs by answering the following questions:

Did your design succeed in measuring wind speed? How did your device measure the relative speed of the wind? What worked well in your design and what didn't work as you planned? Did you have to modify your original plan at all? If so, what did you change? If you had even more time and materials, how would you change your design?

TAKE HOME MESSAGES

Students will better understand the function and application of anemometers in today's world. Students will also better understand the engineering design process and will be able to gather and display their collected data.

SUPPLIES

Hairdryer or fan with multiple speed settings

One set of the following materials for each group of students:

plastic spoons, paper cups, string, tape, scissors, wire, straws, wooden sticks, small wooden (balsa) pieces, bendable wire (such as florist or craft wire), paperclips, rubber bands, toothpicks, aluminum foil, glue, paper, cardboard, plastic wrap, and any other materials you might have available.

Graph paper and pencils for charting results

TALKING POINTS/OPEN ENDED QUESTIONS

Do you think real engineers have to make modifications to their designs as they are building them?
Do you think they succeed perfectly the first time, every time?

RESOURCES

This activity was modified from: http://tryengineering.org/lesson-plans/measuring-wind

More info on anemometers: http://education.nationalgeographic.org/encyclopedia/anemometer/

http://www.actforlibraries.org/uses-of-an-anemometer-3/

http://www.da-vinci-inventions.com/anemometer.aspx

NEXT GENERATION SCIENCE STANDARDS

4th grade

3-5. Engineering Design

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.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

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.MS. Engineering Design

4.ENERGY

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

8th grade

MS. Engineering Design

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 iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

MS. ENERGY

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.

ARIZONA STATE SCIENCE STANDARDS

4th grade

Strand 1: Inquiry Process
- Concept 4: Communication
  - PO 1: Communicate verbally or in writing the results of an inquiry.
  - PO 2: Choose an appropriate graphic representation for collected data.
  - PO 3. Communicate with other groups or individuals to compare the results of a common investigation.

Strand 3: Science in Personal and Social Perspectives
- Concept 2: Science and Technology in Society
  - PO 3: Design and construct a technological solution to a common problem or need using common materials.

Strand 6: Earth and Space Science
- Concept 3: Changes in the Earth and Sky
  - PO 4: Measure changes in weather (e.g., precipitation, wind speed, barometric pressure).

8th grade

Strand 1: Inquiry Process
- Concept 4: Communication
  - PO 1: Communicate the results of an investigation.
  - PO 2: Choose an appropriate graphic representation for collected data.

Strand 3: Science in Personal and Social Perspectives
- Concept 2: Science and Technology in Society
  - PO 3: Design and construct a solution to an identified need or problem using simple classroom materials.

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BOOK YOUR FIELD TRIP TODAY!

If you have a group of 15 or more, you are eligible for group discounts! To schedule a visit, call 602.726.2000 ext. 128 or email reservations@azscience.org

Please see below for rate information:

School Groups

Students $6*
Chaperones $6*
AZ State Certified Educators .... Free

**General Admission is waived for Focused Field Trip Certified Educators, their students, and chaperones (40%+ free lunch = Title 1)*

General Groups

Children (ages 3–17) $6
Adults $7

Add-ons

Traveling Exhibitions- Price Varies, Click here for details
CREATE .... Price varies
(chaperones/teachers are free as they are not participating in the challenges)
Planetarium $4/person
IMAX $5/person

EDUCATOR PROFESSIONAL DEVELOPMENT

Freeport- MacMoran Foundation Center for Leadership in Learning

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