Web Unit Plan

Title: What Does This Graph Tell You?

Description: How do you model or simulate natural phenomena? How do you use trendline data to predict future occurrences? How can spreadsheets help with data analysis? Students explore these questions as they research natural phenomena, design simulations in a lab setting, gather data, use spreadsheet software to analyze and represent their data, and create presentations of their findings.

At a Glance

Grade Level: 9–12

Subject sort (for Web site index): Math, Science

Subjects: Math, Science

Topics: Data Analysis, Functions, Trendlines, Modeling

Higher-Order Thinking Skills: Analysis, Interpretation, Synthesis

Key Learnings: Interpreting Graphs, Analysis of Bivariant Data, Modeling Phenomena, Representing Change

Time Needed: 10 class periods, 50-minute classes

Unit Summary

Students choose natural phenomena to research, and then design and conduct experiments or simulations, if applicable. They predict, gather, and analyze data, and then graph the results using spreadsheet software. Students share their findings with the class through a multimedia presentation. A class wiki is created for people in the community to test their skills at interpreting graphs. In an assessment following the presentations and wiki creation, students play a matching game, where they must determine the relevant graphs from sets of clue cards.

Curriculum-Framing Questions

- **Essential Question**
  Why is studying change important?
- **Unit Questions**
  How do we represent change?
  How do we model natural phenomena?
  How do we conduct scientific research?
- **Content Questions**
  What does this graph tell you?
  What functions or equations are represented?

Assessment Processes

View how a variety of student-centered assessments are used in the What Does This Graph Tell You? Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Day 1

Pose the Essential Question, *Why is studying change important?* Ask students to think individually about the question and then discuss their responses with each other. Ask for volunteers to share responses with the whole class.

Introduce the following Unit Questions:

- *How do we represent change?*
- *How do we model natural phenomena?*
- *How do we conduct scientific research?*

Explain to students that they will be exploring these questions throughout their work on the project.

Divide students into small groups, pass out the What Do These Graphs Tell You? worksheet and ask students to analyze the graphs and share interpretations. Use this activity to assess students' prior knowledge of graphical information, data interpretation, and analysis of bivariant data. The information you gather from listening to the students analyze and discuss the graphs will allow you to tailor the unit more closely to students' learning needs. For example, you may find out that students need more experience in analyzing functions that *fit* the data well and may decide to provide them with more opportunities to do this.

Day 2

Ask students to brainstorm a list of natural phenomena that they could gather data on in a lab setting. You may need to define *natural phenomena* (non-artificial events, in the physical sense, that are not produced by humans, such as volcanic eruptions, weather decay, bacteria, aging, and natural disasters). Have students choose three natural phenomena they would like to research and then design experiments to simulate the phenomena.

Place students in groups of three or four based on interest. Remind students to take some details into consideration as they design experiments, such as the selection of experimental units, issues of randomization, factors in simulating natural phenomena, and the number of trials needed to make a generalization.

Review how to use spreadsheets if necessary, especially choosing the best trendline for scatterplot data. Print and pass out the trendline spreadsheet help document as a resource for students.

Days 3 through 7

Instruct students to use the following six phases as a *general* procedure in working on their projects:

1. Devise a research question.
2. Research the phenomena on the Internet.
3. Design the experiment.
4. Collect data.
5. Produce a scatterplot, analyze it, choose a function over the scatterplot using spreadsheet software, and write an equation.
6. Continue research and find phenomena that produce similar graphs and equations.

Note: *You may find it useful to create a chart or document with the guidelines so students have it to follow.*

Distribute the science research process rubric and review with students so that they understand the expectations for conducting research and designing their experiments.

While the students are working during the first four phases of their experiments, use the graphing student observation sheet to make notes and assess students' work habits, ideas, communication, and cooperation.

During the final two phases of work, use the students observing thinking structured observation as a means to help students see and understand their own thinking and the thinking of others.

Day 8

Ask students to prepare a multimedia presentation that addresses:

- Experimental design used
- Graphical representation of the data
- Other phenomena that produce the same graphic results
- How to find the function or equation of the graph
- Why the phenomena is important to study

Refer students back to the science research process rubric and review it with them so that they understand the expectations for the multimedia presentation.

Day 9

Instruct students to take notes during the presentations in preparation for the final assessment, which is a graph matching game.

Day 10

Copy and cut out the graphs and clue cards from the match game document.

Ask each student to pin one of the graphs onto the back of another student (students should not see their own graphs). Instruct each student to randomly choose from three to five of the "clue cards" that describe the graphs. Encourage students to wander among each other trying to match their clue cards to the correct graphs. Remind students that when they find a match, they should write down the name of the person wearing the graph that matches the clue card directly onto the clue card and then continue until all the clue cards are matched with names. Reinforce the idea that students should not reveal to their classmates which graph is on their back.

*Note: *A student might receive a card that matches the graph that the student is wearing. In that case, the student will not be able to find a person wearing the graph. The student should hold onto the card and at the end of the activity determine whether indeed the clue card matches the graph the student is wearing*.

Collect the clue cards at the end and separate them by name of student. Students should then determine what their graphs look like by reading the clue cards with their name. Discuss any discrepancies.

Day 11
Have students create a class wiki describing each of the different types of graphs they've studied (linear, logarithmic, polynomial, power, exponential, etc.). Ask them to create the wiki so that people from the community can guess the natural phenomena that the different types of graphs represent and then go to a page for solutions. Students can gather data from responses and find which types of graphs are the easiest or most difficult for people to interpret.

Prerequisite Skills

- Enter data into a spreadsheet
- Write a simple formula for a spreadsheet
- Make scatterplots using technology
- Find regression equations using technology
- Find regression coefficients and evaluate the fit of a regression equation for a scatterplot
- Understand the relationships among various functions and graphs
- Recognize linear, quadratic, higher-degree polynomial, exponential, and trigonometric functions

Differentiated Instruction

Resource Student
- Allow more time as needed
- Provide peer tutoring opportunities before or after school

Gifted Student
- Challenge the student to design multiple and varied experiments and situations that result in the same graphic results

English Language Learner
- Allow the student to access Internet sites in the student's first language
- Pair the student with a peer in groups
- Use visuals as a means for explaining the assignments

Credits

A teacher participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

THINGS YOU NEED (highlight box)

Assessment Plan

Assessment Timeline

Before project work begins
- Questioning
- What do These

Students work on project and complete tasks
- Graphing Student
- Students Observing

After project work is completed
- Science Research
- Match Game

	Graphs Tell You? Worksheet	Observation	Thinking	Process Rubric

Several assessments occur at various points along the line within the unit. The What Do These Graphs Tell You? worksheet assesses students' prior knowledge and understanding of graphical information. The graphing student observation sheet is used in the beginning of project work for teachers to take notes and assess students' work habits, ideas, communication, and cooperation skills. The students observing thinking structured observation is used when students work on their experiments to help them see and understand their own thinking and the thinking of others. The science research process rubric is used by students and the teacher to assess the multimedia presentation. Finally, the match game is used as a final assessment of the unit.

Targeted Content Standards and Benchmarks

Project 2061 Benchmarks

1. The Nature of Science
B. Scientific Inquiry

- Investigations are conducted for different reasons, including to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.
- Hypotheses are widely used in science for choosing what data to pay attention to and what additional data to seek, and for guiding the interpretation of the data (both new and previously available).
- Sometimes, scientists can control conditions in order to obtain evidence. When that is not possible for practical or ethical reasons, they try to observe as wide a range of natural occurrences as possible to be able to discern patterns.

2. Nature of Mathematics
A. Patterns and Relationships

- Mathematics is the study of any patterns or relationships, whereas natural science is concerned only with those patterns that are relevant to the observable world. Although mathematics began long ago in practical problems, it soon focused on abstractions from the material world, and then on even more abstract relationships among those abstractions.

9. The Mathematical World
B. Symbolic Relationships

- Any mathematical model, graphic or algebraic, is limited in how well it can represent how the world works. The usefulness of a mathematical model for predicting may be limited by uncertainties in measurements, by neglect of some important influences, or by requiring too much computation.

11. Common Themes
B. Models

- The basic idea of mathematical modeling is to find a mathematical relationship that behaves in the same ways as the objects or processes under investigation. A mathematical model may give insight about how something really works or may fit observations very well without any intuitive meaning.

- Computers have greatly improved the power and use of mathematical models by performing computations that are very long, very complicated, or repetitive. Therefore computers can show the consequences of applying complex rules or of changing the rules. The graphic capabilities of computers make them useful in the design and testing of devices and structures and in the simulation of complicated processes.

- The usefulness of a model can be tested by comparing its predictions to actual observations in the real world. But a close match does not necessarily mean that the model is the only "true" model or the only one that would work.

In many physical, biological, and social systems, changes in one direction tend to produce opposing (but somewhat delayed) influences, leading to repetitive cycles of behavior.

Student Objectives

Students will:

- Use mathematics to represent and analyze relationships in natural phenomena
- Analyze the relationship between two data sets by using scatterplots
- Model data represented in scatterplots with regressions equations
- Determine how well regression equations fit particular data sets
- Communicate discoveries about the relationships between real-world data sets
- Translate among tabular, symbolic, and graphical representations of functions
- Recognize that a variety of problem situations can be modeled by the same type of function

Materials and Resources

Printed Materials

- Reference materials

Supplies

- Lab materials for experiments

Internet Resources

- World Climate: Historical World Climate Data
  www.worldclimate.com*
  Over 85,000 records of world climate data (historical weather averages) from a wide range of sources
- Center for Tsumami Research
  http://nctr.pmel.noaa.gov*
  Dedicated to the research and prediction of tsunami and its impacts on the population and infrastructure of coastal communities
- National Climatic Data Center: National Storm Database
  www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms*
  NCDC Storm Event database that can be used to find various types of storms recorded in a county or recorded by other selection criteria as desired
- Hurricane Alley
  www.hurricanealley.net*

Information concerning tropical cyclones worldwide

Technology—Hardware

- Computers for creating and projecting multimedia presentations, connecting to the Internet, and entering data into spreadsheet software
- Printer for printing graphs and data
- Internet connection to research information

Technology—Software

- Database or spreadsheet software for entering, analyzing, and representing data
- Web browser to research information
- Word processing application to create documents summarizing research
- Multimedia software to present findings and research