Unit 1: Scientific and Engineering Practices

Content Area: **Science**
Course(s): **Science**
Time Period: **Week 1**
Length: **3-4 Weeks**
Status: **Published**

Unit Overview

In this unit, students will define problems more precisely, conduct a more thorough process of choosing the best solution, and optimize the final design. Defining the problem with "precision" involves thinking more deeply about a problem is intended to address or the goals a design is intended to reach. Additionally, students are expected to consider not only the end user, but also the broader society and the environment. Developing possible solutions focuses on the two-stage process of evaluating the different ideas that have been proposed by using a systematic method to determine which solutions are most promising, and by testing different solutions and then combining the best ideas into a new solution that may be better than any of the preliminary ideas. Improving designs involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. This unit will lay the framework for the rest of the units in sixth grade.

Performance Expectations

SCI.6-8.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.
SCI.6-8.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.
SCI.6-8.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.
SCI.6-8.MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Three Dimensions

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in 6-8 builds on K-5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.

- Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)

Developing and Using Models

Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)

Analyzing and Interpreting Data

Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)

Engaging in Argument from Evidence

Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argumen that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Deliminting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge likely to limit possible solutions. (MS-ETS1-1)

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. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)

- Models of all kinds are important for testing solutions. (MS-ETS1-4)

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all test, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of those characteristics may be incoporated into the new design. (MS-ETS1-3)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

Knowledge, Skills, and Assessment

Essential Insights and Understandings/Guiding Questions	Critical Knowledge and Skills	Reco
What is Science?	Science is a way of learning about the natural world. Science also includes all the knowledge gained by exploring the natural world. Scientists use skills such as observing, inferring, predicting, classifying, evaluating, and making models to study the world. **Skill: SWBAT...** • **Identify skills scientists use to learn about the world** Scientists possess certain important attitudes, including curiosity, honesty, creativity, open-mindedness, skepticism, good ethics, and awareness of biases. Scientific reasoning requires a logical way of thinking based on gathering and evaluating evidence. **Skill: SWBAT...** • **Describe the attitudes that are necessary for thinking scientifically, ethically, and without bias.**	**Lab Acti** will obser a specific this desig observatio **Formal A** answer th scientists scientifica scientific an experi laws?

- **Describe scientific reasoning and explain how it is used.**

Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence they gather. An experiment must follow sound scientific principles for its results to be valid. Unlike a theory, a scientific law describes an observed pattern in nature without attempting to explain it.

Skill: SWBAT...

- **Explain what scientific inquiry is and how it involves posing questions and developing hypotheses.**
- **Explain how to design and conduct an experiment so that it uses sound scientific principles.**
- **Differentiate between a scientific theory and a scientific law.**

What are the Tools of Science?

Using SI as the standard system of measurement allows scientists to compare data and communicate with each other about their results. In SI, some units of measurement include meter (m), kilogram (kg), cubic meter (m^3), kilograms per cubic meter (kg/m^3), kelvin (K), and second (s).

Skill: SWBAT...

- **Explain why scientists use a standard measurement system.**
- **Identify the SI units of measure for length, mass, volume, density, time, and temperature.**

Math skills that scientists use to collect data include estimation, accuracy and precision, and significant figures. Scientists calculate percent error; find the mean, median, mode, and range; and check reasonableness to analyze data.

Skill: SWBAT...

- **Describe what math skills scientists use in collecting data and making measurements.**
- **Identify the math tools scientists use to analyze their data.**

Models help scientists understand things they cannot observe directly. A system is a group of parts that work together to produce a specific

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Assessme assessed c scenarios. and identi function or result. Scientists use models to understand how systems might change from feedback or input changes.

Skills: SWBAT...

- **Explain why models are used in science.**
- **Describe different types of systems and identify characteristics that all systems have.**
- **Examine models of natural systems and compare the model to the system itself.**

Line graphs display data that show how the responding variable changes in response to the manipulated variable. Line graphs are powerful tools in science because they allow you to identify trends, make predictions, and recognize anomalous data.

Skill: SWBAT...

- **Explain what kind of data line graphs can display.**
- **Explain why line graphs are powerful tools in science.**

Good preparation helps you stay safe when doing science investigations. When any accident occurs, no matter how minor, tell your teacher immediately. Then listen to your teacher's directions and carry them out quickly.

Skill: SWBAT...

- **Explain why preparation is important in carrying out investigations in the lab and in the field.**
- **Describe what you should do if an accident occurs.**

What is Engineering?

Engineering requires both scientific and technical knowledge to design things that make life better. Engineering has many branches, including: bioengineering, aerospace engineering, mechanical engineering, civil engineering, chemical engineering, and electrical engineering. Engineers design and build products that improve our daily lives in many ways, including: saving lives, energy, time, and effort.

Skills: SWBAT...

- **Explain that engineering is the application of science and technology to design things that make life better.**
- **Identify some branches of engineering and provide examples of engineered products or systems for each**

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branch.
- **Describe how society has benefited from the work of engineers.**

Suggested Resources

ck-12: http://www.ck12.org/

Scientific Method

- http://www.ck12.org/earth-science/Scientific-Method/

Scientific Theories

- http://www.ck12.org/biology/Scientific-Theories/

Scientific Inquiry

- http://www.ck12.org/section/Scientific-Inquiry/

Measurement

- http://www.ck12.org/physics/Scientific-Measurement/lesson/Measurement-PHYS/

Technology Integration

ck12 Flexbook

Chromebooks

iPads

Cellular Devices

Internet

SmartBoard

Differentiation

Differentiation for special education:

- General modifications may include:
  - Modifications & accommodations as listed in the student's IEP
  - Assign a peer to help keep student on task
  - Modified or reduced assignments
  - Reduce length of assignment for different mode of delivery
  - Increase one-to-one time
  - Working contract between you and student at risk
  - Prioritize tasks
  - Think in concrete terms and provide hands-on-tasks
  - Position student near helping peer or have quick access to teacher
  - Anticipate where needs will be
  - Break tests down in smaller increments
- Content specific modifications may include:
  - address misconceptions relating to the nature of science
  - pre-generated graphs
  - mathematical formulas provided
  - teach with visuals
  - scale models
  - lab demonstrations

Differentiation for ELL's:

- General modifications may include:
  - Strategy groups
  - Teacher conferences
  - Graphic organizers
  - Modification plan
  - Collaboration with ELL Teacher
- Content specific vocabulary important for ELL students to understand include: science, observing, quantitative observation, qualitative observation, inferring, predicting, classifying, evaluating, skepticism, ethics, personal bias, cultural bias, experimental bias, objective, subjective, deductive reasoning, inductive reasoning, scientific inquiry, hypothesis, variable, manipulated variable, responding variable, controlled experiment, data, scientific theory, scientific law, metric system, SI, mass, weight, volume, meniscus, density, estimate, accuracy, precision, significant figures, percent error, mean, median, mode, range, anomalous data, model, system, input, process, output, feedback, graph, linear graph, nonlinear graph, engineering, bioengineering, aerospace engineering, mechanical engineering, civil engineering, chemical engineering, electrical engineering

Differentiation to extend learning for gifted students may include:

- **Is It Really True?** Students will design and conduct a scientific experiment to test whether a common belief is true or false.
- **Other Scientific Skills** Students will brainstorm and/or research other skills scientists must have other than inferring and predicting.
- **Deductive Reasoning** Students will read a novel or short story by Sir Arthur Conan Doyle about Sherlock Holmes and identify examples of how Holmes uses deductive reasoning.

- **Cricket Experiment** Design an experiment to test the hypothesis: Crickets are more active at midnight than at noon.
- **Scientific Theory and Scientific Law** Students will choose an area that interests them, identify a scientific theory and scientific law related to that subject area, and summarize the theory and law in their own words.
- **Measure Volume** Students will choose an object and write a procedure for determining its volume.
- **Sink or Float** Students will determine densities of different materials, predict whether each material will float in water, then test their predictions.
- **Fun Facts and Conversions** Students will research a list of fun metric measurement facts about familiar objects or events and then convert each measurement to another metric unit of measurement.
- **Calculate** Determine mean, median, and mode for various numbers.
- **Bar Graphs and Cirlce Graphs** Demonstrate how bar graphs and cirlce graphs are made and used for science.
- **Describe Systems** Identify examples of systems students are familiar with in their classroom, school, home or neighborhood and also identify the input, output, and process of each system. If possible, students will describe feedback in at least one of the systems.
- **Write About Safety** Write a tale of two students, one who follows safety guidelines and first-aid procedures after a lab accident and one who does not.
- **Research Engineering Education** Research the educational requirements of an engineer in one or more of the following engineering fields: bioengineering, mechanical engineering, chemical engineering, civil engineering, or electrical engineering.
- **Fictional Car** Design a fictional car that runs on a material that is plentiful on Earth.

21st Century Skills

CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP9	Model integrity, ethical leadership and effective management.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.