

Unit 01: Scientific Design and Engineering Practices (Week 1-10/Full Year)

Content Area: **Template**

Course(s):

Time Period: **Full Year**

Length: **6 weeks**

Status: **Published**

Stage I: Desired Results

Transfer/Overview/Rationale

Transfer / Overview / Rationale

Unit Rationale

The purpose of this unit...

The engineering design process and scientific experimental design process are both used to solve problems that impact society and the scientific community. Students will learn that while both processes have slight differences, the outcome of solving problems through a series of trial, error, failures, and successes, remain the same. Data collection, analysis, and sharing results and solutions with society and the scientific community are crucial as part of any engineering or experimental design process.

Meaning

Essential Questions

Essential Questions

1. What are the similarities and differences between the engineering design process and scientific experimental design process?
2. What types of problems are best solved using the engineering design process? The scientific experimental design process?
3. What role does data collection play in a successful design process?

4. What role does evidence and communication of evidence play in the design process?

Enduring Understanding/Indicators of Understanding

Enduring Understanding/Indicators of Understanding

1. The engineering design process and scientific experimental design process both have the intended outcome of solving problems using creativity and ingenuity.
2. Both processes, have slight differences, but both involve trial, error, failures, and successes.
3. Data collection is an important part of any design processes.
4. Providing adequate evidence and communicating that evidence with others, is a crucial part of any design process.

Acquisition (Student Learning Objectives)

Knowledge

Knowledge
Students will know...

1. The steps/cycle of the engineering design process
2. The steps/cycle of the scientific experimental design process

3. The role that trial, error, and failures play in both design processes
4. The importance of accurate/precise data collection in both design processes
5. "Adequate" evidence means different things for different problems
6. The components of a successfully communicative conclusion

Skills

Skills

Student will be skilled at ...

1. Identify and/or develop questions/problems that can be answered/solved through the engineering design process and experimental design process (and to distinguish between the two)
2. Identify and apply the steps of the engineering design process
3. Identify and apply the steps of the experimental design process and identify variables
4. Read, follow, and write clear and concise procedures
5. Acknowledge the flexibility in both the engineering design and experimental design processes.
6. Collecting data to later provide as evidence of a successful experiment/solution
7. Analyzing data to later provide as evidence of a successful experiment/solution
8. Provide data as adequate evidence of a successful experiment/solution

9. Effectively communicate the results of an experiment/effectiveness of solution

Standards Alignment

- **MS-ETS1-1:** Define a problem considering criteria and constraints, including scientific principles and environmental impact.
- **MS-ETS1-2:** Evaluate competing solutions using a systematic process.
- **MS-ETS1-3:** Analyze data from tests to improve a design model.
- **MS-ETS1-4:** Develop a model to generate and test iterative solutions.

Integration of Career Readiness, Life Literacies and Key Skills

CAEP.9.2.8.B.2	Develop a Personalized Student Learning Plan with the assistance of an adult mentor that includes information about career areas of interest, goals and an educational plan.
CAEP.9.2.8.B.3	Evaluate communication, collaboration, and leadership skills that can be developed through school, home, work, and extracurricular activities for use in a career.
CAEP.9.2.8.B.4	Evaluate how traditional and nontraditional careers have evolved regionally, nationally, and globally.
CAEP.9.2.8.B.7	Evaluate the impact of online activities and social media on employer decisions.

Technology / Integration of Computer Science and Design Thinking

CS.6-8.8.1.8.AP.6	Refine a solution that meets users' needs by incorporating feedback from team members and users.
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Interdisciplinary Connections: NJSL for ELA, Social Studies, Science and/or Math Section

LA.RL.7.4	Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of rhymes and other repetitions of sounds (e.g., alliteration) on a specific verse or stanza of a poem or section of a story or drama.
LA.RL.7.7	Compare and contrast a written story, drama, or poem to its audio, filmed, staged, or multimedia version, analyzing the effects of techniques unique to each medium (e.g., lighting, sound, color, or camera focus and angles in a film).

LA.RL.7.9

Compare, contrast and reflect on (e.g., practical knowledge, historical/cultural context, and background knowledge) a fictional portrayal of a time, place, or character and a historical account of the same period as a means of understanding how authors of fiction use or alter history.

Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media Literacy **New Section**

see Crosswalks

New Jersey Student Learning Standards

Practice 1. Asking questions (for science) and defining problems (for engineering)

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.

Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.

Ask questions to determine relationships between independent and dependent variables and relationships in models.

Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.

Ask questions that require sufficient and appropriate empirical evidence to answer.

Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.

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.

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.

Construct an explanation using models or representations.

Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.

Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

Crosscutting Statements

2. Cause and Effect: Mechanism and Prediction – Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Connections to Engineering, Technology and Applications of Science Interdependence of Science, Engineering, and Technology

Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.

Science and technology drive each other forward.

Influence of Engineering, Technology, and Science 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.

The uses of technologies and any 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.

Connections to the Nature of Science: Most Closely Associated with Crosscutting Concepts Science is a Human Endeavor

Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination and creativity.

Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism and openness to new ideas.

Individuals and teams from many nations and cultures have contributed to science and to advances in engineering.

Science and engineering are influenced by society and society is influenced by science and engineering.

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

CAEP.9.2.8.B.2	Develop a Personalized Student Learning Plan with the assistance of an adult mentor that includes information about career areas of interest, goals and an educational plan.
CAEP.9.2.8.B.3	Evaluate communication, collaboration, and leadership skills that can be developed through school, home, work, and extracurricular activities for use in a career.
CAEP.9.2.8.B.4	Evaluate how traditional and nontraditional careers have evolved regionally, nationally, and globally.
CAEP.9.2.8.B.6	Demonstrate understanding of the necessary preparation and legal requirements to enter the workforce.
CAEP.9.2.8.B.7	Evaluate the impact of online activities and social media on employer decisions.

Stage 3: Learning Plan

Resource and Mentor Texts

Resources and Mentor Texts

This is a year-long unit infused throughout the other units. However, a few learning activities to introduce the rationale to students at the beginning of the year are below:

- The Secret Lives of Scientists and Engineers (see attachment)
- Popcorn as Prisms (see attachment)
- Bridging the Gap (see attachment)

[Design a satellite](#)
[popcorn-as-prisms.pdf](#)
[Bridging the Gap- 3-doodler](#)

[The Secret Lives of Scientists and Engineers'](#)

Formative Assessment Strategies

Formative Assessment Strategies

1. Quizzes (Wrap-ups)

2. Virtual labs
3. Interactive notebook activities/assignments
4. Labs (based on lab availability/scheduling conflicts).
5. Informal questioning

(Note: Formative Assessments will vary for each unit of study)

Learning Activities/Unit of Study

Learning Activities/Unit of Study

1. Projector
2. Lab Materials (see learning activities for more detail)
3. 3 Doodler
4. Interactive notebooks
5. Interactive notebook materials
6. Student copies (see learning activities for more detail)

<http://edu.the3doodler.com/lessons/stem-bridging-the-gap/>

<http://edu.the3doodler.com/lessons/>

<http://web.csulb.edu/~lhenriqu/STEM-activities.htm>

<http://teachers.egfi-k12.org/category/lessons/grades-6-8-lessons/>

Modifications and/or Accommodations

Suggested Modifications (ELL, Sp. Ed, Gifted, At-risk of Failure)

English Language Learners

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing the students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

Special Education Students

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

Students with 504 Plans

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Gifted & Talented Strategies

Extensions/Enrichments: Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

Modify/Change Activities: Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

Students at Risk of School Failure

Directions or Instructions: Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

Peer Support: Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for

clarification before going to you.

Alternate or Modified Assignments: Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

Increase One to One Time: When other students are working, always touch base with your students at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

Contracts: It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

Hands On: As much as possible, think in concrete terms and provide hands-on tasks. This means a child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.