Unit 1: Engineering Processes (Engineering Design)

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Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

Science: Grade 3

Unit 1: Engineering Processes

Belleville Board of Education

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Unit Overview

Unit 1 focuses on engineering processes. Students will learn how to define problems and design solutions to those problems. Students will learn how to test solutions and make improvements to solutions.

Enduring Understandings

- Engineers design solutions to meet a want or need.
- Technology is human-made devices or systems that meet a want or need.
- Brainstorming, planning, designing, modeling, and prototyping are all parts of the engineering process.
- Engineers must do a lot of pre-work before any final product (technology) is ready for use.
- The first step in a design process is to find a problem.
- Criteria is the desirable features of the solution to an engineering problem.
- Constraints are the limits on the resources that can be used to solve a problem.
- Researching past solutions will help you understand problems and avoid making mistakes.
- Engineers pay close attention to detail, constraints, criteria, and many important aspects.
- Engineers work to design and test solutions.

Essential Questions

- How do we define a problem?
- Where do solutions come from?
- How can we design a solution?
- How do we test and improve a solution?

Exit Skills

By the end of Unit 1, students will be able to:

- Ask questions and define problems.
- Construct explanations and design solutions.
- Find the limits on problem solving in engineering.
- Identify problems, criteria, and constraints.
- Develop possible solutions.
- Optimize the design solution.
- Analyze the influence of science, engineering, and technology on society and the natural world.

New Jersey Student Learning Standards (NJSLS-S) & NGSS

SEP - Planning and Carrying Out Investigations (Lesson 3)

SEP - Asking Questions and Defining Problems (Lesson 1)

SEP - Constructing Explanations and Designing Solutions (Lesson 2)

DCI - Defining and Delimiting Engineering Problems (Lesson 1)

DCI - Developing Possible Solutions (Lessons 2, 3)

DCI - Optimizing the Design Solution (Lesson 3)

CCC - Influence of Engineering, Technology, and Science on Society and the Natural World (Lessons 1, 2, 3)

NextGen Science Standards

SCI.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.
SCI.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.
SCI.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.

Interdisciplinary Connections

Connections to Math:
3.MD.A.2 - Solve problems involving measurement and estimation.
3-5.OA - Operations and Algebraic Thinking

Connections to ELA:
W.3.2 - Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
W.5.9 - Draw evidence from literary or informational texts to support analysis, reflection, and research.
RI.3.1 - Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
RI.3.7 - Use information gained from illustrations and the words in a text to demonstrate understanding of the text.

Learning Objectives

In Unit 1, students will demonstrate the ability to:

Lesson 1: How Do We Define a Problem?

- Determine how to identify a problem.
- Identify criteria and constraints based on a problem.
- Design solutions based on the problem, criteria, and constraints.

Lesson 2: How Do We Design a Solution?

- Research past solutions to assist with designing new solutions.
- Develop proposed solutions with desirable features of the design.
- Determine the importance of communicating with others to enhance solutions.

Lesson 3: How Do We Test and Improve a Solution?

- Justify why failures help make designs better.
- Generate ways engineers can improve their product, solution, or system.
- Determine reasons why solutions should be evaluated and redesigned.

Suggested Activities & Best Practices

HMH Science Dimensions, Unit 1 - Lesson 1: How Do We Define a Problem?:

- **Engage:** "Can You Solve It?" pg. 4-5
- **Explore/Explain:** "Defining Engineering Problems" and "Exploring the Limits on Problem Solving" pg. 16
- **Evaluate:** "Lesson Check" and "Lesson Roundup" pg. 19-21

HMH Science Dimensions, Unit 1 - Lesson 2: How Can We Design a Solution:

- **Engage:** "Can You Solve It?"pg. 22-23
- **Explore/Explain:** "Water Movers","How Dry Am I?," "Testing, Testing" lessons and hands-on activity (Exploration 1, 2, & 3) pg. 24-33
- **Evaluate:** "Lesson Check" and "Lesson Roundup" pg. 39-41

HMH Science Dimensions, Unit 1 - Lesson 3: How Do We Test and Improve a Solution:

- **Engage:** "Can You Solve It?" lesson and hands-on activity pg. 42-43
- **Explore/Explain:** "What Could Possibly Go Wrong?", "Fixing Failures!", "The Best... For Now" lessons and hands-on activity (Exploration 1, 2, & 3) pg. 44 and 46

- **Evaluate:** "Lesson Check" and "Lesson Roundup" pg. 57-59

OPTIONAL: HMH Science Dimensions, Unit 1 - Choose between the Performance Task (The Benefits of Research) and the You Solve It! Online Simulation:

- Identify the Problem
- Research
- Brainstorm
- Design
- Compare
- Evaluate

Assessment Evidence - Checking for Understanding (CFU)

- Admit Tickets/Do Now (Formative)
- Evaluation Rubrics (Summative)
- Exit Tickets (Formative)
- HMH Performance-based Assessment (Alternative)
- Journals (Formatives/Experiments)
- KWL Chart (Formative)
- Labs/Experiments (Alternative)
- Learning Center Activities (Formative)
- Quick Write (Formative)
- Quizzes (Formative)
- Self-Assessments (Formative)
- Think, Pair, Share (Formative)
- Web-based Assessments (Alternative)

Primary Resources & Materials

HMH Science Dimensions: Teacher Edition, Student workbooks, online resources

HMH Equipment & Safety Kits

Ancillary Resources

- BrainPop Educators (Engineering and Design Process)
- Mystery Science

Technology Infusion

- HMH Science Dimensions Digital Components
- Mystery Science
- BrainPop

Alignment to 21st Century Skills & Technology

21st Century Skills & Technology:

- English Language Arts
- Technology
- Mathematics

CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

TECH.8.1.5.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.5.A.1	Select and use the appropriate digital tools and resources to accomplish a variety of tasks including solving problems.
TECH.8.1.5.A.3	Use a graphic organizer to organize information about problem or issue.
TECH.8.1.5.C.CS4	Contribute to project teams to produce original works or solve problems
TECH.8.1.5.F.CS1	Identify and define authentic problems and significant questions for investigation.

21st Century Skills/Interdisciplinary Themes

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- Information Literacy

21st Century Skills

- Environmental Literacy
- Global Awareness

Differentiation

ELL
Lesson 2: pp. 24, 27
Lesson 3: pp. 53, 56

RTI/Extra Support
Lesson 1: pp. 8, 11, 12, 14
Lesson 2: pp. 30, 36
Lesson 3: p. 52

Extension
Lesson 1: pp. 15, 16
Lesson 3: pp. 45, 49

Differentiations:

- Small-group instruction
- Small-group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals
- Repeat directions
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions

- Multisensory approaches
- Preview vocabulary
- Preview content & concepts
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition

Special Education Learning (IEP's & 504's)

- Allow for open-note/open-book assessments
- Implement accommodations/modifications as dictated in the student's IEP/504 plan
- Modified written assignments
- Provide printed/online copies of lesson notes

English Language Learning (ELL)

ELL
Lesson 2: pp. 24, 27
Lesson 3: pp. 53, 56

- Allow for open-note / open-book assessments
- Allow multiple forms of student products (projects, models, slide-shows, etc.) to demonstrate student learning
- Ask and give information using key words
- Demonstrate listening comprehension by responding to questions
- Develop basic sight vocabulary
- Differentiate assessments to reflect selected objectives
- Express ideas in single words
- Modify reading assignments to correlate with lexile level
- Peer tutoring / Peer note-taking
- Speak using content area vocabulary in context
- Teacher-created Study Guide
- Use prior experiences to understanding meanings

- Use videos, illustrations, pictures, and drawings to explain or clarify

At Risk

RTI/Extra Support
Lesson 1: pp. 8, 11, 12, 14
Lesson 2: pp. 30, 36
Lesson 3: p. 52

- Allow for multiple student revisions
- Allow for open-note / open-book assessments
- Allow multiple forms of student products (projects, models, slide-shows, etc.) to demonstrate student learning
- Allow students to select from given assignment choices
- Differentiate assessments to reflect selected objectives
- Mark students' correct and acceptable work, not the mistakes
- Peer tutoring / Peer note-taking
- Promote student collaboration on in-class / outside class assignments
- Reduce lengthy outside reading assignments
- Teach key aspects of a topic - eliminate non-essential information
- Teacher-created Study Guide
- Use authentic assessments with real-life problem-solving
- Use videos, illustrations, pictures, and drawings to explain or clarify

Talented and Gifted Learning (T&G)

Extension
Lesson 1: pp. 15, 16
Lesson 3: pp. 45, 49

- Above grade level placement option for qualified students
- Advanced problem-solving
- Allow students to work at a faster pace
- Cluster grouping
- Complete activities aligned with above grade level text using Benchmark results
- Create a blog or social media page about their unit
- Create a plan to solve an issue presented in the class or in a text
- Debate issues with research to support arguments
- Flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- Multi-disciplinary unit and/or project
- Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities

- Utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

Sample Lesson

Unit Name: Engineering Process

NJSLS: 3-5-ETS1-1

Interdisciplinary Connection: MP.2 - Reason abstractly and quantitatively

Statement of Objective: By the end of this lesson, you'll be able to define a problem.

Anticipatory Set/Do Now: Show an image of a plant on SMART Board and ask: What are the needs of a plant? Think-pair-share. Correct answers include watering the plant, proper drainage, sufficient sun exposure, etc.

Learning Activity: Then, using actual plants (3), have students in groups identify the needs of their plant, and also develop tests for the needs identified e.g. not watering a plant, covering a leaf with foil to block the sun, etc. Only a weekly basis, students will spend about 5 minutes recording their observations on their plant. Complete p. 5 in Student Workbook for further practice aligned to lesson objective.
Student Assessment/CFU's: Student-driven discussion/share-out, student workbook responses

Materials: Plants, anticipated materials (foil, etc.), Student Workbooks

21st Century Themes and Skills: CRP.K-12.CRP6.1

Differentiation/Modifications:

- Students who finish early can write about how plants survive indoors in their Evidence Notebooks

Integration of Technology: SMART Board (Do Now, digital image of plant); Chromebooks (Google Classroom)