

Unit 1: The Engineering Design Process, Safety, and Measurement (6 weeks)

Content Area: **Technology**
Course(s):
Time Period: **Full Year**
Length: **Full Year**
Status: **Published**

UNIT RATIONALE

In this unit, students are introduced to the engineering design process and delve into how it can be used to solve complex problems. Students learn how to use tools safely in processing materials and the importance of measurement and blueprints in the planning of projects. Each step of the engineering design process is fleshed out more prominently as projects progress.

ESSENTIAL QUESTIONS

What is the Engineering Design Process and how is it used to solve problems?
How are tools and materials used safely to create a design project?
Why are measurement and blueprints important when planning a design project?

STANDARDS

NEW JERSEY STUDENT LEARNING STANDARDS: CONTENT AREA

New Jersey (NJSL) - Grades 6-8 - Computer Science and Design Thinking (2020)

8.2.8.ED.1:

Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.

8.2.8.ED.2:

Identify the steps in the design process that could be used to solve a problem.

8.2.8.ED.3:

Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

8.2.8.ED.5:

Explain the need for optimization in a design process.

8.2.8.ED.6:

Analyze how trade-offs can impact the design of a product.

8.2.8.ED.7:

Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

8.2.8.ITH.2:

Compare how technologies have influenced society over time.

CS.6-8.8.2.8.ED.1	Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
CS.6-8.8.2.8.ED.2	Identify the steps in the design process that could be used to solve a problem.
CS.6-8.8.2.8.ED.3	Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
CS.6-8.8.2.8.ED.5	Explain the need for optimization in a design process.
CS.6-8.8.2.8.ED.6	Analyze how trade-offs can impact the design of a product.
CS.6-8.8.2.8.ED.7	Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).
CS.6-8.8.2.8.ITH.2	Compare how technologies have influenced society over time.

NEW JERSEY STUDENT LEARNING STANDARDS: 21st CENTURY

CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
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.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.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

NEW JERSEY STUDENT LEARNING STANDARDS: CAREER READINESS, LIFE LITERACIES

AND KEY SKILLS

TECH.9.4.8.CI.2	Repurpose an existing resource in an innovative way (e.g., 8.2.8.NT.3).
TECH.9.4.8.CT.2	Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
TECH.9.4.8.IML.12	Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.

NEW JERSEY STUDENT LEARNING STANDARDS: COMPUTER SCIENCE AND DESIGN THINKING

CS.6-8.8.2.8.ED.1	Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
CS.6-8.8.2.8.ED.2	Identify the steps in the design process that could be used to solve a problem.
CS.6-8.8.2.8.ED.3	Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
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CS.6-8.8.2.8.ED.6	Analyze how trade-offs can impact the design of a product.
CS.6-8.8.2.8.ED.7	Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).
CS.6-8.8.2.8.ITH.2	Compare how technologies have influenced society over time.

PRE-ASSESSMENTS

Students plan out an example design challenge by designing a party.

Students are tested on their understanding of ruler measurement before the lesson on measurement.

INSTRUCTIONAL PLAN

MODULE 1

Introduction to Tech Ed

Student Learning Intentions (SLI) WALT: (We are learning to...)

I am learning about the rules and safety procedures of the tech ed classroom so that I can safely work on and complete technology projects using varied tools and materials.

Student Learning Strategies	Peer learning Self-reflection Class discussion Posted rules Syllabus
Success Criteria	I can follow the rules and safety procedures of the tech ed classroom to safely use tools and materials in my technology projects.
Formative Assessment (drives instructional decisions)	Completion of class activities and participation in discussion.
Activities and Resources	Introduce course and grading procedures. Students join Google Classroom, and gain access to all posted course resources (syllabus, course outline, rules, safety, etc.). Review all classroom rules and safety procedures with students, allowing discussion where warranted or where students may have questions or need clarification. If time allows, engage students in a groupwork icebreaker design challenge.
Suggested Modifications	

MODULE 2

Activity 1 - What is the Engineering Design Process?

Student Learning Intentions (SLI) WALT: (We are learning to...)	I am learning about the engineering design process so that I can apply it to solve real-world design problems.
Student Learning Strategies	Peer learning Self-reflection Class discussion Visual scaffolding models

Success Criteria	I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements.
Formative Assessment (drives instructional decisions)	Completion of class activities and participation in discussion.
Activities and Resources	<p>Students review a Google Slides presentation delving into engineering and design.</p> <p>When done, students will begin to use the engineering design process to design a party.</p>
Suggested Modifications	

MODULE 3

Activity 2 - How has Technology Advanced through Time?

Student Learning Intentions (SLI) WALT: (We are learning to...)	I am learning about the history of engineering and invention so that I can understand that innovations through engineering are built upon the principles of science, discovery, and iteration.
Student Learning Strategies	<ul style="list-style-type: none"> Research Peer learning Self-reflection Class discussion Cooperative learning
Success Criteria	I can describe several major technological engineering advancements from history, and how they have influence modern technologies.
Formative Assessment (drives instructional decisions)	Students will complete their research activities and participate in class discussion.
Activities and Resources	<p>Engineering Through the Ages video (4:06).</p> <p>Break students into 5 groups to do research on</p>

	<p>inventions from the Ancient Era, Middle Ages, Renaissance, Industrial Revolution, and Modern Era (10-15 min). Students will share their research during appropriate parts of Slideshow.</p> <p>Engineering Through the Ages Slides presentation</p>
Suggested Modifications	

MODULE 4

Activity 3 - Tool Safety (X-acto Knives and Hot Glue Guns)

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning about Xacto (craft) knives so that I can safely use them to make cuts and designs in materials.</p> <p>I am learning about hot glue guns so that I can safely use them to connect materials together.</p>
Student Learning Strategies	<p>Peer learning Self-reflection Class discussion Safety and tool practice Teacher and peer modeling</p>
Success Criteria	<p>I can safely use a Xacto knife, ruler, and cutting mat to make cuts and designs for projects.</p> <p>I can safely use a hot glue gun to connect materials together.</p>
Formative Assessment (drives instructional decisions)	<p>Complete safety quiz with 100% score and practice tool use appropriately.</p>
Activities and Resources	<p>Show video on proper X-acto knife use and demonstrate procedures. Review safe operation of hot glue guns.</p> <p>Discuss Xacto Safety Pledge, allow students to complete and return.</p>

	<p>Xacto and Hot Glue Gun Safety Quiz.</p> <p>Students will complete X-acto practice worksheet.</p>
Suggested Modifications	

MODULE 5

Activity 4 - First Design Challenge (Model Chair Design)

<p>Student Learning Intentions (SLI) WALT: (We are learning to...)</p>	<p>I am learning to use the engineering design process to plan and produce a product that solves a problem.</p> <p>I am learning about Xacto (craft) knives so that I can safely use them to make cuts and designs in materials.</p> <p>I am learning about hot glue guns so that I can safely use them to connect materials together.</p>
<p>Student Learning Strategies</p>	<ul style="list-style-type: none"> Research Peer learning Self-reflection Class discussion Visual scaffolding models Safety and tool practice Journal writing Hands-on project work Teacher and peer modeling
<p>Success Criteria</p>	<p>I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements.</p> <p>I can safely use a Xacto knife, ruler, and cutting mat to make cuts and designs for projects.</p> <p>I can safely use a hot glue gun to connect materials together.</p> <p>I can record the steps I take to complete a project and relate them directly to the engineering design process.</p>

Formative Assessment (drives instructional decisions)	<p>Successful completion of the design challenge.</p> <p>Successful completion of the Engineering Design Process Journal for their design.</p> <p>Check-ins on student progress conducted daily.</p>
Activities and Resources	<p>Review Engineering Design Process.</p> <p>Explain the purpose of and how to use the Engineering Design Process Journal Docs (https://docs.google.com/document/d/1djp_XlxcQqSSZF4EzLrFwDf4ZM0X2nWfkZ6jWJMIXc/edit).</p> <p>Present and begin 5 Chairs Design Challenge (15 min).</p> <p>Emphasize Design Process while working through the challenge.</p> <p>When complete, students are encouraged to share their creations with the class and receive peer feedback.</p>
Suggested Modifications	

MODULE 6

Activity 5 - Measurement with a Ruler

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning about rulers and measurement so that I can read and create blueprints for projects.</p>
Student Learning Strategies	<ul style="list-style-type: none"> Peer learning Self-reflection Class discussion Safety and tool practice Visual models Teacher and peer modeling
Success Criteria	<p>I can use a ruler to read an object's measurement.</p> <p>I can divide inches into fractions for precise</p>

	<p>measurement.</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Students will be assessed on understanding of safety procedures and accuracy through measuring activities.</p>
<p>Activities and Resources</p>	<p>Introduce ruler measurement and get class baseline through a pre-test.</p> <p>As they complete the pre-test, students read through a short handout explaining how rulers are used to find measurements.</p> <p>Begin class discussion on measurement - invite students to the board to help draw a large ruler - breaking up into 1/2s, 1/4s, 1/8s, 1/16s, and 1/32s. Explain that this is how rulers are divided, and that in some careers, it's even more specific. For our purposes, we shouldn't need to worry about anything more precise than 1/16s.</p> <p>After discussion, give students a measuring activity to complete. Lay out a number of objects throughout the shop, and have students record the length and width of each.</p> <p>Next day: Review measurement info from previous day. Hand out sheets of paper about 2"x8 1/2". Walk students through folding it in half over and over to replicate 1/2s, 1/4s, 1/8s, etc. Students can use this to help in their work in the future.</p> <p>Hand out rulers and give students a measurement assessment. They will have to measure lines on a page as well as length and width of scrap lumber in the shop.</p>
<p>Suggested Modifications</p>	<p>If needed to help demonstrate creating fractions: Hand out sheets of paper about 2"x8 1/2". Walk students through folding it in half over and over to replicate 1/2s, 1/4s, 1/8s etc. Students can use this to help in their practice in the future.</p>

MODULE 7

Activity 6 - Orthographic and Isometric Views and Blueprints

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning about detail drawings so that I can describe how they are used in engineering.</p> <p>I am learning to read and draw detail drawings (blueprints) so that I can construct projects from plans.</p>
Student Learning Strategies	<p>Peer learning Self-reflection Class discussion Safety and tool practice Drawing practice Visual models Teacher and peer modeling</p>
Success Criteria	<p>I can use a ruler to measure and draw objects.</p> <p>I can translate a 3D shape into a multi-view drawing.</p> <p>I can describe a detail drawing as an engineering blueprint that holds all information to produce a product or part.</p>
Formative Assessment (drives instructional decisions)	<p>Feedback and participation in discussions.</p> <p>Successful completion of several simple multi-view detail drawings.</p> <p>Check-ins on student progress conducted daily.</p>
Activities and Resources	<p>Google Classroom: What are Orthographic and Isometric views?</p> <p>Class discussion of rough drafts and final design blueprints and the importance of both in the design process.</p> <p>Demonstrate orthographic views and sketching. Examples: video, POV drawing</p>

	Students work individually to draw side and front views of objects, labeling measurements.
Suggested Modifications	

MODULE 8

Activity 7 - Second Design Challenge (Cell Phone Charging Stand)

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning to use the engineering design process to plan and produce a product that solves a problem.</p> <p>I am learning about Xacto (craft) knives so that I can safely use them to make cuts and designs in materials.</p> <p>I am learning about hot glue guns so that I can safely use them to connect materials together.</p> <p>I am learning about the importance of communication in the engineering design process.</p> <p>I am learning about detail drawings so that I can describe how they are used in engineering.</p> <p>I am learning to read and draw detail drawings (blueprints) so that I can construct projects from plans.</p>
Student Learning Strategies	<ul style="list-style-type: none"> Peer learning Self-reflection Class discussion Safety and tool practice Drawing practice Visual models Journal writing Hands-on project work Teacher and peer modeling
Success Criteria	I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements.

	<p>I can safely use a Xacto knife, ruler, and cutting mat to make cuts and designs for projects.</p> <p>I can record the steps I take to complete a project and relate them directly to the engineering design process.</p> <p>I can use a ruler to measure and draw objects.</p> <p>I can translate a 3D shape into a multi-view drawing.</p> <p>I can describe a detail drawing as an engineering blueprint that holds all information to produce a product or part.</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Students will be assessed on understanding of safety procedures through measuring activities, class discussions, and completed projects.</p> <p>Check-ins on student progress conducted daily.</p>
<p>Activities and Resources</p>	<p>Introduce the Cell Phone Stand design challenge to students.</p> <p>Students will use their understanding of measurement, blueprints, materials processing, and the engineering design process to plan and build a cell phone stand based on given requirements.</p>
<p>Suggested Modifications</p>	

MODULE 9

Activity 8 - Project Critique

<p>Student Learning Intentions (SLI) WALT: (We are learning to...)</p>	<p>I am learning to use the engineering design process to plan and produce a product that solves a problem.</p> <p>I am learning about the importance of communication in the engineering design process.</p>
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Student Learning Strategies	Peer learning Self-reflection Presentation and critique Teacher and peer modeling
Success Criteria	<p>I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements.</p> <p>I can communicate a design I have created to others and give feedback on peers' designs.</p>
Formative Assessment (drives instructional decisions)	Students will be assessed on their use of the engineering design process to model presentation, and use of constructive criticism in peer feedback.
Activities and Resources	<p>Review the engineering design process with students, and emphasize the need for communication (both in class and in life/future careers).</p> <p>Introduce the idea of critiques to students, with emphasis on constructive feedback.</p> <p>Students individually engage in short engineering design process-focused presentations of the research, ideation, planning, construction, and testing of their cell phone stands. Their peers are encouraged to give constructive feedback, with the teacher filling in any blanks and providing their own individualized feedback.</p>
Suggested Modifications	

SUGGESTED MODIFICATION

Suggested Modifications (ELL, Sp. Ed, Gifted, At-risk of Failure)
<p>English Language Learners</p> <p>Native language support: The teacher provides auditory or written content to students in their native language</p> <p>Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could</p>

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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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.

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 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.

REFLECTIONS

Activity 2 - takes 1.5 days. Students engaged in presentation and design activity

INTERDISCIPLINARY CONNECTIONS: NEW JERSEY STUDENT LEARNING STANDARDS FOR ELA, SOCIAL STUDIES, SCIENCE AND/OR MATHEMATICS

LA.RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
LA.RST.6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
LA.RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
LA.WHST.6-8.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.
LA.WHST.6-8.2.E	Establish and maintain a formal/academic style, approach, and form.
LA.WHST.6-8.2.F	Provide a concluding statement or section that follows from and supports the information

or explanation presented.

LA.WHST.6-8.4

Produce clear and coherent writing in which the development, organization, voice, and style are appropriate to task, purpose, and audience.

LA.WHST.6-8.5

With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.