7th Grade STEM
Sayreville Middle School
Quarter Long Course

Date of Board Approval:
Curriculum Writer(s): Kimberly Howard

Statement of Purpose

STEM is a 7th grade quarter elective course. The units are designed to prepare students of varying cognitive abilities to become better problem solvers in today's modern world. STEM is an interdisciplinary educational methodology that includes four specific disciplines - Science, Technology, Engineering and Mathematics - which are taught together in a focused, hands-on approach. Traditionally, students would receive mathematics and science instruction as separate courses with little attention on technology and engineering; however, STEM illustrates and practices the interconnectedness of all 4 disciplines through a hands-on and collaborative approach. Through solving real-world problems, students develop interpersonal communication skills, creativity, decision making skills, leadership skills and critical thinking skills. This prepares our students with the foundation upon which they can continue to add information and advance skills that will enable them to assume their responsibilities as lifelong learners and productive members of a global society. Students will ask questions to define problems more precisely, develop and use models, plan and carry out investigations and analyze and interpret data. They will also utilize Mathematics and Computational thinking skills in order to solve a problem, obtain and evaluate evidence and communicate their findings to both their cooperative workgroup as well as to the class. The focus on real-world application through project-based-learning, the use of technology and the engineering design process, enables students to develop useful 21st-Century skills.

In order to demonstrate a cohesive and complete implementation plan, the following general suggestions are provided:

- The use of various formative assessments is encouraged in order to provide an ongoing method of determining the current level of understanding the students have of the material presented.
- Homework, when assigned, should be relevant and reflective of the current teaching taking place in the classroom.
- Organizational strategies should be in place that allows the students the ability to take the information gained in the classroom and put it into terms that are relevant to them.
- Instruction should be differentiated to allow students the best opportunity to learn.
- Assessments should be varied and assess topics of instruction delivered in class.

● Modifications to the curriculum should be included that address students with Individualized Educational Plans (IEP), English Language Learners (ELL), and those requiring other modifications (504 plans).

Table of Contents: Page

Unit 1 - Introduction to STEM and the Engineering Design Process 3

Unit 2 - Rapid Prototyping and 3D Design 11

Unit 3 - Computational Thinking and Robotics 19

Unit 4 - Project Management 29

Unit 1: Introduction to STEM and the Engineering Design Process

Content Area: **Science**
Course(s): **STEM**
Time Period:
Length: **10 days**

Summary of the Unit

STEM is an integrated approach to problem solving. In this unit, students will identify and solve real-world problems using a design-thinking approach. In this unit, students will develop an object, tool, process or system, within a set of design constraints or parameters to solve a problem utilizing the Engineering Design approach. The Engineering Design approach requires students to 1. Ask questions to identify the problem, 2. Brainstorm solutions, 3. Design & Plan their project, 4. Build the project, 5. Test the project and 6. Analyze/Improve and 6. Communicate the results.

Enduring Understandings

Engineers use a design process to develop, test, evaluate, redesign, and communicate design solutions.

Essential Questions

Why is it important to follow a design process when developing solutions to a design challenge? Why should you evaluate design solutions at intervals? What modifications to the design will increase its performance and/or efficiency in accomplishing the task at hand? What can we learn from our mistakes?

Summative Assessment and/or Summative Criteria

Problem solving process, modeling building process, testing process, improving upon design process, articulation of process and design.

Resources

https://www.teachengineering.org/editorspicks

https://tryengineering.org/teacher/

https://www.discoveryeducation.com/

https://www.brainpop.com/teacher

https://www.pbs.org/show/stem/

https://www.birdbraintechnologies.com/

https://msapcenter.ed.gov/stem/STEMResources.aspx?AspxAutoDetectCookieSupport=1

https://www.nsf.gov/news/classroom/engineering.jsp

https://www.stemvillage.com/blog/top-6-engineering-education-resources

https://raeng.org.uk/education-and-skills/schools/stem-resources

https://blog.ck12info.org/top-10-stem-resources/

https://mosamack.com/

http://www.achieve3000.com/

https://betterlesson.com/

https://www.nextgenscience.org/

https://www.stem.org.uk/

https://www.khanacademy.org/

https://student.societyforscience.org/sciencenews-students

http://www.nature.com/

http://ngm.nationalgeographic.com/

http://www.smithsonianmag.com/

http://ngm.nationalgeographic.com/

http://www.popsci.com/

http://www.nasa.gov/

http://www.sciencekids.co.nz/

http://www.howstuffworks.com/

http://www.aurumscience.com/

https://phet.colorado.edu/

Standards

SCI.MS.ETS1.A Defining and Delimiting Engineering Problems

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

SCI.MS-ETS1-3 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.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.

Suggested Modifications for Special Education, English Language Learners and Gifted Students:

*Consistent with individual plans, when appropriate.

Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tools such as WebEx or Google Meet, experts from the community helping with a project, journal articles, and biographies).

Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.

Use project-based science learning to connect science with observable phenomena.

Structure the learning around explaining or solving a social or community-based issue.

Provide ELL students with multiple literacy strategies.

Collaborate with after-school programs or clubs to extend learning opportunities.

Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Suggested Technological Innovations/Use

TED TALKS, Discovery ED, Brain Pop, DIY Channel, Google Classroom, On Course Classroom, Student Chromebooks

Cross Curricular/21st Century Connections

Critical thinking.

Communication skills.

Creativity.

Problem solving.

Perseverance.

Collaboration.

Information literacy.

Technology skills and digital literacy.

Unit Plan

Topic Selection Timeframe	General Objectives	Suggested Instructional Activities	Benchmarks/Assessments	Standards
The Engineering Design Process **(10 days)**	**Define the criteria and constraints of a design problem**	**The Great STEM Challenge:** **A shipwrecked traveler is stranded on a desert island. Students will complete 5 different challenges to help get him back to civilization. Island architect-Construct a hut**	**Rubric for design process** **Physical prototype**	

	Asking Questions and Defining Problems 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.	Crocodile Crossing- Build a Bridge Message in a bottle- waterproof container Pirate defense- coconut catapult Float your boat- raft design The Coast Guard has asked you to design a flotation device in case of emergency. Use action figurine to design a floatation device that can be easily attached to the figurine and provide buoyancy [Kid Spark]() Engineering Materials and Engineering Design Challenges - STEM Pathways Lab Create a structure to hold a bucket with as many ping pong balls as possible. A device is needed to safely land water dropped from the sky to help aide California in the water drought. Incorporate Switlik parachutes and the local History of Amelia Earhart base jumping to test them near Six Flags. Floatation device for an action figurine	Peer feedback form Teacher observations Class participation Final product and explanation Revamping of initial model and explanation Lab form with hypothesis, results and analysis stated, and any pertinent graphing. STEM journal/packet of building and brainstorming process.	MS-ETS 1.1 MS-ETS 1.2 MS-ETS 1.3 MS-ETS 1.4

	Evaluate competing design solutions Engaging in Argument from Evidence Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. Using a systematic process to determine how well they meet the criteria and constraints of the problem.	Build a structure from straws to hold a cup, purpose being to have the cup hold as much weight as possible without collapsing The bridge that connects Sayreville to the Parkway is in need of a rebuild. Taking into account the land topography, design a bridge to hold as much weight as possible. Egg drop device https://stem.neu.edu/resources/activities/eggdrop/ Students will work in groups of 3 or 4 to design and build an egg drop device. The students will be given a budget and defined list of materials that they can 'purchase' to protect their egg. Describe and define material properties. Identify the forces of gravity, drag, and the term air resistance Bridges http://teachers.egfi-k12.org/tag/civil-engineering/ http://www.pbs.org/wgbh/nova/education/ideas/2416_bridge.html Groups of students will design and create a bridge out of various materials such		

	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.	**as toothpicks, string, rubber-bands, and glue. Each group has to study the different types of bridges in order to determine which type will best suit the requirements placed on them. They will also draw a layout of their bridge from different perspectives. Students will need to apply for a small business loan in order to finance their endeavor. They will then need to develop a budget and keep track of their finances in a ledger.** **When their bridges are finished we will do a stress test and an earthquake-shearing test on them.** **Parachutes** **This lesson focuses on parachute design. Teams of students construct parachutes from everyday materials. They then test their parachutes to determine whether they can transport a metal washer to a target on the ground with the slowest possible rate of descent.** **Mosa Mack Design Thinking Unit** **https://mosamack.com/home/design-thinking**		

Unit 2: Rapid Prototyping and 3D Design

Content Area: **Science**
Course(s): **STEM**
Time Period:
Length: **10 days**

Enduring Understandings

Rapid prototyping is a method that can be used to quickly produce and test a new physical product or scale model. Rapid prototyping is the fast fabrication of a physical part, model or assembly using 3D computer aided design (CAD). "Prototypes are routinely used as part of the product design process to give engineers and designers the ability to explore design alternatives, test theories and confirm performance prior to starting production of a new product. Almost every engineering discipline uses prototypes in some way, including aerospace, computer, mechanical, civil, environmental and electrical engineering."
https://www.teachengineering.org/activities/view/cub_creative_activity5

Summary of the Unit

In this unit, students will design and build a prototype of an object for a specific purpose, then troubleshoot and design a part that needs repair or is missing. Students will learn basic CAD software in order to spatially manipulate objects to prepare for 3D fabrication. Additional advanced materials will be available for those students who would like to explore CAD in even greater detail.

Essential Questions

What is rapid prototyping? What is needed for a rapid prototype? How do we explore design alternatives through the creation and testing of prototypes? What is the difference between a prototype and a model? How might we compare and contrast the use of different construction materials in the development of prototypes?

Summative Assessment and/or Summative Criteria

Student Final Projects, Rapid prototyping and CAD assessment, Kidspark Unit Assessment, problem solving process, articulation of process and design, student slide presentations

Resources

https://kidsparkeducation.org/

kidsparkeducation.org/downloads

simplify3d.com/support/print-quality-troubleshooting/

weareteachers.com/3d-printing-math-science/

resourced.prometheanworld.com/use-3d-printers-classroom/

https://www.tinkercad.com/

https://learn.birdbraintechnologies.com/finch/snap/program/1-1

https://www.teachengineering.org/editorspicks

https://tryengineering.org/teacher/

https://www.discoveryeducation.com/

https://www.brainpop.com/teacher

https://www.pbs.org/show/stem/

https://www.birdbraintechnologies.com/

https://msapcenter.ed.gov/stem/STEMResources.aspx?AspxAutoDetectCookieSupport=1

https://www.nsf.gov/news/classroom/engineering.jsp

https://www.stemvillage.com/blog/top-6-engineering-education-resources

https://raeng.org.uk/education-and-skills/schools/stem-resources

https://blog.ck12info.org/top-10-stem-resources/

https://mosamack.com/

http://www.achieve3000.com/

https://betterlesson.com/

https://www.nextgenscience.org/

https://www.stem.org.uk/

https://www.khanacademy.org/

https://student.societyforscience.org/sciencenews-students

http://www.nature.com/

http://ngm.nationalgeographic.com/

http://www.smithsonianmag.com/

http://ngm.nationalgeographic.com/

http://www.popsci.com/

http://www.nasa.gov/

http://www.sciencekids.co.nz/

http://www.howstuffworks.com/

http://www.aurumscience.com/

https://phet.colorado.edu/

https://www.hhmi.org/biointeractive

http://mw.concord.org/modeler/index.html

Standards

SCI.MS.ETS1.A Defining and Delimiting Engineering Problems

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

SCI.MS-ETS1-3 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.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.

TECH.9.4.2.CI.1 Demonstrate openness to new ideas and perspectives (e.g., 1.1.2.CR1a, 2.1.2.EH.1, 6.1.2.CivicsCM.2).

TECH.9.4.2.CI.2 Identify career pathways that highlight personal talents, skills and abilities.

TECH.9.4.2.CT.1 Identify possible approaches and resources to execute a plan (e.g., 1.2.2.CR1b, 8.2.2.ED.3). Advancements in computing technology can change individuals' behaviors. Society is faced with trade-offs due to the increasing globalization and automation that computing brings.

TECH.9.4.2.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

TECH.9.4.2.CT.3 Use a variety of types of thinking to solve problems (e.g., inductive, deductive).

Suggested Modifications for Special Education, English Language Learners and Gifted Students:

*Consistent with individual plans, when appropriate.

Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tools such as WebEx or Google Meet, experts from the community helping with a project, journal articles, and biographies).

Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.

Use project-based science learning to connect science with observable phenomena.

Structure the learning around explaining or solving a social or community-based issue.

Provide ELL students with multiple literacy strategies.

Collaborate with after-school programs or clubs to extend learning opportunities.

Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Suggested Technological Innovations/Use

TED TALKS, Discovery ED, Brain Pop, DIY Channel, Google Classroom, On Course Classroom, Student Chromebooks

Cross Curricular/21st Century Connections

Critical thinking.

Communication skills.

Creativity.

Problem solving.

Perseverance.

Collaboration.

Information literacy.

Technology skills and digital literacy.

Unit Plan

Topic/Selection Timeframe	General Objectives	Instructional Activities	Benchmarks Assessments	Standards
Rapid Prototyping and 3D Design (10 days)	Students will learn how to create custom 3D printed parts using CAD software. Parts will be printed if equipment is available. Students will also utilize pre-printed 3D parts and CAD software to create a prototype to solve a problem. Students will then physically build their prototype.	Students will start out using engineering materials to assemble an airplane model that is missing a propeller. Then, students will set up a Tinkercad account and explore the Tinkercad workspace. Students will explore a 3D virtual parts library. Students will also learn how to import and manipulate objects in Tinkercad as they prepare to create a new propeller for the airplane they built. Students will learn how to use some	Rapid Prototyping and CAD Assessment Student Final Project - rubric graded Daily work checks Do Now checks Peer Feedback Class Participation Teacher Observation Final Product Explanation	MS-ETS 1.1 MS-ETS 1.2 MS-ETS 1.3 MS-ETS 1.4 TECH.9.4.2.CI.1 TECH.9.4.2.CI.2

		of the basic tools in Tinkercad as they create a custom propeller for their airplane. Students will create a 3D, virtual propeller and prepare it for 3D printing. **The part may be physically printed if materials and equipment are available and functioning.**		

Unit 3: Computational Thinking and Robotics

Content Area: **Science**
Course(s): **STEM**
Time Period:
Length: **10 days**

Enduring Understandings

Computational thinking is a set of skills and processes that enable students to navigate complex problems. Complex problems can be broken down into smaller steps to ease the problem solving process. Computational thinking is a four-step process that includes: decomposition, pattern recognition, abstraction and algorithmic thinking. Computational thinking can be applied to nearly any type of problem.

Summary of the Unit

In this unit, students will demonstrate computational thinking skills and program a robot utilizing the SNAP programming language. Students will learn basic SNAP coding and explore how to control and program a robot to create an original final project based on specific design requirements. They will learn basic movement, lights, sound and use of the robots inputs (sensors) to design and have their robot tell a story. Additional advanced materials are available for those students who would like to explore coding in even greater detail.

Essential Questions

What is Computational thinking? How can I break a problem down into smaller parts in order to make it easier to solve? What are the elements used in computational thinking and how can they help me work my way through a complex problem? Does computational thinking vary by discipline?

Summative Assessment and/or Summative Criteria

Student Final Projects, Computational thinking assessment, problem solving process, articulation of process and design, student slide presentations

Resources

https://learn.birdbraintechnologies.com/finch/snap/program/1-1

https://www.teachengineering.org/editorspicks

https://tryengineering.org/teacher/

https://www.discoveryeducation.com/

https://www.brainpop.com/teacher

https://www.pbs.org/show/stem/

https://www.birdbraintechnologies.com/

https://msapcenter.ed.gov/stem/STEMResources.aspx?AspxAutoDetectC

ookieSupport=1 https://www.nsf.gov/news/classroom/engineering.jsp

https://www.stemvillage.com/blog/top-6-engineering-educ

ation-resources

https://raeng.org.uk/education-and-skills/schools/stem-res

ources

https://blog.ck12info.org/top-10-stem-resources/

https://mosamack.com/

http://www.achieve3000.com/

https://betterlesson.com/

https://www.nextgenscience.org/

https://www.stem.org.uk/

https://www.khanacademy.org/

https://student.societyforscience.org/sciencenews-students

http://www.nature.com/

http://ngm.nationalgeographic.com/

http://www.smithsonianmag.com/

http://ngm.nationalgeographic.com/

http://www.popsci.com/

http://www.nasa.gov/

http://www.sciencekids.co.nz/

http://www.howstuffworks.com/

http://www.aurumscience.com/

https://phet.colorado.edu/

Standards

SCI.MS.ETS1.A Defining and Delimiting Engineering Problems

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

SCI.MS-ETS1-3 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.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.

TECH.9.4.2.CI.1 Demonstrate openness to new ideas and perspectives (e.g., 1.1.2.CR1a, 2.1.2.EH.1, 6.1.2.CivicsCM.2).

TECH.9.4.2.CI.2 Identify career pathways that highlight personal talents, skills and abilities.

TECH.9.4.2.CT.1 Identify possible approaches and resources to execute a plan (e.g., 1.2.2.CR1b, 8.2.2.ED.3). Advancements in computing technology can change individuals' behaviors. Society is faced with trade-offs due to the increasing globalization and automation that computing brings.

TECH.9.4.2.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

TECH.9.4.2.CT.3 Use a variety of types of thinking to solve problems (e.g., inductive, deductive).

Suggested Modifications for Special Education, English Language Learners and Gifted Students:

*Consistent with individual plans, when appropriate.

Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tools such as WebEx or Google Meet, experts from the community helping with a project, journal articles, and biographies).

Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.

Use project-based science learning to connect science with observable phenomena.

Structure the learning around explaining or solving a social or community-based issue.

Provide ELL students with multiple literacy strategies.

Collaborate with after-school programs or clubs to extend learning opportunities.

Restructure lesson using UDL principles
(http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Suggested Technological Innovations/Use

TED TALKS, Discovery ED, Brain Pop, DIY Channel, Google Classroom, On Course Classroom, Student Chromebooks

Cross Curricular/21st Century Connections

Critical thinking.

Communication skills.

Creativity.

Problem solving.

Perseverance.

Collaboration.

Information literacy.

Technology skills and digital literacy.

Unit Plan

Topic/Selection Timeframe	General Objectives	Instructional Activities	Benchmarks Assessments	Standards
Computational Thinking and Robotics (10 days)	Thinking and Robotics (10 days) Students will learn how to connect, charge, and start programming a robot using SNAP as the programming language. Students will learn how to program various output functions. Students will learn how to program input functions. Students will create an original project and utilize their robot to tell a story.	Students will sign on to the Cornell.edu or Birdbrain technologies website and learn how to sync and set up their robot for use with the student Chromebooks. Students will learn how to use the SNAP Move and SNAP Turn blocks. Students will learn how to control the robot's wheels independently using the Wheels and Stop blocks. Students will learn how to program the full color LEDs in your robot's beak Coding and Robotics	Coding and Robotics Assessment Student Final Project - rubric graded Daily work checks Do Now checks Peer Feedback Class Participation Teacher Observation Final Product Explanation	MS-ETS 1.1 MS-ETS 1.2 MS-ETS 1.3 MS-ETS 1.4 TECH.9.4.2.CI.1 TECH.9.4.2.CI.2 TECH.9.4.2.CT.1 TECH.9.4.2.CT.2 TECH.9.4.2.CT.3

		Assessment **Student Final Project - rubric graded** **Daily work checks** **Do Now checks** **Peer Feedback** **Class Participation** **Teacher Observation** **Final Product Explanation** **MS-ETS 1.1** **MS-ETS 1.2** **MS-ETS 1.3** **MS-ETS 1.4** **TECH.9.4.2.CI.1** **TECH.9.4.2.CI.2** **TECH.9.4.2.CT.1** **TECH.9.4.2.CT.2** **TECH.9.4.2.CT.3** **Students will create an original project and utilize their robot to tell a story.**		

		and tail. They will also learn how to program the LED screen. Students will learn about controlling the sounds and buzzers on their robot. Students will learn how to use the different kinds of inputs, or sensors, available on their robot: distance sensor 2 light sensors 2 infrared line-following sensors 2 micro:bit buttons accelerometer (can sense tilt) compass (can sense direction) Students will learn to use the blocks for the micro:bit buttons and orientation. These blocks have Boolean values, or values that can only be true or false.		

		Advanced students can learn on loops and variables. **Students will use at least 3 of the 5 different sensors/features of the robot and demonstrate use certain features of SNAP to tell an original** **story.**		

Unit 4: Project Management

Content Area: **Science**
Course(s): **STEM**
Time Period:
Length: **10 days**

Summary of the Unit

Activities in this unit are designed to reinforce group understanding of the nature of project management. In this unit, students will organize a building project from start to finish. Building on their understanding of the engineering design process from Unit 1, students will research, design, plan and build the project within given design constraints. The project will require students to manage their time, work cooperatively and purchase materials within a given budget while dealing with real-world challenges along the way.

Enduring Understandings

Engineers use a design process to develop, test, evaluate, redesign, and communicate design solutions. The constraining factors of scope, time, and budget affect the outcome of a project and should be managed proactively. Project managers are responsible for planning and oversight of projects to ensure they are completed on time and on budget.

Essential Questions

What are best practices when managing a project from start to finish? When is the deadline? Have you had a similar project before? How will the team communicate during the course of the project? What role will each individual team member assume? What tools will be used? What are the project's priorities? Why is it important to follow a design process when developing solutions to a design challenge? Why should you evaluate design solutions at intervals? What modifications to the design will increase its performance and/or efficiency in accomplishing the task at hand? What can we learn from our mistakes? What challenges and risks do you think these projects would face on their way to completion? How do you think project managers could keep these projects on track? What technological tools do you think would help in managing these projects?

Summative Assessment and/or Summative Criteria

Problem solving process, modeling building process, testing process, improving upon design process, articulation of process and design, accounting budgeting worksheet

Resources

https://wlresources.dpi.wi.gov/courseware/lesson/311/overview

https://www.teachengineering.org/editorspicks

https://tryengineering.org/teacher/

https://www.discoveryeducation.com/

https://www.brainpop.com/teacher

https://www.pbs.org/show/stem/

https://www.birdbraintechnologies.com/

https://msapcenter.ed.gov/stem/STEMResources.aspx?AspxAutoDetectCookieSupport=1

https://www.nsf.gov/news/classroom/engineering.jsp

https://www.stemvillage.com/blog/top-6-engineering-education-resources

https://raeng.org.uk/education-and-skills/schools/stem-resources

https://blog.ck12info.org/top-10-stem-resources/

https://mosamack.com/

http://www.achieve3000.com/

https://betterlesson.com/

https://www.nextgenscience.org/

https://www.stem.org.uk/

https://www.khanacademy.org/

https://student.societyforscience.org/sciencenews-students

http://www.nature.com/

http://ngm.nationalgeographic.com/

http://www.smithsonianmag.com/

http://ngm.nationalgeographic.com/

http://www.popsci.com/
http://www.nasa.gov/

http://www.sciencekids.co.nz/

Standards

SCI.MS.ETS1.A Defining and Delimiting Engineering Problems

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

SCI.MS-ETS1-3 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.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.

Suggested Modifications for Special Education, English Language Learners and Gifted Students:

*Consistent with individual plans, when appropriate.

Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tools such as WebEx or Google Meet, experts from the community helping with a project, journal articles, and biographies).

Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.

Use project-based science learning to connect science with observable phenomena.

Structure the learning around explaining or solving a social or community-based issue.

Provide ELL students with multiple literacy strategies.

Collaborate with after-school programs or clubs to extend learning opportunities.

Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Suggested Technological Innovations/Use

TED TALKS, Discovery ED, Brain Pop, DIY Channel, Google Classroom, On Course Classroom, Student Chromebooks

Cross Curricular/21st Century Connections

Critical thinking.

Communication skills.

Creativity.

Problem solving.

Perseverance.

Collaboration.

Information literacy.

Technology skills and digital literacy.

Unit Plan

Topic/Selection Timeframe	General Objectives	Instructional Activities	Benchmarks Assessments	Standards

Project Management (10 days)	Define the criteria and constraints of a design problem Asking Questions and Defining Problems 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. Evaluate competing design solutions Engaging in Argument from Evidence Evaluate competing design solutions based on jointly	Building a toothpick bridge - Students will be challenged to design and build a bridge constructed entirely of toothpicks and glue. Students will learn about and then research the different types of bridges. They will work together collaboratively in group roles and be required to keep track of time and a budget in order to complete the project on time. They will also be "charged a hazardous waste fee" when they leave a mess behind in the classroom. They will need to purchase supplies and will be faced with real-life scenarios, such as price fluctuations in material components.	Rubric for design process Physical prototype Peer feedback form Teacher observations Class participation Final product and explanation Revamping of initial model and explanation STEM journal/packet of building and brainstorming process.	MS-ETS 1.1 MS-ETS 1.2 MS-ETS 1.3 MS-ETS 1.4

	developed and agreed-upon design criteria. Using a systematic process to determine how well they meet the criteria and constraints of the problem. 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.	Bridges are required to support a certain amount of weight that will be hung from the bridge. The more weight supported, the more points earned. *Instructional Activities MAY include Unit 1 listed activities but MUST also incorporate the time/budget constraints.* The Great STEM Challenge: A shipwrecked traveler is stranded on a desert island. Students will complete 5 different challenges to help get him back to civilization. Island architect- Construct a hut Crocodile Crossing- Build a Bridge Message in a bottle- waterproof container Pirate defense- coconut catapult Float your boat- raft design		

		The Coast Guard has asked you to design a flotation device in case of emergency. Use action figurine to design a floatation device that can be easily attached to the figurine and provide buoyancy A device is needed to safely land water dropped from the sky to help aide California in the water drought. Incorporate Switlik parachutes and the local History of Amelia Earhart base jumping to test them near Six Flags. Students would have a budget to spend on materials and a limited amount of time to complete. Floatation device for an action figurine Build a structure from straws to hold a cup, purpose being to have		

		the cup hold as much weight as possible without collapsing The bridge that connects Sayreville to the Parkway is in need of a rebuild. Taking into account the land topography, design a bridge to hold as much weight as possible. Egg drop device https://stem.neu.edu/resources/activities/eggdrop/ Students will work in groups of 3 or 4 to design and build an egg drop device. The students will be given a budget and defined list of materials that they can 'purchase' to protect their egg. Describe and define material properties. Identify the forces of gravity, drag, and the term air resistance Bridges http://teachers.egfi-k12.org/tag/civil-engineering/		

		http://www.pbs.org/wgbh/nova/education/ideas/2416_bridge.html Groups of students will design and create a bridge out of various materials such as toothpicks, string, rubber-bands, and glue. Each group has to study the different types of bridges in order to determine which type will best suit the requirements placed on them. They will also draw a layout of their bridge from different perspectives. Students will need to apply for a small business loan in order to finance their endeavor. They will then need to develop a budget and keep track of their finances in a ledger. When their bridges are finished we will do a stress test and an earthquake-shearing test on them.		

		Parachutes **This lesson focuses on parachute design. Teams of students construct parachutes from everyday materials. They then test their parachutes to determine whether they can transport a metal washer to a target on the ground with the slowest possible rate of descent.**		