Course of Study:

6th-Grade STEM

Course of Study STEM - [APRIL 2023]
STEM Grade 6
Strand: Intro to Problem Solving and Teamwork: Paper Tension Line

<table>
<tr>
<td>Learning Standard:
MS-ETS1-2 - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS-1-4 - 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

6-8.DT.1.d. Explain how optimization is the process of making a product as fully functional and effective as possible.
6-8.DT.1.f. Give examples of how trade-offs must occur when optimizing a design in order to maintain design requirements.</td>
<td>How Taught?
- Students are guided through: Structural Engineering and Paper Tension Line</td>
</tr>
<tr>
<td rowspan="2">Materials:
Structural Engineering and Paper Tension Line</td>
<td>How Assessed?
- Observations of students’ abilities to collaborate

- Assessment and reflection on the success of a prototype design</td>
</tr>
<tr>
<td>How Re-Taught?
- Students refine their prototypes with teacher guidance throughout the activity</td>
</tr>
</table>

Course of Study STEM - [APRIL 2023]
STEM Grade 6
Strand: Steps of the Scientific Inquiry Process

<table>
<tr>
<td>Learning Standard:
Nature of Science Grades 6-8
Scientific Inquiry, Practice and Applications
- Apply knowledge of science content to real-world challenges.
- Identify questions that can be answered through scientific investigations.
- Design and conduct scientific investigations using appropriate safety techniques.
- Analyze and interpret data.
- Think critically and logically to connect evidence and explanations.
- Communicate scientific procedures and explanations.

6.SP.1.d - Interpret Results: Draw logical conclusions from the data based on the original question

6.EE.9 - Represent and analyze quantitative relationships between dependent and independent variables.

6-8.ICT.3.a. Analyze and integrate textual, visual and quantitative information</td>
<td>How Taught?
Scientific Inquiry presentation</td>
</tr>
<tr>
<td rowspan="2">Materials:
Scientific Inquiry presentation</td>
<td>How Assessed?
- Class discussions

- Completion of guided notes</td>
</tr>
<tr>
<td>How Re-Taught?
- Revisited as students apply the inquiry process in experiments throughout the semester</td>
</tr>
</table>

Course of Study STEM - [APRIL 2023]
STEM Grade 6
Strand: Reaction Speed Experiment: Arm Length vs. Reaction Speed

<table>
<tr>
<td>Learning Standard:
Nature of Science Grades 6-8
Scientific Inquiry, Practice and Applications
- Apply knowledge of science content to real-world challenges.
- Identify questions that can be answered through scientific investigations.
- Design and conduct scientific investigations using appropriate safety techniques.
- Analyze and interpret data.
- Think critically and logically to connect evidence and explanations.
- Communicate scientific procedures and explanations.

6.SP.1.d - Interpret Results: Draw logical conclusions from the data based on the original question

6-8.ICT.3.a. Analyze and integrate textual, visual and quantitative information</td>
<td>How Taught?
Arm Length vs. Reaction Speed Experiment

Student experiment sheet

Group discussion - what were flaws in the experiment</td>
</tr>
<tr>
<td rowspan="2">Materials:
Arm Length vs. Reaction Speed Experiment

Student experiment sheet</td>
<td>How Assessed?
- Student experiment sheet</td>
</tr>
<tr>
<td>How Re-Taught?
- Student teams share results and discuss flaws and ways to improve the experiment</td>
</tr>
</table>

Course of Study STEM - [APRIL 2023]
STEM Grade 6
Strand: Bottle Flip Experiment

<table>
<tr>
<td>Learning Standard:
Nature of Science Grades 6-8
Scientific Inquiry, Practice and Applications
- Apply knowledge of science content to real-world challenges.
- Identify questions that can be answered through scientific investigations.
- Design and conduct scientific investigations using appropriate safety techniques.
- Analyze and interpret data.
- Think critically and logically to connect evidence and explanations.
- Communicate scientific procedures and explanations.

6.SP.1.d - Interpret Results: Draw logical conclusions from the data based on the original question

6-8.ICT.3.a. Analyze and integrate textual, visual and quantitative information</td>
<td>How Taught?
Bottle Flip Experiment Presentation

Student experiment sheet

Group discussion - what were flaws in the experiment</td>
</tr>
<tr>
<td rowspan="2">Materials:
Bottle Flip Experiment Presentation

Student experiment sheet</td>
<td>How Assessed?
- Student experiment sheet</td>
</tr>
<tr>
<td>How Re-Taught?
- Student teams share results and discuss flaws and ways to improve the experiment</td>
</tr>
</table>

Course of Study STEM - [APRIL 2023]
STEM Grade 6
Strand: Introduction to the Engineering Design Process

<table>
<tr>
<td>Learning Standard:
DESIGNING TECHNOLOGICAL AND ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS

6-8.ST.1.b. Explore the advantages and disadvantages of widespread use, accessibility and reliance on technology in one’s world.
6-8.ST.2.b. Explain the positive and negative impact the use of technology can have on personal, professional and community relationships
6-8.ST.3.c. Analyze how technological innovations and inventions can have multiple applications, both intended and unintended.

6-8.DT.1.d. Explain how optimization is the process of making a product as fully functional and effective as possible.
6-8.DT.1.f. Give examples of how trade-offs must occur when optimizing a design in order to maintain design requirements.
6-8.DT.2.a. Apply a complete design process to solve an identified individual or community problem: research, develop, test, evaluate and present several possible solutions, and redesign to improve the solution.
6-8.DT.2.b. Describe how invention is a process of turning ideas and imagination into devices and systems
6-8.DT.2.c. Explain how innovation is the process of modifying an existing system or system element(s) to improve it
6-8.DT.2.d. Consider multiple factors, including criteria and constraints, (e.g., research, cost, time, materials, feedback, safety) to justify decisions when developing products and systems to solve problems.
6-8.DT.4.b. Analyze environments or products that are examples of the application of the principles of universal or inclusive design.</td>
<td>How Taught?
Engineering Design Process Presentation</td>
</tr>
<tr>
<td rowspan="2">Materials:
Engineering Design Process Presentation

Student Note Sheet

Kid Shark Tank video</td>
<td>How Assessed?
- student note sheet completion
- formative class discussions</td>
</tr>
<tr>
<td>How Re-Taught?
- Revisited as students apply the engineering design process throughout the semester</td>
</tr>
</table>

Course of Study STEM - [APRIL 2023]
STEM Grade 6

Strand: Engineering Design Process - Air Powered Rocket Design

<table>
<tr>
<td>Learning Standard:
Nature of Science Grades 6-8 (source pg. 10)
- Design and conduct scientific investigations using appropriate safety techniques.
- Use appropriate mathematics, tools and techniques to gather data and information.
- Analyze and interpret data.

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

6.EE.9 - Represent and analyze quantitative relationships between dependent and independent variables.

6.SP.1.b - Collect Data: Design and use a plan to collect appropriate data to answer a statistical question.
6.SP.1.c - Analyze Data: Select appropriate graphical methods and numerical measures to analyze data
6.SP.1.d - Interpret Results: Draw logical conclusions from the data based on the original question</td>
<td>How Taught?

Rocket Slideshow

https://blogs.nasa.gov/Rocketology/2015/07/09/designing-a-rocket-in-six-easy-steps/

After testing, walk student through graphing data using spreadsheets</td>
</tr>
<tr>
<td rowspan="2">Materials:
Rocket Slideshow

https://blogs.nasa.gov/Rocketology/2015/07/09/designing-a-rocket-in-six-easy-steps/

DIY Rocket landing video</td>
<td>How Assessed?
- Accuracy of mass, length, and distance measurements

- Graph and analyze data from various rocket designs

- Draw conclusions of the ideal rocket design using data as evidence</td>
</tr>
<tr>
<td>How Re-Taught?
- Student revisit graphing data in a future project</td>
</tr>
</table>

Course of Study STEM - [APRIL 2023]
STEM Grade 6
Strand: Lunar Hotel Engineering

<table>
<tr>
<td>Learning Standard:
Next Gen Science Standards (NGSS) MS.Engineering 6-8:
MS-ETS1-1 - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2 - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Nature of Science Grades 6-8 (source pg. 10)
Scientific Inquiry, Practice and Applications
- Apply knowledge of science content to real-world challenges.
- Analyze and interpret data.
- Develop descriptions, models, explanations and predictions.

Ohio’s Cognitive Demands for Science (pg. 13, table 2)
DESIGNING TECHNOLOGICAL AND ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS
6-8.DT.1.f. Give examples of how trade-offs must occur when optimizing a design in order to maintain design requirements.
6-8.DT.2.b. Describe how invention is a process of turning ideas and imagination into devices and systems
6-8.DT.2.c. Explain how innovation is the process of modifying an existing system or system element(s) to improve it
6-8.DT.2.d. Consider multiple factors, including criteria and constraints, (e.g., research, cost, time, materials, feedback, safety) to justify decisions when developing products and systems to solve problems.
6-8.DT.3.c. Evaluate the effectiveness of the group’s collaboration during the engineering design process and the contribution of the varying roles.</td>
<td>How Taught?
Lunar hotel presentation

Design Assessment</td>
</tr>
<tr>
<td rowspan="2">Materials:
Lunar hotel presentation

Design Assessment

NASA resource link</td>
<td>How Assessed?
Design Assessment</td>
</tr>
<tr>
<td>How Re-Taught?
- Students are provided feedback throughout the design process to refine their prototypes</td>
</tr>
</table>

Strand: Journal on the Importance of Learning STEM and Practice Writing a Claim with Explanation

Learning Standard: W.6.1 Write arguments to support claims with clear reasons and relevant evidence. W.6.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	**How Taught?** **Journal #1 Required or Optional STEM class**
Materials: **Journal #1 Required or Optional STEM class**	**How Assessed?** - Journal Rubric
	How Re-Taught? - Students refine making a claim and evidence throughout the semester

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Strand: Writing - Supporting a Claim - Journal on Esports in school

Learning Standard: W.6.1 Write arguments to support claims with clear reasons and relevant evidence. W.6.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. 6-8.ST.1.b. Explore the advantages and disadvantages of widespread use, accessibility and reliance on technology in one's world. 6-8.ST.2.b. Explain the positive and negative impact the use of technology can have on personal, professional and community relationships 6-8.ST.3.c. Analyze how technological innovations and inventions can have multiple applications, both intended and unintended	**How Taught?** **- Journal prompt and presentation** **- Students are walked through the writing format of making a claim and providing evidence**
Materials: **Journal prompt and presentation**	**How Assessed?** - Journal Rubric - Formative student discussions after writing

	How Re-Taught? - Students refine making a claim and evidence throughout the semester

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Strand: 3D Design and Printing Using CAD

Learning Standard: 6.NS.5 - Understand that positive and negative numbers are used together to describe quantities having opposite directions or values, use positive and negative numbers to represent quantities in real-world contexts 6-8.ICT.3.c. Create artifacts using digital learning tools and resources to demonstrate knowledge 6-8.DT.2.d. Consider multiple factors, including criteria and constraints, (e.g., research, cost, time, materials, feedback, safety) to justify decisions when developing products and systems to solve problems.	**How Taught?** **- Teacher guided instruction on basic modeling of 3D shapes in TinkerCad** **- Review of metric system and converting to millimeters in TinkerCad**
Materials: **www.TinkerCad.com** **3D printed Chromebook Clip**	**How Assessed?** **3D printed Chromebook Clip** (assessment found in slide show)
	How Re-Taught? - Students are provided feedback on designs, make changes, and resubmit projects

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Strand: 3D Printed Product Design and Investment Pitch

<table>
<tr>
<td>Learning Standard:
6-8.DT.1.f. Give examples of how trade-offs must occur when optimizing a design in order to maintain design requirements.

6-8.DT.2.d. Consider multiple factors, including criteria and constraints, (e.g., research, cost, time, materials, feedback, safety) to justify decisions when developing products and systems to solve problems.

6-8.DT.4.c. Apply the design principle “form follows function” to develop a product</td>
<td>How Taught?
- Students receive previous instruction in TinkerCad 3D modeling

- Students are introduced to “investors” and “pitches” along with examples

- Students provided requirements: Product pitch requirements</td>
</tr>
<tr>
<td rowspan="2">Materials:
6th grade product pitch template

Product pitch requirements</td>
<td>How Assessed?
Product pitch requirements</td>
</tr>
<tr>
<td>How Re-Taught?
- Students are provided feedback on their designs throughout the design process.
- Students refine ideas based on feedback from the teacher</td>
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Course of Study STEM - [APRIL 2023]
STEM Grade 6

Strand: Rubber Band Lego Car

<table>
<tr>
<td>Learning Standard:
Ohio's Cognitive Demands for Science (pg. 13, table 2)
DESIGNING TECHNOLOGICAL/ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS

Next Gen Science Standards (NGSS) MS.Engineering 6-8:
MS-ETS1-1 - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution
MS-ETS1-2 - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
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.

6-8.DT.1.d. Explain how optimization is the process of making a product as fully functional and effective as possible.
6-8.DT.1.f. Give examples of how trade-offs must occur when optimizing a design in order to maintain design requirements.
6-8.DT.2.a. Apply a complete design process to solve an identified individual or community problem: research, develop, test, evaluate and present several possible solutions, and redesign to improve the solution.
6-8.DT.2.c. Explain how innovation is the process of modifying an existing system or system element(s) to improve it</td>
<td>How Taught?

- Students are put in teams of 3-4 and assigned specific roles

- Presentation, requirements, and constraints</td>
</tr>
<tr>
<td rowspan="2">Materials:
Presentation, requirements, and constraints</td>
<td>How Assessed?
- Students complete a reflection each day on their progress
- Formative assessment of students working in groups
- Students refine their prototypes with teacher guidance throughout the activity</td>
</tr>
<tr>
<td>How Re-Taught?</td>
</tr>
</table>

	- Students will revisit the engineering design process throughout future projects, applying what they learned in this activity - Students refine their prototypes with teacher guidance throughout the activity

Strand: Solar Oven Engineering

Learning Standard: 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. MS-ETS1-2 - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. 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. 6.SP.1.c - Analyze Data: Select appropriate graphical methods and numerical measures to analyze data 6-8.DT.2.d. Consider multiple factors, including criteria and constraints, (e.g., research, cost, time, materials, feedback, safety) to justify decisions when developing products and systems to solve problems	**How Taught?** **- Presentation: Solar Oven Presentation** **- Students are grouped into teams of 3-4**
Materials: **Solar Oven Presentation** Student documentation Student Data Table	**How Assessed?** Student documentation Student Data Table
	How Re-Taught? - Students refine their prototypes with teacher guidance throughout the activity

Course of Study STEM - [APRIL 2023]
STEM Grade 6
Strand: Robotics

<table>
<tr>
<td>Learning Standard:
Ohio's Cognitive Demands for Science (pg. 13, table 2)
DESIGNING TECHNOLOGICAL/ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS
Requires student to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.

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

6.NS.5 - Understand that positive and negative numbers are used together to describe quantities having opposite directions or values, use positive and negative numbers to represent quantities in real-world contexts

6-8.ICT.1.b. Select and use digital learning tools or resources to support planning, implementing and reflecting upon a defined task.</td>
<td>How Taught?
- Students are introduced to robotics through this presentation: Introduction to Robotics Presentation

- Modeling programming using the Mindstorms Programming App

- Students are put into groups of 2-3 to build a driving base robot using Lego Mindstorms EV3 kits</td>
</tr>
<tr>
<td rowspan="2">Materials:
Introduction to Robotics Presentation

Uses for Modern Robots

SumoBot Sample Videos

Robotics Bracket Challenge

EV3 Building Instructions

Walking and Flying Robot video</td>
<td>How Assessed?
Robot Tasks Level 1

Robot Tasks Level 2 and 3

Bracket Challenge Score Sheet</td>
</tr>
<tr>
<td>How Re-Taught?
- Students are provided feedback and retaught programming skills as they move through the Level 1-3 task sheets</td>
</tr>
</table>

Strand: Maps, Civil Engineering Water Treatment Systems

Learning Standard: **Nature of Science Grades 6-8 (source pg. 10)** Science is a Human Endeavor - Individuals from different social, cultural, and ethnic backgrounds work as scientists and engineers. - Scientists and engineers are guided by habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism and openness to ideas. - Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic,imagination and creativity 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. MS-ETS1-2 - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. 6th grade social studies standard: 3. Geographic tools can be used to gather, process and report information about people, places and environments.	**How Taught?** Class Intro Slideshow Urban Water Cycle video
Materials: Town Map Urban Water Cycle video Student Water System Budget and Rational	**How Assessed?** Student Water System Budget and Rational Team Presentation Template **How Re-Taught?**

Class Intro Slideshow **Team Presentation Template**	- Students are provided feedback from the teacher between individual plans and created a group plan