STEM works THINKit

CODING

Community Need

Our community needs

Tech Tool Ideas:

Career Connections:

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1.

2.

3.

4.

STEM works THINKit

CIRCUITS & HARDWARE

Community Need

Our community needs

Tech Tool Ideas:

Career Connections:

Define the Problem

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Gather Pertinent Info

1.

2.

3.

4.

STEM works THINKit

VIRTUAL REALITY

Community Need

Our community needs

Tech Tool Ideas:

Career Connections:

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1.

2.

3.

4.

STEM works THINKit

PROTOTYPE

Community Need

Our community needs

Tech Tool Ideas:

Career Connections:

01 DEFINE THE PROBLEM

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

02 GATHER PERTINENT INFO

Gather Pertinent Info

1.

2.

3.

4.

03 GENERATE IDEAS!

04 REFLECT & SELECT!

05 DESIGN SOLUTION!

06 TEST & OPTIMIZE!

07 SHARE & REFLECT!

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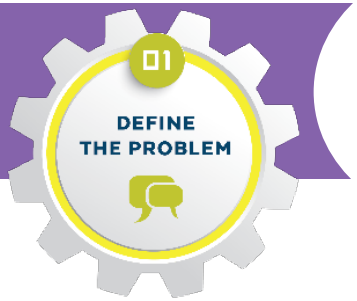
GIS & DRONE

Community Need

Our community needs

Tech Tool Ideas:

Career Connections:



Define the Problem

Our engineering & design goal is to...

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Three Constraints! Our solution is limited by...

Gather Pertinent Info

1.

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4.

STEM works THINKit

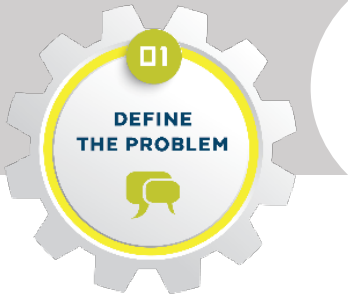
DIGITAL MEDIA

Community Need

Our community needs

Tech Tool Ideas:

Career Connections:



Define the Problem

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Gather Pertinent Info

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2.

3.

4.

STEM works THINKit

CODING

GIS & DRONE

Community Need

Our community needs a new automated transit route for both tourists and families to get where they need to go on a trolley or bus. It needs to be reliable and safe.

Tech Tool Ideas:

Ozobot, Sphero, littleBits, ArcGIS Story Maps, Drone Technology

Career Connections:

Programmer
Transit Operator
Community Planner
Drone Pilot

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How might code direct an autonomous vehicle?
2. What city are you in?
3. Where might people want to stop?
4. How can you make it safe for people to get on and off the trolley?
5. What are the purpose of medians in the road?
6. Can you communicate where and when to expect the trolley (predict a schedule of stops)?
7. How can you use measurement to scale the time in your prototype to represent real time for a real transportation schedule?

Unit Extension Ideas

Connect to the NGSS Standards!

Compare the safety or efficiency of the shape of different routes.

K-2

- ❑ **PE:** Engineering Design: K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- ❑ **SEP:** Asking Questions and Defining Problems, Developing and Using Models, Analyzing and Interpreting Data
- ❑ **DCI:** **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Structure and Function

Optimize the pattern of visual code that deliver autonomous vehicle transport on different routes.

4th

- ❑ **PE:** Waves and Their Applications in Technologies for Information Transfer: 4-PS4-3.Generate and compare multiple solutions that use patterns to transfer information.
- ❑ **SEP:** Asking Constructing Explanations & Designing Solutions
- ❑ **DCI:** PS4.C: Information Technologies & Instrumentation. **EDP:** ETS1.C: Optimizing the Design Solutions
- ❑ **CCC:** Patterns

Given the same speed of a vehicle, explore safety implications of an impact when parked versus moving on a designated route. Draw conclusions about the placement of a route and/or the a road median's size and location.

6-8

- ❑ **PE:** Motion and Stability: Forces and Interactions: MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- ❑ **SEP:** Constructing Explanations & Designing Solutions
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Systems and System Models

Observe and compare vehicles (objects) of different mass during collision and mathematically make predictions about the effects of a full versus an empty bus on safety. Alter the velocity of the moving object over a set distance. Measure/graph mass vs. distance moved upon impact. Have students infer relationships between net forces, mass, and acceleration (change in velocity over time) to make solutions for traffic or road safety.

9-12

- ❑ **PE:** Motions and Stability: Forces and Interactions: HS-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- ❑ **SEP:** Analyzing & Interpreting Data
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Cause & Effects

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CODING PROTOTYPE

Community Need

Cats and dogs often play by pretending to stalk prey. Many pets live in small ohanas and don't have much space. How can these pets get more exercise to stay healthy and fit?

Tech Tool Ideas:

Ozobot, littleBits, Sphero, Microduino, Arduino, Micro:bit

Career Connections:

Programmer
Toy Designer
Inventor

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What kind of pet is the design for?
2. What kind of prey might the pet chase?
3. If you are using programming, how can you write a program to that mimics the movement of prey?
4. How can you decorate the tool to entice the pet to play?
5. Are your materials safe for a pet?
6. How will you market your design with the community?

Unit Extension Ideas

Connect to the NGSS Standards!

Design and explain how the solution helps a specific animal as it: sees, hears, grasps an object, and/or helps it feed or find water. Discuss the concept of biomimicry, how humans find solutions by mimicking nature and natural processes.

1st

- ❑ **PE:** From Molecules to Organisms: Structures and Processes: 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** LS1.A: Structure and Function, LS1.D: Information Processing
- ❑ **CCC:** Cause and Effect

Explain how the solution will help a specific animal survive well in its environment. Explain why it may not meet the needs of other animals.

3rd

- ❑ **PE:** Biological Evolution: Unity & Diversity: 3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and come cannot survive at all.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS4.C: Adaptation
- ❑ **CCC:** Cause & Effect

Expand the issue of feral populations of animals in Hawaii. Explore issues of resource availability, population control (growth and reproduction), and carrying capacity. Use mathematics to explore possible effects feral populations, if left unchecked, on native species and ecosystems.

6-8

- ❑ **PE:** Ecosystems: Interactions, Energy and Dynamics: MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- ❑ **SEP:** Analyzing & Interpreting Data
- ❑ **DCI:** LS2.A: Interdependent Relationships in Ecosystems
- ❑ **CCC:** Cause & Effect

Use mathematics to diagram historical, current, and future prediction of the population size of introduced species (biocontrol or accidental introduction) in Hawaii versus native species populations. Identify how introduced species have had a historical impact on native species through predation, competition, and disease. Explore how these factors contribute to the fundamental tension on the abundance (number of individuals) of species, or carrying capacity, in any ecosystem.

9-12

- ❑ **PE:** Ecosystems: Interactions, Energy and Dynamics: HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- ❑ **SEP:** Using Mathematics and Computational Thinking
- ❑ **DCI:** LS2.A: Interdependent Relationships in Ecosystems
- ❑ **CCC:** Scale, Proportion, and Quantity

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CIRCUITS & HARDWARE

CODING

Community Need

Pets can easily get lost and some have even been hit by cars! Some pets overheat or are not warm enough. Pet owners would like a way to see or protect their pet outside so they can be healthy, safe, or easily found.

Tech Tool Ideas:

Conductive Connections
Snap Circuits
Micro:bit
Arduino

Career Connections:

Programmer
Electrician
Electrical Engineer
Machinist

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. Is the invention stationary or wearable?
2. How might your device fit on a pet or be secured to a wall, post, or the ground?
3. Will the device use sound, light, or another kind of energy? If so, what is needed to make a circuit or what is needed for thermal energy transfer?
4. If it is raining, or if a pet needs a bath, does the device need to be waterproof?
5. Can the pet owner easily detach the device?
6. How is your design safe for a pet?
7. How will you market your device to your community?

Unit Extension Ideas

Connect to the NGSS Standards!

Decide on some physical criteria for success and collect data on the physical properties of each design. Students might rate performance by durability, strength, flexibility, hardness, texture, absorbency, etc. Analyze the data to decide on designs best suited for your solution.

2nd

- ❑ **PE:** Matter and Its Interactions: 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
- ❑ **SEP:** Analyzing and Interpreting Data
- ❑ **DCI:** PS1.A: Structure and Properties of Matter
- ❑ **CCC:** Cause and Effect

Challenge students to create a solution that uses heat, light, or sound energy.

4th

- ❑ **PE:** Energy: 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.B Conservation of Energy and Energy Transfer, PS3.D Energy in chemical Processes and Everyday Life, **EDP**: ETS1.A: Defining Engineering Problems
- ❑ **CCC:** Energy and Matter

Challenge students to create a solution that uses thermal energy transfer to either heat or cool a pet. Have students think about the pet shipping industry, keeping pets warm in cold areas and cool in warm areas.

6-8

- ❑ **PE:** Energy: MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.A: Definitions of Energy, PS3.B Conservation of Energy and Energy Transfer, **EDP**: ETS1.A: Defining Engineering Problems, ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Energy and Matter

Challenge students to design a solution for an individual's specific pet, using input from the owner for criteria and constraints. The solution must keep the pet safe and incorporate energy transfer. Students should measure success using quantitative and qualitative evaluation.

9-12

- ❑ **PE:** Energy: HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.A: Definitions of Energy, PS3.D Energy in Chemical Processes, **EDP**: ETS1.A: Defining and Delimitating an Engineering Problem
- ❑ **CCC:** Energy and Matter

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CODING

CIRCUITS & HARDWARE

Community Need

The county fair is coming up and your school is designing and building a parade float. Any animatronics that light up, move or make sounds are especially fun!

Tech Tool Ideas:

Ozobot, Sphero, littleBits, Micro:bit, Makey Makey, Snap Circuits, Arduino

Career Connections:

Machinist
Programmer
Set Designer
Electrical Engineer
Electrician

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How can you use the tech tools to design movement, sounds, or lights?

2. What materials will make the movement of your animatronics seem more lifelike?

3. Will your animatronics be autonomous or will it be controlled by people riding on the float?

4. How can you use code to control movement?

5. Does your float have a theme or message that you want your community to understand?

Unit Extension Ideas

Connect to the NGSS Standards!

Students design a float with access to the same materials. Discuss the variance in final designs. Encourage students to disassemble their work and recycle their materials to improve/build an alternative solution.

2nd

- ❑ **PE:** Matter and its Interactions: 2-PS1-3: Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS1.A: Structures and Properties of Matter
- ❑ **CCC:** Energy and Matter

Discuss the path of each float design. Can their motion be predicted? Have students explain how they use observation and measurement (distance, direction, or time) to predict the future motion/path of their float. Explain how technology was used to make it predictable or explain why the motion may not be predictable.

3rd

- ❑ **PE:** Motion and Stability: Forces and Interactions: 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Patterns

Research and discuss electromagnetic trains. Have students use magnets to either make a vehicle move or make an animatronic device that simulates movement using magnets, electrically charged objects, and/or gravity.

6-8

- ❑ **PE:** Motion and Stability: Forces and Interactions: MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.B: Types of Interactions
- ❑ **CCC:** Cause & Effect

Parade floats travel at a slow speed but people often ride them. If an accident were to occur, design a solution to minimize the risk (impact) during a collision. (This idea may also be extended to solutions that minimize the collision risk of animals riding in truck beds). Be sure to include a method that could be used to systematically collect data that would measure the devices ability to protect against damage!

9-12

- ❑ **PE:** Motion and Stability: Forces and Interactions: HS-PS2-3: Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
- ❑ **SEP:** Constructing Explanations and Designing Solutions.
- ❑ **DCI:** PS2.A: Forces and Motion, **EDP:** ETS1.A: Defining and Delimitating an Engineering Problem, ETS1.C: Optimizing the Design Solution
- ❑ **CCC:** Cause and Effect

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CIRCUITS & HARDWARE

PROTOTYPE

Community Need

Many buildings do not have air conditioning, but it is also important to save energy. Our homes and stores may need to use alternative energy, increase shade, turn lights off while keeping a fan running, or have improved designs for natural air flow. This helps save energy for our homes and businesses

Tech Tool Ideas:

Snap Circuits
K'NEX Solar Energy
Legos

Career Connections:

Electrician
Electrical Engineer
Landscaper
Solar Installer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How can you limit energy use and/or cooling costs?

2. Are there non-electronic ways to save energy and/or keep spaces cooler?

3. What is needed for a circuit?

4. Why do the switches in your house not turn everything off?

5. What is a parallel or series circuit?

6. How will you share your design with the community?

Unit Extension Ideas

Connect to the NGSS Standards!

Observe the effects of the sun on the temperature of objects, including buildings and the air inside rooms. Design a solution to keep buildings or rooms cooler during hot days.

K

- ❑ **PE:** Energy: K-PS3-1: Make observations to determine the effect of sunlight on Earth's surface.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS3.B: Conservation of Energy and Energy Transfer
- ❑ **CCC:** Cause and Effect

Did you know that some hotels have lights that shut off when you leave the room? Design, test, and improve a solution that will keep a space cooler by producing motion, sound, or light.

4th

- ❑ **PE:** Energy: 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.B: Conservation of Energy and Energy Transfer, PS3.D: Energy in Chemical Processes and Everyday Life,
  EDP: ETS1.A: Defining Engineering Problems
- ❑ **CCC:** Energy and Matter

Energy moves from hotter regions to colder ones. Design a space that would encourage natural air flow, which could also be accelerated by fans, to cool or warm a room.

6-8

- ❑ **PE:** Energy: MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3. A Definitions of Energy, PS3.B Conservation of Energy and Energy Transfer,
  EDP: ETS1.A Defining and Delimitating an Engineering Problem
- ❑ **CCC:** Energy and Matter

Explore small scale local solutions that could be widespread, if effective, for cooling homes and/or saving daily energy use. Evaluate current solutions, then choose one solution to further refine. Explain how it can reduce the impact of human activities on Earth.

9-12

- ❑ **PE:** Earth and Human Activity: HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- ❑ **SEP:** Constructing Explanations and Designing Solutions.
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems,
  EDP: ETS1.B Developing Possible Solutions
- ❑ **CCC:** Stability and Change

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CIRCUITS & HARDWARE

PROTOTYPE

Community Need

Many streets are not well lit, but evening is the coolest time of day for exercising. People might walk alone, with pets, or even push strollers. Our community of walkers, bikers, and runners need wearable technology that alerts drivers to their location for safety.

Tech Tool Ideas:

Conductive Connections, Micro:bit, Formcard, Instamorph

Career Connections:

Fashion Designer
Electrician
Inventor

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How might you alert drivers with light and/or sound?
2. Will designs of certain colors be more effective?
3. Where might the technology be worn or attached? Should it be detachable?
4. Should the device be water resistant?
5. Does the device need to be washable?
6. How will you market your design?

Unit Extension Ideas

Connect to the NGSS Standards!

Using student's designs, explore how their wearable technology illuminates an object and makes that object visible in darkness. The set-up might be observing the design through a pinhole in a box, comparing visibility when off versus on.

1

- ❑ **PE:** Waves and Their Applications in Technologies for Information Transfer: 1-PS4-2. Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS4.B: Electromagnetic Radiation
- ❑ **CCC:** Cause and Effect

Student's wearable technology design should include the principles of illumination via reflection to make that object visible in darkness. When sharing out, have students explain the scientific principles that make their design visible.

4th

- ❑ **PE:** Waves and Their Applications in Technologies for Information Transfer: 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
- ❑ **SEP:** Developing and Using Models
- ❑ **DCI:** PS4.B: Electromagnetic Radiation
- ❑ **CCC:** Cause and Effect

Compare materials based on their ability to reflect, absorb, or transmit light (or sound). Using this information, have students design wearable technology devices and explain how their model uses the scientific properties of waves (light and or sound) to work.

6-8

- ❑ **PE:** Waves and their Applications in Technologies for Information Transfer MS-PS4-2.Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
- ❑ **SEP:** Developing and Using Models
- ❑ **DCI:** PS4.A: Wave Properties, PS4.B: Electromagnetic Radiation
- ❑ **CCC:** Structure and Function

Explore popular devices used for safety and fitness. Identify and explain how each device uses wave properties and principles to transmit and capture information and energy: chemical processes (battery cells, solar cell energy capture), wave properties (light, sound, digital information sent as wave pulses), and electromagnetic radiation (photoelectric materials emit electrons).

9-12

- ❑ **PE:** Waves and their Applications in Technologies for Information Transfer. HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit, store or capture information and energy.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** PS3.D: Energy in Chemical Processes, PS4.A: Wave Properties, PS4.B: Electromagnetic Radiation, PS4.C: Information Technologies and Instrumentation
- ❑ **CCC:** Cause and Effect

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PROTOTYPE

CIRCUITS & HARDWARE

Community Need

Technology changes so fast. Smart devices need to be upgraded often. Often the old device is thrown away and we end up with a lot of waste. New upgraded devices can be expensive. Could there be a more environmentally friendly design?

Tech Tool Ideas:	Career Connections:
Kano	Inventor
Piper	Computer Engineer
Raspberry Pi	Designer

Define the Problem

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Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. Could smart devices be modular?
2. What are the components of a smart device? What pieces are for protection? What is the computer? Where is the software? Should it look beautiful?
3. How will the components of your new smart device connect and work together?
4. How is a smart device connected to and part of the internet of things (IoT)? Is it secure?
5. What will your new design be? (Is it a phone, tablet, or something else?)
6. Will your device save the consumer money?
7. How does your design environmentally friendly?
8. Can you pitch your idea?

Unit Extension Ideas

Connect to the NGSS Standards!

Is owning the newest toy or ordering takeout good for the environment? Where does all our trash go? Students explore how their families may have positive or negative impacts on the environment (land, water, air, and animals). How can we reduce, reuse, recycle, and redesign? For a negative impact, students design and communicate a solution with a model/sketch.

K

- ❑ **PE:** Earth and Human Activity: K-ESS3-3: Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Cause and Effect

Find and compare two similar products that are options for consumers to purchase. Products are rated by their possible impacts on the environment: land, vegetation, streams, ocean, air, and even outer space. Communicate information in a product review.

5th

- ❑ **PE:** Earth and Human Activity: 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems
- ❑ **CCC:** Systems and System Models

Examine human environmental impacts of pollution caused by consumerism on the air, water, or land. Find a solution that exists. Students then design a plan to monitor the impact of that solution. Explain the proposed method for monitoring and use feedback to improve the method..

6-8

- ❑ **PE:** Earth and Human Activity: MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems
- ❑ **CCC:** Cause and Effect

Student evaluate their redesign (or another solution) on how it reduces impacts of human activities on natural systems. Evaluate the solution by its cost, safety, reliability, aesthetics and consider social, cultural, and environmental impacts. For evaluation, students may also consider the local and global impacts of pre-production and materials sourcing such as quantities and types of pollutants released, changes to biomass, species diversity, or areal changes in land surface.

9-12

- ❑ **PE:** Earth and Human Activity: HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- ❑ **SEP:** Science and Engineering Practices
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Stability and Change

STEM works THINKit

VIRTUAL REALITY

GIS

Community Need

Your relative just graduated and is going off to college. Your family is having a party to celebrate! Everyone wants a unique digital scrapbook where childhood memories can be geotagged, and new memories can be added!

Tech Tool Ideas:

Aria Creator (VR)
ArcGIS Story Maps
Google Maps

Career Connections:

Storyteller, Journalist
Geospatial Map Technician
Social Media Marketer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How can technology be used to geotag memories to share a life story?
2. How should the information (visuals and quotes) be organized?
3. How can a story be told without posting personal information (internet privacy)?
4. What events or milestones might a family want highlighted?
5. How will the content be shared with family?

Unit Extension Ideas

Connect to the NGSS Standards!

Brainstorm list of materials you might use to design a physical memory book. Diagram how each item may impact the environment. How does choosing to create a digital portfolio, (that can be viewed anywhere) reduce your families impact on the land, water, and living things?

K

- ❑ **PE:** Earth and Human Activity: K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP**: ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Cause and Effect

There are many hereditary traits that are passed from parents to children. Students can explore ideas such as eye, hair, and skin color. To dive deeper, have students look through family photos to see if they can find dominant traits that family members share like attached earlobes, tongue rolling, cleft chin, dimples, freckles, windows peak hairline shape, and more!

3rd

- ❑ **PE:** Heredity: Inheritance and Variation of Traits: 3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
- ❑ **SEP:** Analyzing and Interpreting Data
- ❑ **DCI:** LS3.A: Inheritance of Traits, LS3.B: Variation of Traits
- ❑ **CCC:** Patterns

Compare and contrast various means of physical and digital memory book platforms such as: social media, virtual reality, ArcGIS Story Maps, videos, file folders on a computer, etc. Evaluation may include reliability, stability, sharing, copying, transferring, security, theft, etc. Using this information, decide which options may be recommended to criteria and constraints for a family.

6-8

- ❑ **PE:** Engineering Design MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** (Project & design specific)

Evaluate advantages and disadvantages of a physical versus various digital means for a memory book: reliability, stability, sharing, copying, transferring, security, theft, etc. Comparisons may include: social media, virtual reality, ArcGIS Story Maps, videos, file folders on a computer, etc.

9-12

- ❑ **PE:** Waves and their Applications in Technologies for Information Transfer: HS-PS4-2. Evaluate questions about the advantages of using digital transmission and storage of information.
- ❑ **SEP:** Asking Questions and Defining Problems
- ❑ **DCI:** PS4.A: Wave Properties
- ❑ **CCC:** Stability and Change

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DIGITAL MEDIA

CODING

Community Need

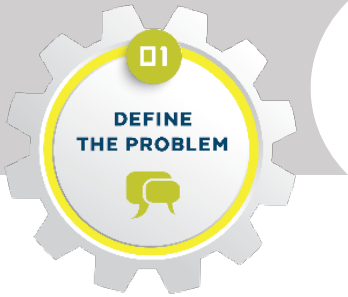
Students often miss school when they are sick and the doctor's office sometimes has a long wait. To help, a local doctor's office wants to have an educational game that people in the wait room can play. This game should be fun and also teach the community about ways to be healthy and get better.

Tech Tool Ideas:

Bloxels
Makey Makey

Career Connections:

Script Writer, Toy Maker
Video Game Designer



Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How can games be used as educational learning tools?

2. Can you write dialogue to listen to or read in the game?

3. What health topic(s) will you teach?

4. How will you have the player interact with the information?

5. How can the doctor's office let parents or kids know about the game?

Unit Extension Ideas

Connect to the NGSS Standards!

After research (texts/media), students develop a game that teaches ways kids and parents can communicate to have what they need to stay healthy. How do people let others know what they need? Caregivers may respond by cooking, comforting, healing, and teaching other safe behaviors.

1st

- ❑ **PE:** Molecules to Organisms: Structures and Processes: 1-LS1-2: Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** LS1.B: Growth and Development of Organisms
- ❑ **CCC:** Patterns

Using specific examples, students explain how their game helps family groups to be healthier through making positive choices that may include topics: healthy food, protection from weather, safety in the environment, or coping with stress or difficult situations.

3rd

- ❑ **PE:** Ecosystems: Interactions, Energy, and Dynamics: 3-LS2-1. Construct an argument that some animals form groups that help members survive.
- ❑ **SEP:** SEP: Engaging in Argument from Evidence
- ❑ **DCI:** LS2.D: Social Interactions and Group Behavior
- ❑ **CCC:** Cause and Effect

Create a game about genetics, where the goal is to 'build organisms' by collecting genes. Through creative design of playing cards, game boards, or even clay models, a player creates organisms with characteristic traits from: (1) traits from normal genes on their chromosomes or (2) traits impacted by gene mutation, resulting in new features with harmful, beneficial, or neutral effects on the structure and function of the organism.

6-8

- ❑ **PE:** MS-LS3-1: Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- ❑ **SEP:** Developing and Using Models
- ❑ **DCI:** LS3.A: Inheritance of Traits, LS3.B: Variation of Traits
- ❑ **CCC:** Structure and Function

Design reading material or an interactive model for families about genetics and heredity. Make it interactive, perhaps by including 'Q&A' or 'I spy a characteristic trait' or a genetic 'choose your own adventure' book. Include interesting characteristics or traits that children get from parents (example: eye color, blood type, ear lobes, etc.). Consider including scientific ideas about similarities and differences in DNA of different living things, known and unknown function of segments of genetic code, interaction of nature versus nurture, and even genetic modification!

9-12

- ❑ **PE:** HS-LS3-1: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- ❑ **SEP:** Asking Questions and Defining Problems
- ❑ **DCI:** LS1.A: Structure and Function, LS3.A: Inheritance of Traits
- ❑ **CCC:** Cause and Effect

STEM works THINKit

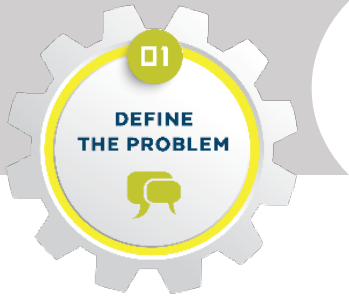
DIGITAL MEDIA

VIRTUAL REALITY

Community Need

A local store sells beach items and wants to advertise their products while teaching the community about ocean safety. They want to display 5-10 second stop motion animations or a 1-3 minute VR experiences that's eye catching, upbeat, or even funny to deliver a message.

Tech Tool Ideas:	Career Connections:
HUE Animation Studio	Marketer
Animation apps	Storyteller
Aria Creator (VR)	Animator



Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What product will be advertised?
2. What will the safety message be?
3. Do the characters need to be human?
4. What is stop motion animation or what is virtual reality?
5. What will the script be? Is using humor appropriate?
6. Will a jingle help deliver a message?
7. How will the animation or experience be advertised in the store?

Unit Extension Ideas

Connect to the NGSS Standards!

Focus on a specific ocean habitat: reef or tide pools. Include the diversity of different kind of organisms and how humans can practice ocean safety to both stay safe and keep organisms safe.

2nd

- ❑ **PE:** Biological Evolution: Unity and Diversity: 2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** LS4.D: Biodiversity and Humans
- ❑ **CCC:** (Project Specific)

Project contains explanation on how a specific product being advertised is an environmentally friendly solution/choice for the habitat and animals that live there. (For example: reef-safe sunscreen or floats to use when snorkeling).

3rd

- ❑ **PE:** Biological Evolution: Unity and Diversity: 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS2.C: Ecosystem Dynamics, Functioning, and Resilience, LS4.D: Biodiversity and Humans
- ❑ **CCC:** Systems and System Models

Research a current disruption of a physical or biological component of the reef ecosystem that has led to shifts in its populations of organisms. Use this information as evidence to support a claim for a needed solution to avert future ecosystem impact.

6-8

- ❑ **PE:** Ecosystems: Interactions, Energy, and Dynamics: MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- ❑ **CCC:** Stability and Change

Research a natural or human-induced change in the reef environment that has contributed to the expansion of some species, the emergence of new distinct species, or the decline/extinction of some species due to the inability to adjust to change that is too drastic to be able to survive or reproduce. Use this information as evidence to support a claim for a needed solution to avert future ecosystem impact.

9-12

- ❑ **PE:** Biological Evolution: Unity and Diversity: HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS4.C: Adaptation
- ❑ **CCC:** Cause and Effect

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GIS & DRONE

PROTOTYPE

Community Need

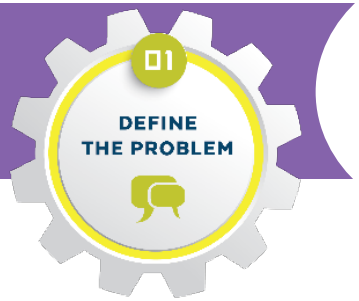
There are many beautiful places to go hiking and swimming but sometimes people get hurt and cannot hike back. Drones can be used to find people and carry emergency supplies before a helicopter can arrive. Creating emergency drop kits with a message to the injured person will help calm and treat them.

Tech Tool Ideas:

ArcGIS Story Maps
Drone Technology
Recyclables

Career Connections:

Emergency Medical Technician
Geospatial Analyst
Drone Pilot
Packaging Engineer



Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What might the emergency drone supply kit need to contain?
2. How might emergency staff communicate with the injured or lost hiker (without cell service)?
3. How might the safety kit be attached, detached, and/or reattached?
4. How might you train and communicate with the hiking community or medical staff to properly use the safety drone?
5. How do balanced and unbalanced forces allow a drone to fly and maneuver? How might this impact the weight or shape of your kit?

Unit Extension Ideas

Connect to the NGSS Standards!

Explore possible materials used for packaging an emergency kit. Does it need to: stay dry, survive a fall, easily seen, reopen/close? Decide on the intended purpose and test materials based on properties such as: strength, flexibility, absorbance, durability, texture, absorbency, weight, etc.

2nd

- ❑ **PE:** Matter and Its Interactions: 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
- ❑ **SEP:** Analyzing and Interpreting Data
- ❑ **DCI:** PS1.A: Structure and Properties of Matter
- ❑ **CCC:** Cause and Effect

Model and/or test the implication of forces on first aid kit design. For a drone to lift off, the upward force on the drone, provided by the movement of air by the propellers, needs to be greater than the downward force of gravity. If a first air kit is added, the gravitational force increases, and more upward force is needed to fly.

5th

- ❑ **PE:** Motion and Stability: Forces and Interactions: 5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** PS2.B: Types of Interactions
- ❑ **CCC:** Cause and Effect

Model effects of balanced and unbalanced forces on drone flight (up, down, forward, backward, etc.). Explore the effects of mass on forces and changes in motion. How does the addition of an emergency kit or wind impact the model of forces involved in flight?

6-8

- ❑ **PE:** Motion and Stability: Forces and Interactions: MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Stability and Change

Solution design should prioritize criteria and consider tradeoffs/constraints such as weight, durability, cost, safety, reliability, aesthetics; as well as any regulations, social, cultural, or environmental impacts.

9-12

- ❑ **PE:** Engineering Design: HS-ETS1-3.Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** (Project Design Specific)

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VIRTUAL REALITY

GIS

Community Need

Zoos and aquariums try to teach visitors about the animals and plants they keep. Posters or displays aren't often read and without traveling worldwide, it is hard to picture the environments these animal live in. Is there a new way for guests to learn about and experience the habitats of the flora and fauna?

Tech Tool Ideas:

Google Street View App
Aria Creator
ArcGIS Story Maps

Career Connections:

Biologist, Zoologist
360° Photographer
Virtual Reality Developer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How can virtual reality be used to teach guests about flora and fauna?
2. Which flora or fauna will you focus on?
3. If you use images that are not yours, are they properly cited?
4. How does the technology work: Google Street View & Google Cardboard, Aria Creator, or ArcGIS Story Maps?
5. How will you digitally share or advertise the experience so a visitor knows what to do?

Unit Extension Ideas

Connect to the NGSS Standards!

Introduce the viewer to the idea that habitats are unique and different geographic regions may have a unique diversity of plants and animals living on land and in water.

2nd

- ❑ **PE:** Biological Evolution: Unity and Diversity: 2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** LS4.D: Biodiversity and Humans
- ❑ **CCC:** (Project Dependent)

Communicate how the zoo imitates a habitat, since an organism survival depends on how well adapted it is to a specific habitat. Or explain how environmental or human caused impacts are predicted to effect habitat and have current or future impacts on of species survival. How are zoos often involved in conservation efforts?

3rd

- ❑ **PE:** Biological Evolution: Unity and Diversity: 3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS4.C: Adaptation
- ❑ **CCC:** Cause and Effect

Consider scientific, economic, and social implications of efforts trying to support conservation of biodiversity efforts to stabilize in ecosystems. Compare the complexity of the two different methods and communicate the proposed plan as well as success or shortcomings of each. Possible societal needs to consider: water availability/purification, nutrient cycling, soil erosion, food availability, medicine, etc.

6-8

- ❑ **PE:** Ecosystems: Interactions, Energy, and Dynamics: MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS2.C: Ecosystem Dynamics, Functioning, and Resilience, LS4.D: Biodiversity and Humans, **EDP**: ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Stability and Change

The completeness of an ecosystem is used to measure its health; certain conditions are indicators of overall health and keystone species have a huge influence. Create an interactive simulation or game, where the participant can make a series of choices that would ultimately effect the health of an ecosystem. The goal would be to mitigate negative impact and increase biodiversity. Consider including choices that would also have economic and social implications.

9-12

- ❑ **PE:** Biological Evolution: Unity and Diversity: HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- ❑ **SEP:** Using Mathematics and Computational Thinking
- ❑ **DCI:** LS4.C: Adaptation, LS4.D: Biodiversity and Humans, **EDP**: ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Cause and Effect

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PROTOTYPE

CIRCUITS & HARDWARE

Community Need

New rides are being designed for next year's county fair. The rides, like bumper cars and roller coasters, need to change in both speed and direction. Design for safety! Riders should never fall out of the rides!

Tech Tool Ideas:

Sphero
K'NEX
littleBits

Career Connections:

Civil Engineer
Physicist
Machinist
Programmer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What are different kinds of amusement park rides? What makes rides extra fun?

2. How can gravity and ramps help increase or decrease speed?

3. Could a string on a wheel help pull riders up a ramp?

4. What can be used to change the direction of the riders?

5. How can code and/or electronics help to automate the ride?

6. How will you keep riders safe?

Unit Extension Ideas

Connect to the NGSS Standards!

Design a ride with a pull/push or a collision. Build and test parts of the ride. Through observation, draw conclusions about the cause and effect relationships between pushes/pulls or collisions on changes in speed (faster, slower, or stopping) and direction.

K

- ❑ **PE:** Motion and Stability: Forces and Interactions: K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion, PS2.B: Types of Interactions, PS3.C: Relationship Between Energy and Forces
- ❑ **CCC:** Cause and Effect

When not in motion, gravity pulls objects downward while Earth pushes upward, keeping objects in place. Horizontal forces can move this balanced object. In a bumper car ride, draw unbalanced forces to predict how horizontal forces of different sizes can cause an object to move (or stay put). Using evidence from several trials, design a safety mechanism for bumper car riders when they experience an unbalanced force.

3rd

- ❑ **PE:** PE: Motion and Stability: Forces and Interactions: 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion, PS2.B: Types of Interactions
- ❑ **CCC:** Cause and Effect

Engineer a Sphero chariot that can carry mass. For each trial, change the mass of the vehicle being moved with the same code, and measure the distance traveled. Graph mass versus distance and make observations about motion. Infer and diagram the sum and direction of forces acting on the vehicle.

6-8

- ❑ **PE:** Motion and Stability: Forces and Interactions: MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Stability and Change

Engineer a device for Sphero to exert force on the mass of an object by pulling or pushing. Using the accelerometer and graph with Sphero, design an experiment to collect data that shows the mathematical relationship: The net force on a macroscopic object is proportional to its mass and its acceleration.

9-12

- ❑ **PE:** HS-PS2-1: Motion and Stability: Forces and Interactions: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- ❑ **SEP:** Analyzing and Interpreting Data
- ❑ **DCI:** PS2.A: Forces and Motion
- ❑ **CCC:** Cause and Effect

STEM works THINKit

PROTOTYPE

DIGITAL MEDIA

Community Need

Humans use a lot of plastic! For example, our clothing, soap, bottles, and tupperware can contain plastic! Plastic breaks down over time and is eaten by creatures that live in the ocean. Communicate a solution, build a model, or make a plan to reduce the impact of humans on water, land or animals.

Tech Tool Ideas:

Low tech (recyclables, posters, Formcard, Instamorph)
High tech (movie, blog, e-newsletter, Tinkercad)

Career Connections:

Ecologist
Designer
Biologist
Journalist

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. Why is plastic bad for the environment?
2. What are the current impacts of plastics on our water, land, or plants?
3. What is the history of plastic use and what will happen if we continue to use plastic at the same rate?
4. Can you make a plan to recycle more?
5. Are there environmentally sustainable alternatives to throw away objects?
6. Can you invent something that helps clean up current plastic? (For example, create a device that sifts sand and water to find small pieces of plastic.)
7. Are there biodegradable alternatives to plastic?

Unit Extension Ideas

Connect to the NGSS Standards!

Make a list of things that help a family live comfortably (food, electronics, objects, etc.). Rate each item on its environmental impact. Students choose one to redesign to reduce their impact on the land, water, air, or other living things.

K

- **PE:** Earth and Human Activity: K-ESS3-3: Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
- **SEP:** Obtaining, Evaluating, and Communicating Information
- **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP:** ETS1.B: Developing Possible Solutions
- **CCC:** Cause and Effect

What happens when animals eat plastics from our thrown away devices as food? The animal starves from nutrients as plastics move up the food chain and into the food web. When animals die, the plastic doesn't decompose and the cycle continues. Have students model a natural pathway of matter from plant to decomposer, with that of a diet including plastics. Use models to show nature's pathway of moving all matter through the environment.

5th

- **PE:** Ecosystems: Interactions, Energy, and Dynamics: 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- **SEP:** Developing and Using Models
- **DCI:** LS2.A: Interdependent Relationships in Ecosystems, LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- **CCC:** Systems and System Models

As human population grows, so does current per-capita consumption of natural resources. Have students plan a method for minimizing human impact on the environment and explain how their planned solution could help limit per capita consumption (include the plan's limitations as well as possible positive impact). Possible focus on energy, water use, land usage, pollution, etc.

6-8

- **PE:** Earth and Human Activity: MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- **SEP:** Constructing Explanations and Designing Solutions
- **DCI:** ESS3.C: Human Impacts on Earth Systems
- **CCC:** Cause and Effect

Have students research and evaluate a current solution on how it reduces impacts of human activities on natural systems. Evaluate the solution by its cost, safety, reliability, aesthetics, and consider social, cultural, and environmental impacts. For evaluation, students may also consider the local and global impacts of pre-production and materials sourcing such as quantities and types of pollutants released, changes to biomass, species diversity, or areal changes in land surface.

9-12

- **PE:** Earth and Human Activity: HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- **SEP:** Science and Engineering Practices
- **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP**: ETS1.B: Developing Possible Solutions
- **CCC:** Stability and Change

STEM works THINKit

PROTOTYPE GIS

Community Need

Many homes are built close to drainage ditches that become rivers during storms. Soil erodes and disperses into ocean, sometimes covering coral reefs. A development is being built by a dry creek that becomes a river during storms. The community needs a design using natural and fabricated solutions to keep soil from eroding.

Tech Tool Ideas:	Career Connections:
Low tech (Recyclables)	Environmental Engineer
High tech (SketchUp, CoSpaces, ArcGIS)	Landscaper
	Ecologist

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What is a riparian zone?
2. How do the roots of plants create buffer zone?
3. What species of shrubs or trees prevent erosion? Can native species be used?
4. How high or often may the river flood?
5. What man-made building solutions help keep soil stable, or protect homes and people during flooding?
6. Can multiple solutions be used?

Unit Extension Ideas

Connect to the NGSS Standards!

Students compare each other's solutions and suggest ways to improve designs. Then, use feedback to make improvements or combine all the best ideas into a new solution.

2nd

- ❑ **PE:** Earth's Systems: 2-ESS2-1: Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ESS2.A: Earth Materials and Systems, EDP: ETS1.C: Optimizing the Design Solution
- ❑ **CCC:** Stability and Change

Identify, categorize and describe types of weathering: Hunt for signs of weathering on school campus (water, tree roots), observe before and after photos of local effects (hurricanes, seasonal changes in beaches), research/collect images of large scale erosion effects (mudslides, tsunamis) and effects over long periods of time (canyons, arches, glacial movement).

4th

- ❑ **PE:** Earth's Systems 4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** ESS2.A: Earth Materials and Systems, ESS2.E: Biogeology
- ❑ **CCC:** Cause and Effect

Research coastal erosion in Hawaii and other areas. Create a timeline (or story map) of reporting about the topic. Using the information, project the timeline into the predicted future as well as the past. For the future, include erosion predictions and/or predicted effects. For the past, record when the 'factors of causation' were documented and may have begun.

6-8

- ❑ **PE:** Earth's Systems: MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ESS2.A: Earth's Materials and Systems, ESS2.C: The Roles of Water in Earth's Surface Processes
- ❑ **CCC:** Scale Proportion and Quantity

Water has unique combination of physical and chemical properties central to the planet's dynamics. Each group creates an experiment that investigates one of the following: (1) water's exceptional capacity to absorb, store, and release large amounts of energy, (2) transmit sunlight, (3) expand upon freezing, (4) dissolve and transport materials, and (5) lower the viscosities and melting points of rocks. Each inquiry should include references to a real world example.

9-12

- ❑ **PE:** Earth's Systems: HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- ❑ **SEP:** Planning and Carrying Out Investigations
- ❑ **DCI:** ESS2.C: The Roles of Water in Earth's Surface Processes
- ❑ **CCC:** Structure and Function

STEM works THINKit

PROTOTYPE

Community Need

Over 1 billion people in the world do not have access to electricity. Cooking with wood or coal causes lung problems and releases more carbon into the environment. A solar device that converts the suns rays to heat to cook food or to dry it out for preservation would be very helpful.

Tech Tool Ideas:

Low tech (Recyclables, Thermometer)

Career Connections:

Product Engineer
Thermal Engineer
Inventor

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What is energy transfer?
2. How does the greenhouse effect work?
3. What causes air to flow naturally?
4. What materials optimize thermal transfer?
5. What materials optimize the conversion of solar radiation to heat energy?
6. What are current product examples of thermal cooking or solar dehydration?

Unit Extension Ideas

Connect to the NGSS Standards!

Present the model to share how the design reduces impact on the air while helping people in their environment.

K

- ❑ **PE:** Earth and Human Activity: K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems, **EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Cause and Effect

Through research, explore how various solar designs and products are being used by communities around the world. Obtain and organize information on how using less fuel, like coal and wood, protects resources in the environment, contributes to better human health, and helps communities.

5th

- ❑ **PE:** Earth and Human Activity: 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- ❑ **SEP:** Obtaining, Evaluating, and Communicating Information
- ❑ **DCI:** ESS3.C: Human Impacts on Earth Systems
- ❑ ❑ **CCC:** Systems and System Models

For the design, define the criteria (for example: temperature, cheap supplies) and constraints (size, limited supplies). Create a method with a clear systematic way to test the design and have data that can be used for evaluation (example: temperature rise over time). Modify design based on the data (consider how the design performed to best meet the criteria and constraints).

6-8

- ❑ **PE:** Energy: MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.A: Definitions of Energy, PS3.B: Conservation of Energy and Energy Transfer, **EDP**: ETS1.A: Defining and Delimiting an Engineering Problem, ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Energy and Matter

Energy cannot be destroyed but it can be converted. Students design, build, and refine a device within given constraints. Then, students diagram, how, and where energy is being converted from one form to another. Diagram should show all energy inputs and outputs of the system (including reflection, absorption, and transfer). Using these scientific principles, students explain how they met the requirements set by society for the device.

9-12

- ❑ **PE:** Energy: HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** PS3.A: Definitions of Energy, PS3.D: Energy in Chemical Processes, **EDP:** ETS1.A: Defining and Delimiting an Engineering Problem
- ❑ **CCC:** Energy and Matter

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PROTOTYPE

CIRCUITS & HARDWARE

Community Need

Sometimes there aren't enough pollinators for farming! This might be because there are too many crops to pollinate or there are not enough pollinators due to the effects of pesticides or diseases. Beehives have been rented by the truckload to help pollinate fields of crops, but this is expensive and not always possible. Tools that mimic pollinators of flowers or help to disperse seeds are needed.

Tech Tool Ideas:

Recyclables
K'NEX

Career Connections:

Inventor
Agroecologist

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. What is biomimicry?
2. Is there a local plant that currently struggles with pollination or seed dispersal?
3. Will your tool design focus on pollination or seed dispersal?
4. What parts of a pollinator aid in pollination? Or how are seeds dispersed in nature?
5. Is a certain size or texture of material needed for pollinating or dispersing seeds?
6. Can the same sized tool be used on all flowers or seeds?
7. What specific plant(s) is your tool designed for?

Unit Extension Ideas

Connect to the NGSS Standards!

Diagram and/or build a tool to mimic the function of an animal in dispersing seeds or pollinating plants. Explain and demonstrate how your device is used.

2nd

- ❑ **PE:** Ecosystems: Interactions, Energy, and Dynamics: 2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
- ❑ **SEP:** Developing and Using Models
- ❑ **DCI:** LS2.A: Interdependent Relationships in Ecosystems; EDP: ETS1.B: Developing Possible Solutions
- ❑ **CCC:** Structure and Function

What will happen to plants if the organisms that pollinate are not healthy, move, or die? Research: What plants need pollinators? Are there plants that would not be affected if pollinators did not survive? What plants do people eat that need pollinators? Students diagram two scenarios and create a list of benefits and drawbacks for each: (1) No pollinators and no solution (2) A solution for pollinators, such as a pollination tool.

3rd

- ❑ **PE:** Biological Evolution: Unity and Diversity: 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS2.C: Ecosystem Dynamics, Functioning, and Resilience, LS4.D: Biodiversity and Humans
- ❑ **CCC:** System and System Models

Research the specialized features of plants and animals necessary for pollination and/or seed dispersal that contribute to their probability of reproduction and survival. Explain how the information was used in the solution design. Predict potential impact of the design on organisms.

6-8

- ❑ **PE:** From Molecules to Organisms: Structures and Processes: MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI:** LS1.B: Growth and Development of Organisms
- ❑ **CCC:** Cause and Effect

Attach estimated values (area, volume, number) to quantify the scale of each issue. Then, outline a cause and effect web of relationships of human impact on biodiversity due to our methods of societal food production. Possible issues to computationally explore: human population growth, food surplus and scarcity, monetary needs, soil health, crop rotation, monoculture farming, pesticides, insect health, organic methods, fertilizers, water use, water quality, clear cutting, slash and burn, wildlife corridors, aquifer level, etc. Explore how food production impacts ecosystems and biodiversity.

9-12

- ❑ **PE:** Biological Evolution: Unity and Diversity: HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- ❑ **SEP:** Using Mathematics and Computational Thinking
- ❑ **DCI:** LS4.C: Adaptation, LS4.D: Biodiversity and Humans
- ❑ **CCC:** Cause and Effect

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PROTOTYPE

Community Need

Many homes are built close to active fault lines or volcanoes. This means an earthquake might affect the home. Can you design a tool that would make items in a home less likely to fall over or create a home design that makes the foundation better for earthquakes. Your design can make homes safer!

Tech Tool Ideas:	Career Connections:
Recyclables	Environmental Engineer
K'NEX	Seismic Engineer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How do earthquakes effect buildings of different materials?
2. How do earthquakes effect objects in a home?
3. What are the most dangerous safety risks to humans and animals in an earthquake?
4. What have engineers done to prevent homes from collapsing in earthquakes?
5. What kinds of objects inside a house might need to be secured or supported during an earthquake?

Unit Extension Ideas

Connect to the NGSS Standards!

Organize research about the scale and geologic timing of natural events. Compare timescales for natural events or disasters. How often do they occur? How long is the time between events? How long is the event itself? How big or small is the impact on human society? Examples: tides, hurricanes (quick, seasonal); volcanic explosions, earthquakes (quick, sporadic); erosion of rocks, filling of aquifers (slow, constant).

2nd

- ❑ **PE:** Earth's Place in the Universe: 2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ESS1.C: The History of Planet Earth
- ❑ **CCC:** Stability and Change

Students compare designs using constructive critique. Affirming good design characteristics and advise on ideas to improve solutions. Students explain how and why they would (or wouldn't) utilize feedback to redesign and improve their solution.

4th

- ❑ **PE:** Earth and Human Activity: 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ESS3.B: Natural Hazards, **EDP:** ETS1.B: Designing Solutions to Engineering Problems
- ❑ **CCC:** Cause and Effect

Geographically map the history of earthquakes in a region. Observe and describe patterns of location, magnitude, and event timing. Use data to map the locations and likelihood of future events. Using this map, make recommendations about where and when preventative measures should be used.

6-8

- ❑ **PE:** Earth and Human Activity: MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- ❑ **SEP:** Analyzing and Interpreting Data
- ❑ **DCI:** ESS3.B: Natural Hazards
- ❑ **CCC:** Patterns

How does resource availability (food, water, fossil fuels, fertile soil) and natural hazards/geologic events (floods, drought, hurricane, sea level rise, temperature changes, tsunamis, earthquakes, erosion) affect populations and the development of society (population, migration)? Using evidence, explain the historical impact, current issues/impact, and future projected impact. How do societal choices impact society through systems of cause and effect relationships?

9-12

- ❑ **PE:** Earth and Human Activity: HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ESS3.A: Natural Resources, ESS3.B: Natural Hazards
- ❑ ❑ **CCC:** Cause and Effect

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GIS & DRONE

DIGITAL MEDIA

Community Need

Drone technology is excellent for creative photography. For the upcoming school open house, students want a photo booth featuring three photos from unique perspectives. The booth needs to be easy to operate, so students with little experience can run the booth.

Tech Tool Ideas:

Drone Technology
Drone Camera

Career Connections:

Photographer, Event Planner
Drone Pilot
Programmer

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. How will you keep the experience safe?

2. To save time, how might you automate parts of the photo booth experience?

3. Drone batteries die quickly, how will you make sure the station is open for as long as it can be?

4. On a low cost budget, how might you share the photos with families?

5. What is your plan or system for training other people to help run the booth?

Unit Extension Ideas

Connect to the NGSS Standards!

Design a safety and training manual that communicates in diagrams and a series of sequential directions on how to run the photo booth. The manual might include one or more of the following: how to code and fly the drone, set up the booth, take photos, and share images.

K-2

- ❑ **PE:** Engineering Design K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- ❑ **SEP:** Asking Questions and Defining Problems
- ❑ **DCI: EDP:** ETS1.A: Defining and Delimiting Engineering Problems
- ❑ **CCC:** Structure and Function

After the design process, students reflect on how their experience relates to the following statements. (1) Team communication is an important part of the process and can lead to more design solutions. (2) Researching the problem prior to creating a solution helps to broaden and inform solution ideas. (3) Testing to see how it performs under a range of likely conditions helps improvement. (4) Criteria help you design a solution and constraints limit your possibilities.

3-5

- ❑ **PE:** Engineering Design: 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.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI: EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** (Project Dependent)

Students compare and evaluate each other's processes using constructive critique on how it meets criteria and constraints. Affirm parts of the process that work and gives advise on how to improve what's confusing. Students explain how they would (or wouldn't) utilize feedback and then redesign to improve their solution.

6-8

- ❑ **PE:** Engineering Design: MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI: EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** (Project Dependent)

As a team, using at least three criteria for design, focus and systematically approach a solution by making a plan for content. Make decisions about the priority of certain criteria over others (identify trade-offs).

9-12

- ❑ **PE:** Engineering Design: HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI: EDP:** ETS1.C: Optimizing the Design Solution
- ❑ **CCC:** (Project Dependent)

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VIRTUAL REALITY

DIGITAL MEDIA

Community Need

A group of exchange students from Japan are coming to your school next year. These students and their parents are both nervous and excited about what life is like where you live. A virtual tour could really help prepare the students and families for the upcoming year at your school.

Tech Tool Ideas:

Google Street View App
Aria Creator
ArcGIS Story Maps

Career Connections:

Journalist, Storyteller
360° Photographer
Travel Concierge

Define the Problem

Our engineering & design goal is to...

Our community is...

Three Criteria! We are successful if...

Three Constraints! Our solution is limited by...

Gather Pertinent Info

1. Are there ways or tools you can use to better support the communication of a second language?

2. What places would you share using virtual reality or virtual tours?

3. Are there any cultural or environmental differences that exchange students should learn about?

4. How does the technology work: Google Street View, Google Cardboard, Aria Creator, or ArcGIS Story Maps?

5. How will you digitally share the virtual tour with these students and their families before their travel?

Unit Extension Ideas

Connect to the NGSS Standards!

What sequence of information would be helpful to virtually see or experience prior to visiting a new country? Students sketch a plan to 'virtually shape' their 360° scenes and information by making a plan of the best content and the sequence or location of these images to be viewed within a virtual 360° setting.

K-2

- ❑ **PE:** Engineering Design K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- ❑ **SEP:** Asking Questions and Defining Problems
- ❑ **DCI: EDP:** ETS1.A: Defining and Delimiting Engineering Problems
- ❑ **CCC:** Structure and Function

After the design process, students reflect on how their experience relates to the following statements. (1) Team communication is an important part of the process and can lead to more design solutions. (2) Researching the problem prior to creating a solution helps to broaden and inform solution ideas. (3) Testing to see how it performs under a range of likely conditions helps improvement. (4) Criteria help you design a solution and constraints limit your possibilities.

3-5

- ❑ **PE:** Engineering Design: 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.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** (Project Dependent)

Students compare and evaluate each other's virtual solutions, using constructive critique on how it meets criteria and constraints. Affirm parts of the solution that is helpful and gives advise on how to improve what's confusing. Students explain how they would (or wouldn't) utilize feedback and then redesign to improve their solution.

6-8

- ❑ **PE:** Engineering Design: MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- ❑ **SEP:** Engaging in Argument from Evidence
- ❑ **DCI: EDP:** ETS1.B: Developing Possible Solutions
- ❑ **CCC:** (Project Dependent)

As a team, using at least three criteria for design, focus and systematically approach a solution by making a plan for content. Make decisions about the priority of certain criteria over others (identify trade-offs).

9-12

- ❑ **PE:** Engineering Design: HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- ❑ **SEP:** Constructing Explanations and Designing Solutions
- ❑ **DCI:** ETS1.C: Optimizing the Design Solution
- ❑ **CCC:** (Project Dependent)