



TEACHER GUIDEBOOK

2025 - 2026

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This icon indicates a pause
in the activity for class
discussion.



This icon indicates the
corresponding page number in
the Student Guidebook

Section Descriptions



Section 1

Section 1 of the Teacher Guidebook includes an overview of the STEM Challenge along with teacher and student benefits and expectations.

The Student Guidebook version of this section provides a less detailed timeline and does not include information about the Junior STEM Challenge or teacher-specific pages.



Section 2

Section 2 of the Teacher Guidebook contains STEM Challenge activities along with their accompanying materials. This includes the required activity, *Activity 1: Let's Get Started*. Student activity sheets are also included for the optional field trip to Frost Science and meet the scientist opportunities.

The Student Guidebook version of this section only contains activity sheets for the STEM Challenge activities, not including the field trip and Meet the Museum Scientist activity sheets.



Section 3

Section 3 of the Teacher Guidebook includes additional materials to support teachers in integrating the STEM Challenge into their curriculum and in guiding students through their STEM Challenge projects. Along with the additional materials, Section 3 includes additional pages to use for planning.

The Student Guidebook does not contain any of the information from Section 3 of the Teacher Guidebook.



Section 4

Section 4 of the Teacher Guidebook contains information about STEM Challenge final products, including guidelines for student models and displays. This section also contains tips and resources for students and teachers.

The Student Guidebook version of this section contains information about APA guidelines from *Activity 2: Sound Sources*.



Resources: STEM Challenge Website

Additional resources can be found on the STEM Challenge website. Resources listed on the STEM Challenge website may be modified over time.

Section 1

About the STEM Challenge



Section 1 of the Teacher Guidebook includes an overview of the STEM Challenge and Junior STEM Challenge along with teacher and student benefits and expectations. Student benefits and expectations in Section 1 are also given to students in their Student Guidebook. The end of Section 1 also includes a copy of the Teacher Agreement.

*“Scientists investigate that which already is;
engineers create that which has never been.”*

—Albert Einstein



The Frost Science STEM Challenge

The Frost Science STEM Challenge engages middle and high school students and teachers with a year-long STEM investigation. In this challenge, students will use the engineering design process to create new and innovative solutions to some of the problems scientists are currently trying to solve. These problems are based on each of Frost Science's four fields of study: astronomy, marine science, paleontology, and health.

Through this dynamic program, students can work in a group or individually to pick a problem, develop and model a solution, and present their work. Even though many students might be working on the same topic, these problems are broad, and they should use their unique interests, knowledge, and skillsets to derive their own creative solution.

The STEM Challenge is an ever-evolving challenge, with the overall program structure remaining constant but the theme and problems for students to solve changing each year. This gives students the opportunity to compete in the STEM Challenge across multiple years.

At the end of the 2025-2026 school year, teachers will submit student projects for the first round of judging. Then, finalists will be invited to present their projects the STEM Challenge Expo. Students will be judged by experts and scientists in the fields of marine science, health, paleontology, astronomy, and education. Winning groups and individuals will receive college scholarships covering up to four years of college. While only top performing students will be invited to present their projects at Frost Science, all STEM Challenge students are encouraged to come to the museum for the STEM Challenge Expo.

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STEM Challenge

Student Timeline

- 1 Receive the Student Guidebook
- 2 Review the STEM Challenge
- 3 Complete *Activity 1: Let's Get Started*
- 4 Research the topic and create a list of reputable resources
- 5 Identify and list issues related to your prompt
- 6 Brainstorm your challenge/identified issues
- 7 Identify potential ideas/solutions
- 8 Select one idea/solution
- 9 Refine and finalize your idea/solution
- 10 Create a model of your solution that utilizes at least one physical component
- 11 Create a display
- 12 Turn in a digital copy or photographs of your presentation display, photographs of your model, and a copy of your history design file to your teacher
- 13 Your teacher submits projects for the first round of judging
- 14 Students that pass the first round of judging will receive invitations to the STEM Challenge Expo at Frost Science
- 15 Finalists will attend the STEM Challenge Expo for the final round of judging
- 16 Winners will be announced!

STEM Challenge

Teacher Timeline

- 1 Provide your students with the Student Guidebook
- 2 Give students an overview of the STEM Challenge
- 3 **Mandatory:** Complete *Activity 1: Let's Get Started* with students
 - As part of Activity 1, students will identify whether they will work in groups or individually, select their prompt, and begin to plan their STEM Challenge project.
- 4 **Optional:** Complete *Activity 2: Sound Sources* with students
- 5 Students research the topic of their prompt and create a list of reputable resources
- 6 Students identify and list issues related to their prompt
- 7 Students brainstorm their challenge/identified issues
- 8 Students produce an outline of potential ideas/solutions
- 9 Students select one idea/solution
- 10 **Optional:** Complete *Activity 3: Iterative Ideas* with students
- 11 Students refine their idea/solution
- 12 **Optional:** Complete *Activity 5: Mix-it-up* with students to refine their solution
- 13 Students refine and finalize their idea/solution
- 14 Students create a model of their solution
- 15 Students create a display

STEM Challenge Teacher Timeline

(continued)

- 
- 16 **Optional:** Complete *Activity 4: Pitch Your Point* with students
 - 17 Students develop a pitch for their projects
 - 18 **Optional:** Complete *Activity 5: Mix-it-up* with students to refine their pitch
 - 19 Students practice their presentation
 - This presentation should be no longer than 10 minutes.
 - 20 Select several projects (per class/extracurricular) to submit for the first round of judging
 - 21 Submit a digital copy of each selected project's display, model, and history design file for round one of judging by **March 13**
 - These submissions must include either digital copies or photographs that are clearly legible.
 - 22 Students that pass the first round of judging will receive invitations to present at the STEM Challenge Expo at Frost Science
 - 23 Students invited to the STEM Challenge Expo can revise their projects based on the feedback provided by judges
 - 24 Invited students, along with their teachers, arrive at the museum and set up their display and models for the second round of judging



2025 - 2026 STEM Challenge Theme

The STEM Challenge prompts will change each year of the STEM Challenge and are based around a central theme. The 2025-2026 STEM Challenge theme is “Innovating with Technology to Advance Science.”

Innovating with Technology to Advance Science

Technology has become an increasingly prevalent part of everyday life. This year’s STEM Challenge theme prompts students to think about how emerging technologies can be used to advance science. As students think about the multitudinous uses of technology, they are encouraged to use emerging technologies to develop and model their solutions.

Emerging technologies in the context of the STEM Challenge can be defined as any technology that is currently in development, gaining new features, or being used in new ways. Students may use emerging technologies within their solutions or may begin developing their own emerging technology as part of the STEM Challenge.

Some current emerging technologies include:

- 3-Dimensional Modeling and Printing
- Artificial Intelligence
- Biotechnology
- Immersive Technologies
- Implantables
- Nanotechnology
- Robotics
- Wearables

2025 - 2026 STEM Challenge Prompts

In the STEM Challenge, students will be developing a solution to one of four prompts. These prompts are based on different scientific disciplines and are broad, allowing students to create a wide variety of different solutions. These prompts will change each year of the STEM Challenge and are based around the central theme.

Teachers may choose to let students pick from any of the STEM Challenge prompts or limit the prompts students can address. For example, while a research elective may allow students to pick any of the STEM Challenge prompts, a marine science class may require students to address the marine science prompt.

In the STEM Challenge, students are expected to address only one STEM Challenge prompt. However, if students develop a solution that could potentially address more than one STEM Challenge prompt, allow them to explore that option. While this is an unlikely scenario, it should be encouraged if it arises.



Marine Science

Many agencies use technology to monitor and regulate marine activities. Design a solution that uses emerging technology to monitor or respond to human-led or naturally occurring marine activity.



Astronomy

As we continue to explore our universe, we need technology capable of supporting and entertaining astronauts in space and on other planets. Design a product or solution that uses emerging technology to fill at least one basic need for an astronaut in space.



Paleontology

Many fossils are located in hard-to-reach or remote environments and are only accessible seasonally. Design a solution that uses emerging technologies to find, access, extract, or preserve fossils more efficiently in extreme environments.



Health

Emerging technologies are being used to help recognize patterns in health data and diagnose and treat patients. However, these technologies are difficult to access and can be expensive or prone to errors. Design or improve upon a technology that accurately interprets health related data or makes healthcare more accessible and efficient.

The Junior STEM Challenge

For the second year of the STEM Challenge, students and teachers participating in the Junior STEM Challenge are provided with the same materials and resources as their high school counterparts. Teachers in the Junior STEM Challenge are responsible for modifying all content and materials for their students. Middle school specific curricula are currently under development. While the museum has not yet made any modifications to the materials and resources provided for the Junior STEM Challenge, there are several differences between the STEM Challenge and the Junior STEM Challenge.

Unlike the STEM Challenge, students participating in the Junior STEM Challenge cannot work on individual projects and must complete a group project. Groups must consist of 2-4 students. In addition, the final project requirements for the Junior STEM Challenge differ from those of the STEM Challenge. While STEM Challenge students are required to create a display for their project, prepare a 10-minute presentation, and model their solution, Junior STEM Challenge students are only required to create a display for their project and prepare a 5-minute presentation. Junior STEM Challenge students are not required to model their solution; However, students can still earn points on the judging rubric for creating a model. Junior STEM Challenge participants are also not required to use APA citations. Students can still earn points on the judging rubric for using APA citations within their project but will not be penalized if they do not use in-text citations. While both are not required in Junior STEM Challenge projects, creating a model and using APA formatting can help projects stand out and may make the difference between a great project and an outstanding project.

Students participating in the Junior STEM Challenge will also be provided with the same STEM Challenge prompts as high school students. However, middle school teachers should provide Junior STEM Challenge students with a simplified version of the STEM Challenge prompts. While both STEM Challenge and Junior STEM Challenge prompts address the same topics, the simplified prompts provide additional context and guidance for middle school students.

Simplified Prompts for Junior STEM Challenge

Marine Science



Many agencies use technology to watch and manage marine activities. These activities can include anything from tracking hurricanes to identifying illegal fishing operations. Design a solution that uses emerging technology to watch or manage a human or natural marine activity.

Astronomy



As we continue to explore our universe, we need technology that can transport, support, and entertain astronauts in space and on other planets. Design a product or solution that uses emerging technology to create food, water, shelter, or entertainment for an astronaut stationed on a planet other than Earth.

Paleontology



Many fossils are located in hard-to-reach places and can only be accessed during certain times of the year. This is because excavation trips have to end for extreme weather, like freezing temperatures or sandstorms. Design a solution that uses emerging technologies to help find, get to, or remove fossils in extreme environments.

Health



Emerging technologies are being used to help find patterns in health data and diagnose and treat patients. These emerging technologies range from artificial intelligence identifying skin cancer to nanorobots performing delicate, non-invasive surgeries. However, these technologies can be hard to find or use and can be expensive or make mistakes. Design or upgrade a technology that looks at health related data or makes healthcare more accessible, efficient, and affordable.

Why Should You Participate in the STEM Challenge?

As part of the STEM Challenge, teachers who attend the Professional Learning experience on September 23, 2025 and submit student projects are eligible to receive a \$500 stipend. This stipend may be used to reimburse teachers for classroom materials or otherwise support them in facilitating the STEM Challenge.

Teachers participating in the STEM Challenge may also reserve a field trip to Frost Science with a Learning Lab for 30 students and virtual Meet the Museum Scientist opportunities at no cost. Frost Science field trips include self-guided tours through the museum and one STEM Challenge Learning Lab. STEM Challenge Learning Labs involve a 45-minute facilitated, hands-on learning experience in Frost Science's Knight Learning Center.

While these field trips and Learning Labs are provided at no cost, add-ons to these field trips do have an associated cost. These add-ons include lunches and Frost Planetarium shows. Students and schools can provide their own lunches during field trips, or they can be purchased through Frost Science for an additional cost.

Meet the Museum Scientist opportunities are fully virtual, 45-minute-long programs hosted on Microsoft Teams. Students are encouraged to ask the presenting scientist questions about their field, job, and research.

To schedule your field trip to Frost Science, go to the STEM Challenge page on the Frost Science website.

“Invest in our teachers, and our children will succeed.”

—Barack Obama

M-DCPS Teacher Benefits

Teachers in Miami-Dade County Public Schools can receive additional benefits for participating in the STEM Challenge. These teachers can receive STE(A)M Designation and credit for completing an in-school challenge.

To receive STE(A)M Designation, teachers must complete four engagements. These engagements include:

- Attending a Professional Learning experience on September 23, 2025.
- Scheduling and attending a field trip to Frost Science.
- Scheduling and engaging with a STEM Challenge Outreach.
- Scheduling and engaging with at least one virtual Meet the Museum Scientist opportunity.

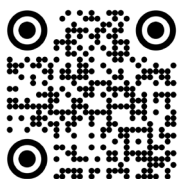
Teachers are recommended to attend two Meet the Museum Scientist opportunities with their students.

- Attending and participating in the STEM Challenge Expo with students.

Teachers with students who have passed the first round of judging will be invited to attend the STEM Challenge Expo at Frost Science. This engagement can only be used for STE(A)M Designation if teachers attend the Expo with students that have passed the first round of judging.

**Register for a STEM Challenge Field Trip
using the link or QR code below:**

<https://forms.office.com/r/H7aVgBjv1F>



**Register for a STEM Challenge Outreach
using the link or QR code below:**

<https://www.frostscience.org/outreach-reservations-form/>





Why Should Your Students Participate in the STEM Challenge?

The STEM Challenge is unique in that it allows students to more fully and realistically explore what it means to be a scientist than a traditional science fair. In a traditional science fair, students write a hypothesis, design a research experiment to test their hypothesis, collect data, and draw conclusions from their data. Instead of taking this approach, the STEM Challenge asks students to engineer solutions to large-scale scientific problems.

By participating in the STEM Challenge, students will gain experience identifying specific issues, applying the engineering design process, and designing solutions to real-world problems. The problems presented in the STEM Challenge are also the same problems that many scientists are working to solve, and student-designed solutions will be judged by scientists in their respective fields. This means that students will be actively contributing to select scientific fields by engaging with these high-stakes issues.

Students participating in the STEM Challenge also can earn college scholarships. STEM Challenge projects will be evaluated in a rigorous two-stage judging process. The first round of judging will occur virtually, and the second round of judging will be held in-person at Frost Science. Top performing students can win the following scholarships through Florida Prepaid:

Individual Projects

- 1st Place – 4-year Florida University Plan
- 2nd Place – 3-year Florida University Plan
- 3rd Place – 2-year Florida University Plan
- Top Oral Presentation – 1-year Florida University Plan
- Top Model – 1-year Florida University Plan

Group Projects

- 1st Place – 3-year Florida University Plan
- 2nd Place – 2-year Florida University Plan
- 3rd Place – 2-year Florida University Plan
- Top Oral Presentation – 1-year Florida University Plan
- Top Model – 1-year Florida University Plan

Junior STEM Challenge Projects

(Middle School, Group Only)

- 1st Place – 1-year Florida University Plan
- 2nd Place – 1-year Florida University Plan
- 3rd Place – 1-year Florida University Plan

For winners to receive college scholarships through Florida Prepaid, they must:

- Have a valid Social Security Number
- Be less than 21 years of age
- Not have graduated high school
- Be a Florida resident for at least 1 year
- Be a U.S. citizen

If the winning student does not meet one of these criteria, Frost Science will work directly with the student to distribute the scholarship. Scholarships not distributed through Florida Prepaid will not qualify for the matched scholarship value and will be of lesser monetary value.

Florida University Plans distributed through Florida Prepaid are designed to be used at public Florida state universities but may be applied to tuition at private and out-of-state schools. When these scholarships are applied to private and out-of-state schools, their monetary value will be applied to student tuition, and will likely not cover the same portion of total educational cost that they would at a public Florida state university.

Teacher Expectations

Teach Activity 1: Let's Get Started

Participating teachers are expected to guide students through the STEM Challenge as they brainstorm and create their solutions, construct a model of their solution, and design a presentation. To begin, teachers will introduce students to the STEM Challenge by teaching *Activity 1: Let's Get Started*. This activity is mandatory for all participating students and teachers as it introduces procedures that will aid in the completion of the STEM Challenge and guides students to start their STEM Challenge projects.

Teach or Encourage Students to Complete Remaining Activities

While only *Activity 1: Let's Get Started* is required, teaching activities 2-5 is highly recommended. These activities guide students in identifying reliable sources, applying the engineering design process, and creating strong presentations. Teachers who do not plan to teach the remaining activities in class are expected to encourage students to complete these activities on their own. They may suggest completing these activities independently or require students to complete a portion of each activity for homework. If teachers require students complete a portion of each activity for homework, teachers may optionally hold class discussions to review each homework question.

Guide Students to Project Completion

Teachers are also expected to allow students to come up with their own original solutions to the STEM Challenge prompts. While teachers may provide guidance that directs students to pursue specific paths, they may not answer STEM Challenge prompts for their students. Acceptable guidance by teachers includes helping students recognize that their solution may not be realistic, that their identified problem is too broad or difficult to address, that their presentation is missing key components, or providing other general feedback. Unacceptable guidance by teachers includes telling students how to solve their identified issue, telling students what part of their solution to model, or telling students to address a specific issue within their prompt. For example, while teachers may require students to address the marine science prompt, they may not tell students to focus on developing a solution that increases the efficiency of oxygen recovery on the International Space Station.

Submit Top Student Projects

Teachers will submit their top student projects for the first round of judging. Teachers are expected to be unbiased in their selection of top student projects. All high-quality and complete student projects should be considered regardless of student performance in school. Exceptions to this rule include cases of severe disciplinary action.

Student Expectations

Complete Activity 1: Let's Get Started

Students will start the STEM Challenge by completing *Activity 1: Let's Get Started*. This activity guides them through an abbreviated, practice version of the STEM Challenge and recommends procedures that will be helpful when they begin their own STEM Challenge project.

Design a Realistic Solution

Designing a solution is an integral part of the STEM Challenge. In designing their solution, students should consider multiple options, evaluating each option for its ease of implementation and its probability of success. While students can design any solution they can imagine, they need to make sure that their solution is realistic and addresses their prompt.

Use the Engineering Design Process

As students design their solution, they should also refine it. Creating one solution without reflecting upon any potential flaws can lead to designing an unrealistic solution that is ineffective in addressing the prompt. Using the engineering design process to look for flaws within a solution, correcting the identified flaws, and repeating the process will help students design a strong solution.

Overcome Obstacles

As students design their solution and complete their STEM Challenge project, they will encounter obstacles along the way. These obstacles are a part of the engineering design process and the STEM Challenge. When students encounter these obstacles, they should look at them as learning opportunities and a way to improve their work. This experience can be difficult and frustrating, but persevering and addressing each obstacle as it comes is an important science and life skill. Sometimes, the best end products are created by overcoming the greatest challenges.

Create a Model and Presentation

Students must also create a model and a display that showcases their solution. While there are criteria for what the models and displays must include, there is not a required format for either the model or display. Students should use their creativity, skills, and interests to create their model and display. While many displays will take the form of a poster, students should not be afraid to branch out and explore other display options.

STEM CHALLENGE TEACHER AGREEMENT

Purpose

This agreement defines the roles and responsibilities of teachers participating in the STEM Challenge during the 2025-2026 academic year. This document is not a legally binding agreement or contract.

Agreements

As a participant, I:

1. Agree to participate in the STEM Challenge with students during the 2025-2026 academic year.
2. Agree to receive the STEM Challenge curriculum and implement *Activity 1: Let's Get Started* with participating students.
3. Agree to have students complete at least one STEM Challenge project, producing a display and model that presents a solution to one of the four STEM Challenge prompts.
4. Agree to digitally submit student projects to Frost Science by March 13, 2026.
5. Understand that I will receive a stipend of \$500 for attending the Professional Learning experiences, teaching *Activity 1: Let's Get Started*, and submitting at least one student project. This stipend may be used as seen fit.
6. Understand that participation in the STEM Challenge includes opportunities for a field trip to Frost Science with a STEM Challenge Learning Lab and virtual Meet the Museum Scientist programs at no cost.
7. Understand that participation in the STEM Challenge can be used to receive STE(A)M Designation through M-DCPS. Events include a Professional Learning experience on September 23, 2025, engagement with the field trip and Meet the Museum Scientist opportunities, and attendance at the STEM Challenge Expo day on April 18, 2026.
8. Understand that completion of the STEM Challenge can be used to receive credit for completing an in-school challenge through M-DCPS. To receive credit for completing an in-school challenge, M-DCPS teachers must attend a Professional Learning experience on September 23, 2025 and teachers must submit student STEM Challenge projects by March 13, 2026.
9. Understand that receiving STE(A)M Designation and in-school challenge credit must be approved by M-DCPS and appropriate M-DCPS paperwork must be filled out by each school/teacher.

School Name Teacher Name Date Signature	Analisa Duran, Ph.D. Knight Senior Director of Science Education Phillip and Patricia Frost Museum of Science Signature
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Section 2

Student Activities



This section provides an overview of each resource type provided in Section 2 of the Teacher Guidebook. As a reminder, you are only required to teach *Activity 1: Let's Get Started*. Teachers are encouraged to use and modify any of the provided resources as needed.

Activities

The provided activities may be used to guide students through the STEM Challenge. These activities contain procedural guidance and do not contain any content related to the STEM Challenge prompts. The Teacher Guidebook contains activity plans and student activity sheets complete with exemplar responses.

Field Trip Resources

For the optional field trips to Frost Science, teachers are provided with several scavenger hunts they can distribute to their students. These scavenger hunts guide students through exploring the museum and help students learn more about their STEM Challenge prompts.

Meet the Museum Scientist Resources

Teachers are provided with a preparatory guide that can be distributed to their students for the optional Meet the Museum Scientist opportunities. The guide helps students prepare questions that will give them a better understanding of what it means to be a scientist and the STEM Challenge.

“Never be limited by other people’s imagination; never limit others because of your own limited imagination.”

—Mae Jemison

Activity 1: Let's Get Started

Overview

Students will learn more about the STEM Challenge by using guided questions to brainstorm a practice STEM Challenge prompt. After completing the STEM Challenge practice, students will analyze and discuss the principles behind the guided questions, read the STEM Challenge prompts and begin planning their STEM Challenge project.

Objectives

By the end of this activity, students will be able to:

- Describe the STEM Challenge.
- Identify the basic procedures needed to complete the STEM Challenge.
- Understand the importance of remaining open to ideas by brainstorming multiple problems and solutions.
- Create a plan for completing the STEM Challenge.

Key Messages

- The STEM Challenge is a year-long science project that encourages participating students to design and model solutions to real-world issues.
- In the STEM Challenge, students will brainstorm solutions to one of four prompts that address real-world issues, with each prompt focusing on a different discipline.

Time Needed: 50 minutes

Standards

NGSSS Gifted Learners Benchmarks

G.K12.4.1.1c, Problem Investigation-Perform: Use established criteria to focus the problem statement and generate solutions.

G.K12.4.3.2d, Creative Methodology-Accomplish: Design original problem solving models for use in specific situations.

NGSSS Science Benchmarks

SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science.

- *During Activity 1: Let's Get Started*, students will work through a STEM Challenge practice project. As part of this practice, students discuss the importance of narrowing a wide breadth of information into a clearly defined, realistic, and solvable problem.
- Within the STEM Challenge, students will have to research the prompt's topic and define a specific problem to address.

SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in science.

- *In Activity 1: Let's Get Started*, students are asked to describe how they could model a solution to the provided prompt in the STEM Challenge practice. The question provides several examples of how students may develop models that demonstrate their solution in part or in full.

Background Information

STEM Challenge

The STEM Challenge is an inquiry-based and student-centered program designed and developed by the Phillip and Patricia Frost Museum of Science (Frost Science). In this year-long program, students will investigate and design solutions for an identified real-world issue in one of four science disciplines: marine science, health, astronomy, and paleontology. First, students will select a discipline and prompt, then they will research their selected topic. During their investigation, students will identify real world issues associated with the prompt, brainstorm solutions to the issue, design and create a model of their solution, and prepare a presentation to be displayed at Frost Science during the STEM Challenge Expo.

STEM Challenge Prompts

Marine Science: Many agencies use technology to monitor and regulate marine activities. Design a solution that uses emerging technology to monitor or respond to human-led or naturally occurring marine activity.

Astronomy: As we continue to explore our universe, we need technology capable of supporting and entertaining astronauts in space and on other planets. Design a product or solution that uses emerging technology to fill at least one basic need for an astronaut in space.

Paleontology: Many fossils are located in hard-to-reach or remote environments and are only accessible seasonally. Design a solution that uses emerging technologies to find, access, extract, or preserve fossils more efficiently in extreme environments.

Health: Emerging technologies are being used to help recognize patterns in health data and diagnose and treat patients. However, these technologies are difficult to access and can be expensive or prone to errors. Design or improve upon a technology that accurately interprets health related data or makes healthcare more accessible and efficient.

Materials (per student)

- Student Guidebook
- Computer
- Pencil

Set-Up Procedure

1. Make sure that there are computers available for all students. If students do not have personal devices, reserve a computer lab or computer cart. If students have personal devices, remind students one class day prior that they will need their computer on the following class day.
2. Set out Student Guidebooks to be distributed when directed to by the instructions.
3. Optional: Open PowerPoint.

Activity Procedures

INTRODUCTION: This part of the activity will introduce students to the STEM Challenge and will prepare students to complete the STEM Challenge Practice.

TIME REQUIRED: 5 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Introduce the STEM Challenge as a new and exciting challenge that students will be participating in this school year. Then distribute the STEM Challenge Student Guidebook to all students.	1. Students will listen to the introduction.
2. Ask students to print their name on the cover of their guidebook and use the Table of Contents to find the “STEM Challenge Overview.”	2-4. Students will listen, follow instructions, and follow along using their guidebook.
3. Present an overview of the STEM Challenge using the information provided in their guidebook.	
4. Tell students to turn to page 13 and complete the Pre-Participation Survey. This survey can be accessed via URL or QR code. If they cannot scan the QR code to the survey, please ask students to navigate to the survey using the URL. Make sure students have successfully submitted the survey before closing the page. Teachers and mentors must also complete a separate Pre-Participation Survey designed for teachers. Teachers and mentors that did not complete the STEM Challenge Pre-Survey during the STEM Challenge Professional Learning experience should complete the survey at this time. https://forms.office.com/r/8AZEQQbyBu 	

STEM CHALLENGE PRACTICE: In this part of the activity, students will engage with an abbreviated STEM Challenge procedure before reflecting on the process in the next section of the activity. (Note: While the STEM Challenge may be completed in groups, this activity should be completed individually.)

TIME REQUIRED: 5 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask each student to turn to the “STEM Challenge Practice” activity on page 12 and write the prompt, which will be the topic for their STEM Challenge Practice, in the designated space at the top of their page. The prompt for the “STEM Challenge Practice” is, “As technology becomes more advanced, older devices are quickly discarded, creating electronic waste or e-waste. Some discarded devices can contain harmful chemicals that can pollute the environment. What is one issue caused by e-waste, and how can we prevent or reduce the impacts of this issue?” If using the associated PowerPoint presentation, play the included video about E-Waste from the UN Environment Programme. This video can also be found at: https://youtu.be/5k-PR4y_ng0?si=1OqDS0VeinhURxHj 	1. Students will write the “STEM Challenge Practice” prompt in the designated space at the top of the page in their guidebook.
2. Distribute computers to all students in the class, ask students to take out their computers, or allow students to use their phone. Ask students to take 5 minutes to review the E-Waste Fact Sheet in their guidebook, complete any additional research, take notes, and identify at least five potential issues associated with the prompt. Circulate the classroom as students conduct their research, looking for students who are using general search terms. Encourage students with general search terms to be more specific. Note: Students can use AI to help aid them in the initial research process. For example, students may use Gemini Deep Research to learn more about E-Waste. As a reminder, all information provided by AI must be fact-checked prior to use.	2. Students will research the topic, taking notes in their guidebook. Q1: Identify at least five problems or issues that address the prompt. Be specific. A: Student answers may vary. Example issue: A lot of technology has planned obsolescence. In other words, the manufacturers intentionally design the technology to have a limited lifespan and once that lifespan is over, the technology becomes e-waste. This issue is especially prevalent in smartphone manufacturing.

3. Ask students to continue their research and answer questions 2-7 in the “STEM Challenge Practice” section of the activity.

As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses. Use the following questions to help students refine their answers:

- How does this solution address the problem you identified?
- How is this solution practical?
- What does it mean for a solution to be practical?
- How does this solution address the prompt?
- What is a stakeholder?
- Is your model physical or digital?
- What components does your model have?
- Does your model have labels?
- What type of physical display could you use to show the solutions, procedures, or the outcome of your solution?

3. Students will continue to research the topic of their prompt and answer the questions in their guidebooks.

Q2: *Brainstorm at least one solution for each of the problems you identified.*

A: Student answers may vary. Example solution: Modular smartphones could be designed to minimize e-waste and extend the lifespan of smartphones. These modular smartphones could have interchangeable parts that can be upgraded or replaced over time in a similar fashion to a desktop computer in a tower. By upgrading each part of the smartphone separately, people would be able to customize their phone and would not need to purchase a whole-new phone every time smartphone technology advances.

Q3: *What problem/solution is the most practical and best addresses the prompt? Does this solution already exist? If so, how can you improve it to better address this issue?*

A: Student answers may vary. Example: Out of all the identified problems and solutions, the problem and accompanying solution for planned obsolescence in smartphones best addresses the prompt. While modular smartphones already exist, there are very few modular smartphone brands and those that exist are not readily available in the United States. Furthermore, the modular smartphones that already exist are larger and slower than non-modular smartphones. Starting a smaller, new modular smartphone brand in the United States can combat the culture of planned obsolescence and reduce the amount of smartphone e-waste being produced.

Q4: *How can this solution be implemented? Be as detailed as possible.*

A: Student answers may vary. Example: The modular smartphone will need to be designed to have interchangeable parts, with several variations for each component. Each component variation should be of a different material or performance level. For example, each modular phone will have 8 options for users to pick from: housing, motherboard, computer, memory, storage, camera, display, and battery. All modular smartphones will be equipped with the same sensors, charging port, modems, speakers, microphone, and antenna. Once the modular smartphone has been developed, it will have to be strategically marketed as a sustainable, affordable, and customizable, long-lasting smartphone.

	Q5: <i>Who is responsible for implementing solutions for this issue? In other words, who are your stakeholders?</i> A: Student answers may vary. Example: The customers and smartphone users are the stakeholders for modular smartphones. This product would likely need to be funded through Kickstarter or another crowdfunding platform. This solution only works if it can break into the smartphone market as a viable option. Q6: <i>Describe the design of a physical or digital model that represents or demonstrates this solution. Models may include fully functional devices, scaled/miniature replicas of the solution, 3-dimensional models, or sections of code. If you are struggling to design a model, go back and take a closer look at the problem/solution you selected.</i> A: Student answers may vary. Example: A model of this solution may include a 3-dimensional model of the modular smartphone components, showing how each component fits together to create the modular smartphone. Q7: <i>How would this model help explain or demonstrate your solution? What would this model add to a presentation about your solution?</i> A: Student answers may vary. Example: The 3-dimensional components can be moved and manipulated to show potential customers different smartphone configurations and builds. During the presentation, the audience members can each “build” their own smartphone digitally. This will help illustrate how easy it will be for buyers to create their own custom smartphone.
4. Ask students to find a partner and share their developed problem, solution, and model design. Ask students to continue to share with new partners for approximately 5 minutes. (Note: You may ask students to present to a specific number of partners or set the time limit for this section of the activity.) As students share their answers, circulate the classroom to make sure students are sharing their problem, solution, and model design.	4. Students will share the answers they recorded in their guidebooks with a partner. After both students have finished sharing their answers, they will find new partners. Students will continue to repeat this process until they are told to stop.

PRACTICE DEBRIEF: In this part of the activity, students will break down some of the thought processes behind the procedures and considerations recommended in the “STEM Challenge Practice” section of the activity. These procedures and considerations will be used as students complete their STEM Challenge Projects.

TIME REQUIRED: 20 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to turn to the “Practice Debrief” section of the activity in their guidebook. Explain that this section of the activity is designed to help them understand the importance of and reflect on each step they took during the “STEM Challenge Practice” portion of the activity. Ask students to answer the first five questions in the “Practice Debrief” section of the activity. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	1. Students will answer the first five questions in the “Practice Debrief” section of their guidebook. Q1: What was the most challenging part of creating a solution for the provided prompt? Why? A: Student answers may vary. Example: Identifying a specific, solvable issue was the most difficult part of the process. While requiring corporations to manufacture more sustainable technology without planned obsolescence would be more effective, it would receive a lot of push back and would be difficult to enforce. We needed to be able to identify a solution that could realistically be implemented and address the problem. Q2: Why is it important to brainstorm more than one issue and solution associated with the prompt? A: While there are many issues associated with the topic of the prompt, some issues are more difficult to problem solve. The issue being selected for the STEM Challenge needs to be realistically solvable. Q3: What are the advantages of brainstorming more than one solution for each issue? A: The first solution you produce may not always be the most realistic or the best solution to the problem in question. By brainstorming multiple solutions to each problem, you can compare the feasibility of each solution and find the best problem/solution combination. Q4: What is the importance of explaining every detail behind the implementation of your solution? Why is it important to be as specific as possible? A: The more specific you are with the solution, the easier it is to assess if the solution is realistic or implementable. Solutions with a broad scope and no discernable goal are much more difficult to implement as they often have too many moving parts. Q5: Why is it important to consider your stakeholders? A: The stakeholders are invested in your solution. They may either be funding the solutions implementation or implementing the solution themselves. As the project manager, one of your jobs is ensuring stakeholders get a solution that solves their issues.

2. Discuss the answers to the first five questions in the “Practice Debrief” section with students. You may start the discussion by asking for one or two students to share their answers. This discussion should last approximately 4 minutes. To help guide the student discussion about the brainstorming process, use the following guiding questions: • How did you narrow down a broad topic and a wide breadth of information into solvable issues? • What might happen if you only brainstorm the solutions for one issue? • Why is it important to think about the scope/specificity of the issue you selected? • Why is it important to think about the scope/specificity of proposed solutions? Students should leave this discussion with the understanding that they should keep an open mind while brainstorming STEM Challenge project ideas, as it will help them pick a realistic and feasible problem/solution combination.	2. Students will share the answers to the first five questions with the whole class. Students will elaborate on other students’ answers to form a strong understanding about the importance of brainstorming several solutions for a wide variety of issues related to the prompt.
3. Ask students to answer the next two questions, questions 6 and 7, in the “Practice Debrief” section of the activity. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	3. Students will answer the next two questions in the “Practice Debrief” section of the activity. Q6: In this activity, you were asked to describe how you would model your solution to the provided prompt. What difficulties did you encounter in designing this model? A: Student answers may vary. Example: The model was difficult to design because we would have had to make sure each of the modeled components fit together and had accurate sizes. We would also need to make sure that each of the components had substantial attachment points so that the smartphone was sturdy when put together and we had to make sure that our modular smartphone was different from other modular smartphones on the market. Q7: What challenges would you expect to encounter in creating the model you designed? Think of the time, materials, tools, and software required to create your model. A: Student answers may vary. Example: Creating a 3-dimensional model of the modular smartphone components that allows the components to connect and create functional circuits would be difficult. While we have access to free 3-dimensional modeling software, it would take a considerable amount of time to create our models.
4. Discuss the answers to questions 6 and 7 with students. As with the previous discussion, ask for one or two students to share their answers to initiate the discussion. This discussion should last approximately 5 minutes.	4. Students will share their answers to questions 6 and 7 with the whole class. Students will elaborate on other students’ answers to form a strong understanding of model design considerations and challenges.

To help guide the student discussion, use the following guiding questions: • What is a model? • Did you have to go back and change what problem/ solution combination you selected to create a model? Why or why not? • What components did you feel your model had to include? • Why is it important to think of the time needed to create the model? • Why is it important to consider the materials required to create the model? • What would an “unsatisfactory” model look like? • What would an “exemplary” model look like? Students should leave this discussion with the understanding that the STEM Challenge will require students to create a model that adds value to their project and final presentation. Students should also leave this conversation with the understanding that their model must be realistic to create given the time limit and the budget of their project.	
5. Ask students to answer the last two questions in the “Practice Debrief” section of the activity. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	5. Students will answer the last two questions in the “Practice Debrief” section of the activity. Q8: <i>How did the issues and solutions to the prompt vary from person to person?</i> A: Despite everyone being given the same prompt, the issues people identified varied widely. Even among students who tackled the same issue, students produced wildly different solutions. Q9: <i>What are the advantages of having a lot of people brainstorm the same prompt?</i> A: Perspectives, knowledge, and skillsets vary widely from person to person. When more people tackle a single issue, they are more likely to produce innovative and effective solutions to the problem.
6. Discuss the answers to the last two questions with students. As with the previous discussions, ask for one or two students to share their answers to initiate the discussion. This discussion should last approximately 3 minutes. To help guide the student discussion, use the following guiding questions: • How are people different in the ways they solve problems? • How do you approach problems? (Note: Several students should be asked this question.) • How can disagreement be a good thing? • Why might engineers work in groups? Students should leave this discussion with the understanding that having a large, diverse population brainstorm the same problem can lead to new, unexpected solutions.	6. Students will share their answers to the last two questions with the whole class. Students will elaborate on other students’ answers to form a strong understanding of why all individuals participating in the STEM Challenge Project work on the same pre-determined prompts.

7. Ask students to turn to a partner and share at least one thing they learned that surprised them during the “Practice Debrief.” As students share their answers, circulate the classroom to make sure students are staying on topic.	7. Students will share something they learned that surprised them with a partner.
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STEM CHALLENGE PREPARATION: In this part of the activity, students will start the STEM Challenge Project by selecting a STEM Challenge prompt, forming groups, setting an anticipated timeline and designating tasks.	
TIME REQUIRED: 10 minutes	
What the Teacher Does	Anticipated Student Behaviors/Responses
1. Inform students that they will now begin their STEM Challenge! (Note: Make sure students know their responses for this part of the activity are not set in stone and that they will be able to adjust some of their answers during their STEM Challenge.) If students are required to address specific prompts or are required to work in a group or individually, tell them now. To start the STEM Challenge, ask students to answer the first four questions found in the “STEM Challenge Preparation” section of the activity. As students record their answers in their guidebooks, circulate the classroom looking for explanations. Encourage students with short answers to go back and think through each of their responses.	1. Students will answer the first three questions in the “STEM Challenge Preparation” section of the activity. Q1: Review the 2025-2026 STEM Challenge prompts. Which prompt interests you the most? Why? A: Student answers may vary. Example: I am most interested in the health prompt. This is because I used to live in a rural area and have seen firsthand how the lack of access to affordable healthcare can impact rural communities. Q2: You can work individually or in a group for the STEM Challenge. What are the advantages and disadvantages of working in a group? What are the advantages and disadvantages of working alone? A: When working in a group, group members will be able to distribute the workload, with each member playing to their strengths and skillsets. Groups will also have a wider range of perspectives, helping the group work past any creative blocks. However, members may disagree on how to accomplish a task and no single member may have full creative control. When working alone, the individual completing the project will have an increased workload, but they will be in full creative control of the project and will be able to complete the project at their discretion. Q3: What does your workload look like this year? How much time do you have to dedicate to this project? A: Student answers may vary. Example: My workload this year is heavy as I am involved in two extracurriculars. Between sports, rehearsals, and my AP classes, I do not have much free time outside of school to spend on the STEM Challenge.
2. Ask at least two students to share their answers to question 2. If these students did not provide a full answer to question 2, ask students to add onto the student responses until question 2 has been fully answered.	2. Students will share their answers to question 2.

3. Ask students to answer question 4 in their guidebook. As they do so, make sure they understand this is a long-term project. While working with friends can be fun in the short term, students must ensure that the group they choose can work together to accomplish the STEM Challenge. Monitor group formation to make sure students form productive groups. To optionally facilitate group formation, assign one prompt to each corner of the room. Direct students to stand in the corner of the room associated with the prompt they identified in question 1. Students should then form groups with other students that are standing in the same corner as them. If students are required to work in a group or individually, remind them now as this will determine their answers to question 4.	3. When answering question 4, students will get up and move around to find potential group members and form groups. Q4: <i>Identify whether you would like to work individually or in a group. If you want to work in a group, find your group members now. Groups should be no larger than four students.</i> A: Student answers may vary. Example: I would like to work in a group.
4. Ask students to sit with their group if applicable and answer the last two questions in the “STEM Challenge Preparation” section of the activity. If students are required to address specific prompts, remind them now as this will determine their answers to question 5. As students begin to plan their STEM Challenge project in their guidebooks, circulate the classroom looking for detailed project timelines. Encourage students with few procedural tasks to break down their procedural tasks into smaller steps.	4. Students will answer the last two questions in the “STEM Challenge Preparation” section of the activity. Q5: <i>Select one prompt to complete for this year’s STEM Challenge. If working in a group, make sure all group members agree with the prompt selection.</i> A: Student answers may vary. Example: We will be working on the astronomy prompt. Q6: <i>In your guidebook, turn to page 45 to propose a project timeline, record group member names, and optionally delegate tasks amongst group members.</i> A: Action - Students should turn to the planning page to propose their project timeline. Students will finalize their selected prompt in the provided space and will turn to page 45 in their guidebook. Students will use the designated spaces to begin to organize and plan their STEM Challenge.
5. To finish this activity, remind students that the guidebook contains a lot of information to guide them in completing their STEM Challenge. As such, they need to store their guidebook in a safe place. If desired, this can be a designated place in the classroom. Optionally, direct students to begin researching their prompt.	5. Students will finish organizing and planning their STEM Challenge.

Notes/Considerations

Students should be allowed to ask clarifying questions at any time during the lesson.

As any groups formed by students are set for the duration of the STEM Challenge, it is important to ensure that all group members can be productive and work as a team in their designated group. If you identify any groups that may be unproductive or have an elevated risk for conflict, you should adjust student groups.

If you have more than 50 minutes to complete this activity, give students more time during group discussions.

Activity 1: Let's Get Started

STEM Challenge Practice

About Electronic Waste

Electronic waste, or e-waste, refers to any discarded electronic device or equipment.

Electronics can be discarded for a variety of reasons but are usually thrown away because they have been replaced, have become outdated, or have broken.

While the types of items that are classified as e-waste vary, many of these items include computer components.

- The main categories of e-waste, ranked by their global volume from highest to lowest, are as follows:
 1. Small everyday electronics like toaster or electric toothbrushes
 2. Large appliances like electric stoves or washing machines
 3. Cooling and heating units like refrigerators and air conditioners
 4. Display screens like televisions or computer monitors
 5. Lighting devices like LED light bulbs or fluorescent lights
 6. Communication devices like smartphones and laptops
- Other categories of e-waste include medical devices, electric tools, toys, sports equipment, monitoring devices, batteries, cables and wires, and photovoltaic panels (solar panels).

Rapid technological progress and brief product lifespans leads to high volumes of e-waste.

E-waste contains valuable materials like gold and copper, but it also contains hazardous metals and chemicals including lead, mercury, cadmium, chromium, beryllium, and flame retardants.

Harmful Impacts of E-Waste

- E-waste can leach hazardous metals and chemicals into the environment, where they can contaminate soil and groundwater.
- Improper recycling of e-waste through burning and acid baths can release hazardous metals and chemicals into the air where they can negatively impact human health.
- Exposure to hazardous metals and chemicals released by e-waste can cause neurological damage, respiratory problems, and an increased risk of cancer.

Sources:

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World Health Organization (WHO) (2024, October 1). *Electronic waste (e-waste)*. WHO. Retrieved July 11, 2025, from [https://www.who.int/news-room/fact-sheets/detail/electronic-waste-\(e-waste\)](https://www.who.int/news-room/fact-sheets/detail/electronic-waste-(e-waste))



Activity 1

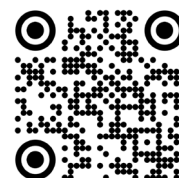
Let's Get Started

STEM Challenge Pre-Participation Survey

Instructions: Complete the STEM Challenge Pre-Participation Survey. To access this survey, use the survey QR code or URL. Make sure you click “Submit” at the bottom of the survey and receive a confirmation message before closing the window.

Pre-Participation Survey:

<https://forms.office.com/r/QAJzC0DvGb>



STEM Challenge Practice

Instructions: Using the prompt provided in Activity 1, independently answer the questions below to identify issues and potential solutions.

Prompt:

“As technology becomes more advanced, older devices are quickly discarded, creating electronic waste or e-waste. Some discarded devices can contain harmful chemicals that can pollute the environment. What is one issue caused by e-waste, and how can we prevent or reduce the impacts of this issue?”

1. Identify at least five problems or issues that address the prompt. Be specific.

Student answers may vary. Example issue: A lot of technology has planned obsolescence. In other words, the manufacturers intentionally design the technology to have a limited lifespan and once that lifespan is over, the technology becomes e-waste. This issue is especially prevalent in smartphone manufacturing.

2. Brainstorm at least one solution for each of the problems you identified.

Modular smartphones could be designed to minimize e-waste and extend the lifespan of smartphones. These modular smartphones could have interchangeable parts that can be upgraded or replaced over time in a similar fashion to a desktop computer in a tower. By upgrading each part of the smartphone separately, people would be able to customize their phone and would not need to purchase a whole-new phone every time smartphone technology advances.



3. What problem/solution is the most practical and best addresses the prompt? Does this solution already exist? If so, how can you improve it to better address this issue?

Student answers may vary. Example: Out of all the identified problems and solutions, the problem and accompanying solution for planned obsolescence in smartphones best addresses the prompt. While modular smartphones already exist, there are very few modular smartphone brands and those that exist are not readily available in the United States. Furthermore, the modular smartphones that already exist are larger and slower than non-modular smartphones. Starting a smaller, new modular smartphone brand in the United States can combat the culture of planned obsolescence and reduce the amount of smartphone e-waste being produced.

4. How can this solution be implemented? Be as detailed as possible.

Student answers may vary. Example: The modular smartphone will need to be designed to have interchangeable parts, with several variations for each component. Each component variation should be of a different material or performance level. For example, each modular phone will have 8 options for users to pick from: Case, motherboard, computer, memory, storage, camera, display, and battery. All modular smartphones will be equipped with the same sensors, charging port, modems, speakers, microphone, and antenna. Once the modular smartphone has been developed, it will have to be strategically marketed as a sustainable, affordable, and customizable, long-lasting smartphone.

5. Who is responsible for implementing solutions for this issue? In other words, who are your stakeholders?

Student answers may vary. Example: The customers and smartphone users are the stakeholders for modular smartphones. This product would likely need to be funded through Kickstarter or another crowdfunding platform. This solution only works if it can break into the smartphone market as a viable option.



6. Describe the design of a physical or digital model that represents or demonstrates this solution. Models may include fully functional devices, scaled/miniature replicas of the solution, 3-dimensional models, or sections of code. If you are struggling to design a model, go back and take a closer look at the problem/solution you selected.

Student answers may vary. Example: A model of this solution may include a 3-dimensional model of the modular smartphone components, showing how each component fits together to create the modular smartphone.

7. How would this model help explain or demonstrate your solution? What would this model add to a presentation about your solution?

Student answers may vary. Example: The 3-dimensional components can be moved and manipulated to show potential customers different smartphone configurations and builds. During the presentation, the audience members can each "build" their own smartphone digitally. This will help illustrate how easy it will be for buyers to create their own custom smartphone.



Practice Debrief

Instructions: Independently answer the questions below to reflect on the STEM Challenge Practice provided in Activity 1.

1. What was the most challenging part of creating a solution for the provided prompt? Why?

Student answers may vary. Example: Identifying a specific, solvable issue was the most difficult part of the process. While requiring corporations to manufacture more sustainable technology without planned obsolescence would be more effective, it would receive a lot of push back and would be difficult to enforce. We needed to be able to identify a solution that could realistically be implemented and address the problem.

2. Why is it important to brainstorm more than one issue and solution associated with the prompt?

While there are many issues associated with the topic of the prompt, some issues are more difficult to problem solve. The issue being selected for the STEM Challenge needs to be realistically solvable.

3. What are the advantages of brainstorming more than one solution for each issue?

The first solution you produce may not always be the most realistic or the best solution to the problem in question. By brainstorming multiple solutions to each problem, you can compare the feasibility of each solution and find the best problem/solution combination.



4. What is the importance of explaining every detail behind the implementation of your solution? Why is it important to be as specific as possible?

The more specific you are with the solution, the easier it is to assess if the solution is realistic or implementable. Solutions with a broad scope and no discernable goal are much more difficult to implement as they often have too many moving parts.

5. Why is it important to consider your stakeholders?

The stakeholders are invested in your solution. They may either be funding the solutions implementation or implementing the solution themselves. As the project manager, one of your jobs is ensuring stakeholders get a solution that solves their issues.





6. In this activity, you were asked to describe how you would model your solution to the provided prompt. What difficulties did you encounter in designing this model?

Student answers may vary. Example: The model was difficult to design because we would have had to make sure each of the modeled components fit together and had accurate sizes. We would also need to make sure that each of the components had substantial attachment points so that the smartphone was sturdy when put together and we had to make sure that our modular smartphone was different from other modular smartphones on the market.

7. What challenges would you expect to encounter in creating the model you designed? Think of the time, materials, tools, and software required to create your model.

Student answers may vary. Example: Creating a 3-dimensional model of the modular smartphone components that allows the components to connect and create functional circuits would be difficult. While we have access to free 3-dimensional modeling software, it would take a considerable amount of time to create our models.





8. How did the issues and solutions to the prompt vary from person to person?

Despite everyone being given the same prompt, the issues people identified varied widely. Even among students who tackled the same issue, students produced wildly different solutions.

9. What are the advantages of having a lot of people brainstorm the same prompt?

Perspectives, knowledge, and skillsets vary widely from person to person. When more people tackle a single issue, they are more likely to produce innovative and effective solutions to the problem.





STEM Challenge Preparation

Instructions: Independently answer the questions and follow the directions below to prepare for the STEM Challenge.

1. Review the 2025-2026 STEM Challenge prompts. Which prompt interests you the most? Why?

Student answers may vary. Example: I am most interested in the health prompt. This is because I used to live in a rural area and have seen firsthand how the lack of access to affordable healthcare can impact rural communities.

2. You can work individually or in a group for the STEM Challenge. What are the advantages and disadvantages of working in a group? What are the advantages and disadvantages of working alone?

When working in a group, group members will be able to distribute the workload, with each member playing to their strengths and skillsets. Groups will also have a wider range of perspectives, helping the group work past any creative blocks. However, members may disagree on how to accomplish a task and no single member may have full creative control. When working alone, the individual completing the project will have an increased workload, but they will be in full creative control of the project and will be able to complete the project at their discretion.



3. What does your workload look like this year? How much time do you have to dedicate to this project?

Student answers may vary. Example: My workload this year is heavy as I am involved in two extracurriculars. Between sports, rehearsals, and my AP classes, I do not have much free time outside of school to spend on the STEM Challenge.



4. Identify whether you would like to work individually or in a group. If you want to work in a group, find your group members now. Groups should be no larger than 4 students.

Student answers may vary. Example: I would like to work in a group.



5. Select one prompt to complete for this year's STEM Challenge. If working in a group, make sure all group members agree with the prompt selection.

Student answers may vary. Example: We will be working on the astronomy prompt.

6. In your guidebook, turn to page 45 to propose a project timeline, record group member names, and optionally delegate tasks amongst group members.

Action - Students should turn to the planning page to propose their project timeline



STEM Challenge Planning

Instructions: Use this activity sheet to plan your STEM Challenge project.

Name(s):

Selected Prompt:

1. Are you working in a group or individually? If you are working in a group, who are your group members?

2. Begin planning your STEM Challenge by listing each procedural task you would like to complete. For example, you may include “Finish Solution Draft 1” or “Finalize model.” If you are working in a group, your group can optionally assign tasks to group members.

3. Use the planner to record due dates for the STEM Challenge. Each page directly corresponds to one Quarter of the M-DCPS 2025-2026 school year, excluding December 23 – January 3. Along with any due dates for the STEM Challenge, try to schedule each procedural task you listed in response to question 2.

STEM Challenge Planner

AUGUST

SEPTEMBER

OCTOBER

MON	TUE	WED	THU	FRI
11	12	13	14	15
18	19	20	21	22
25	26	27	28	29
SEPT. 1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
29	30	OCT. 1	2	3
6	7	8	9	10
13	14	15	16	17
Legal holiday		M-DCPS Teacher planning day, professional learning day or recess day.		



OCTOBER

NOVEMBER

DECEMBER

JANUARY

MON	TUE	WED	THU	FRI
20	21	22	23	24
27	28	29	30	31
NOV. 3	4	5	6	7
10	11	12	13	14
17	18	19	20	21
24	25	26	27	28
DEC. 1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
JAN. 5, 2025	6	7	8	9
12	13	14	15	16
Legal holiday		M-DCPS Teacher planning day, professional learning day or recess day.		



JANUARY

FEBRUARY

MARCH

MON	TUE	WED	THU	FRI
19	20	21	22	23
26	27	28	29	30
FEB. 2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27
MAR. 2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27
30	31	April 1	2	3
Legal holiday		M-DCPS Teacher planning day, professional learning day or recess day.		



APRIL

MON	TUE	WED	THU	FRI
6	7	8	9	10
13	14	15	16	17
SATURDAY, APRIL 18				
STEM CHALLENGE				
EXPO AT FROST SCIENCE				
20	21	22	23	24
Legal holiday		M-DCPS Teacher planning day, professional learning day or recess day.		

Sound Sources: Activity 2

Overview

In this activity, students will learn about primary, secondary, and tertiary sources and how bias can influence a source's reliability. After completing this activity, students will be able to identify reliable sources for their STEM Challenge, read scientific articles, and cite their sources in APA format.

Objectives

By the end of this activity, students will be able to:

- Describe the relationship between unreliability and bias.
- Define and identify primary, secondary, and tertiary sources.
- Describe the purpose of a scientific abstract.
- Read and interpret scientific articles at a basic level.
- Identify reliable sources of information.
- Use APA formatting.

Key Messages

- Unbiased primary or secondary sources are reliable resources.
- Reading the abstract, introduction, and conclusion sections of a scientific article can help a student gain a basic understanding of the research study and its outcomes.

Time Needed: 40 minutes

Standards

NGSSS Gifted Learners Benchmarks

G.K12.4.2.3a, Critical Thinking-Know: Distinguish between fact and opinion in a variety of sources.

NGSSS Science Benchmarks

SC.912.N.1.4: Identify sources of information and assess their reliability according to the strict standards of scientific investigation.

- *Activity 2: Sound Sources* helps students identify reliable sources as unbiased primary or secondary sources. It also teaches students how to read scientific articles.
- Within the STEM Challenge, students will have to research the prompt's topic and define a specific problem to address.

SC.912.N.1.5 Describe and provide examples of how similar investigations conducted in many parts of the world result in the same outcome.

- While *Activity 2: Sound Sources* does not address this standard in depth, it discusses how reliable scientific investigations are replicable.

Background Information

Primary, Secondary, and Tertiary Sources

Sources can be categorized into three different types: Primary, secondary, and tertiary sources. Primary sources are original documents that contain source material. This source material may be raw data, documentation of an event, images, or other records.

A primary source provides original source material in full. For example, if a source contains the text of a speech given by a politician, it provides the entire text as opposed to picking and choosing sections of the speech to quote.

Secondary sources do not contain the entire original source material but may contain selected portions of it. The focus of these secondary sources is to interpret, describe, or analyze the original source materials. For example, a news source may use quotes from a politician's speech to help describe and summarize the key themes of the speech and analyze the politician's motives.

Finally, tertiary sources reference both primary and secondary sources to summarize or consolidate information. For example, a source may reference news articles and a politician's speech to summarize an event, but it does not provide any original interpretations or analysis.

Scientific Articles

Scientific articles are a primary source produced by scientists. These articles are often organized into six sections. The first section, the abstract, succinctly summarizes the paper's introduction, methods and data, results, and the implications of the results. After the abstract, the scientific article is usually sectioned into an introduction, methods, results, discussion, and conclusion.

The introduction contains the information necessary to understand the research study and often identifies the study's hypothesis. The methods section describes the materials and techniques used to perform the study. These are described in enough detail that other researchers could replicate the study using the information provided. After the methods, the results present the outcomes produced from statistical analyses of the raw data. The discussion and conclusion sections interpret significant trends or results, explore what they mean in relation to the study and its hypothesis, and place the findings in context of the existing body of scientific literature.

When reading a scientific paper for the first time, it is often most productive for an individual to read the abstract and skim the introduction and conclusion to determine if the scientific paper is relevant to their interests. If the scientific paper is relevant, individuals will typically go back and take their time reading the article in its entirety.

APA Formatting

American Psychological Association (APA) formatting is commonly used to cite scientific reviews and articles. Students completing the STEM Challenge must use APA formatting when citing sources, and in-text citations must be included within each STEM Challenge display. In-text citations identify information obtained from another source, helping students avoid plagiarism. Information obtained from other sources should be paraphrased and should not appear in quotes. Each in-text citation must have a corresponding citation in the references section on a student's STEM Challenge display.

While there are a variety of websites that can automatically produce citations for students, they do not produce in-text citations. In-text citations should be written as follows:

In-Text Citations	
No author	(Title of Source, Year)
One author	(Last name of Author, Year)
Two authors	(Last name of Author 1 & Last name of Author 2, Year)
More than one author	(Last name Author 1 et al., Year)
If citing multiple works	(In-text citation 1; In-text citation 2)

If students must use a direct quote, the page number of the quotation should be included at the end of the in-text citation in the following format: p. #

Most of the cited works used in the STEM Challenge will be websites. These websites can be cited as follows:

Lastname, F. M. (Year, Month Date). *Title of page*. Site name. URL

While many scientific articles may be found online, they use a different APA citation format than websites.

Scientific articles can be cited as follows:

Lastname, F.M. (Year). Title of article. *Journal name*, volume number (issue number), pages. URL

For scientific articles, Google Scholar or the scientific journal may already provide a citation in APA format.

If one of the components, such as the author's middle name or the date published, are missing from the source material, they may be omitted from the in-text citations and the citation listed in the references section. Every in-text citation should have a corresponding citation listed in the references section. Citations listed in the references section should be listed in alphabetical order.

Non-website or scientific article sources use different APA citations formats. For referencing other sources, such as books or videos, reference apastyle.apa.org or use an online citation generator. If using an online citation generator, always check that the format is set correctly and double check the citation for any potential errors.

Materials (per student)

- Student Guidebook
- Computer
- Pencil

Set-Up Procedure

1. Make sure that there are computers available for all students. If students do not have personal devices, reserve a computer lab or computer cart. If students have personal devices, remind students one class day prior that they will need their computer on the following class day.
2. Ensure that students have access to their Student Guidebooks and their in-progress STEM Challenge projects.
3. Optional: Open PowerPoint.

Activity Procedures

INTRODUCTION: <i>This part of the activity will prepare students to reflect on their STEM Challenge sources.</i>	
TIME REQUIRED: 8 minutes	
What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to open their guidebooks to the “Sound Sources” student worksheet on page 23 . If students have access to computers, ask students to take out their computers and log in.	1. Students will open their guidebooks to the appropriate page and will turn on their computers.
2. Once students have their guidebooks open to the correct page, tell students that anyone working in a group for the STEM Challenge should move to sit with the rest of their group members.	2. Students working in a group for the STEM Challenge will stand up and move to sit with the rest of their group members. Students may rearrange classroom furniture so they can face and talk to all their group members.
3. If using the recommended pacing guides, students should have begun to research the topic of their selected prompt. Tell students to take out the list of sources they are using for the STEM Challenge. This list may be handwritten or on their computers. Ask students to show how they feel about their sources by giving either a thumbs up or thumbs down. Scan the room to gain a basic understanding of how students feel about their sources for the STEM Challenge. This should be a vague question about how students feel in general. Students may respond based on their number of sources, source quality, etc. If students have not begun to research their prompt, skip to step 5.	3. Students will retrieve the sources they are using for the STEM Challenge. When asked how they feel about their sources, students should give a thumbs up or a thumbs down.
4. Ask several students, from separate groups, to share the reason behind their response. If a student mentions having difficulty finding strong/good/reliable sources, highlight their answer and move ahead to the next step in the activity. If no students mention having difficulty finding strong/good/reliable sources, ask students one of the following guiding questions: • Are there any other reasons why someone may feel bad about their sources? • Is there any possibility you could be using a source that provides inaccurate information?	4. Selected students will share why they gave a thumbs up or thumbs down. If guiding questions are used, selected students will provide answers.
5. Ask students the following question: What make a source “bad” or “good?” Tell students to take two minutes to list out the traits of “bad” and “good” sources individually on a piece of scrap paper. As students list the traits of “bad” and “good” sources, circulate the classroom and take note of the most common student responses.	5. Students will independently create two lists. One list will contain the traits of “bad” sources and one list will contain the traits of a “good” sources.
6. Select students to share the traits they identified for “bad” sources. As each student shares the traits of a “bad” source, write each trait in an easily visible location. Repeat this process for “good” sources.	6. Selected students will share the traits of “bad” and “good” sources.

7. Ask each student to list 3 examples of what they believe are reliable sources and 3 examples of what they believe are unreliable sources on their worksheet. If students have access to computers, ask students to find specific web-based sources. This should be completed individually and silently. Tell students to justify each of their answers and to not to share their answers with anyone. Do not define reliable or unreliable for students.	7. Students will identify what they believe to be several reliable and unreliable sources and will justify each of their answers on their worksheet.
8. Tell students that at the end of the activity, they will be using their newly formed knowledge of how to identify a reliable resource to re-evaluate their answers.	8. Students will keep their answers private.

BODY OF THE ACTIVITY: *In this part of the activity, students will learn how to identify reliable articles. This includes students learning the importance of utilizing unbiased primary and secondary sources for their STEM Challenge.*

TIME REQUIRED: 25 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Introduce students to the idea of reliable and unreliable information by telling students that open collaborative sources, like Wikipedia, or AI generated responses are often fine for everyday information, but are not considered reliable sources for academic purposes. Ask students to look at both sources on their worksheets and answer the first three reliability questions. If students are in a group for the STEM Challenge, they may discuss their answers with the rest of their group. The ability to openly discuss questions with their group members applies to the remainder of this activity. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses. Share with students that they can use the URLs or the QR codes found on page 23 or can use the resource links on the STEM Challenge web page.	1. If applicable, students will discuss the questions within their STEM Challenge group. Students will look at both sources on their worksheets and answer the first three questions in the activity. <i>Look at the following sources:</i> <i>Unreliable source:</i> https://en.wikipedia.org/wiki/Dolphin <i>Reliable source:</i> https://www.fisheries.noaa.gov/dolphins-porpoises Q1: <i>How can you tell which source is reliable and which source is unreliable? What sets the reliable source apart from the unreliable source?</i> A: The reliable source is published by a well-known organization, the National Oceanic and Atmospheric Administration (NOAA), which is part of the US government and employs scientific experts. Wikipedia is maintained by volunteers who may or may not be experts in the designated field. The content on Wikipedia is also not fact-checked and could contain misinformation. While both sources cite scientific articles, we know all of NOAA's sources are cited. We do not know if Wikipedia has cited all their sources. Q2: <i>What does it mean if something is reliable?</i> A: It is trustworthy. You can take what it says at face value without having to worry about any intentional or accidental misinformation. Q3: <i>What is the importance of using reliable sources in your STEM Challenge?</i> A: We want our solution to be realistic and based on accurate information so that it can potentially solve our identified issue. A solution built on misinformation may not be realistic or applicable.

2. Ask for students to raise their hands to share their answers. Call on as many students as necessary until students have full and complete answers. Encourage students to add onto their answers while students share. With good notes, this activity can become a reference to guide students in determining the reliability of a source.	2. Selected students will share their answers to the questions.
3. Ask students to answer question 4 on their worksheet. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	3. If applicable, students will discuss the question within their STEM Challenge group. Students will answer question 4. Q4: <i>Reliable sources should remain unbiased. Imagine that you are researching the relationship between screen-time and mental health and find two articles of interest. One article is written by a psychologist and published in a medical journal, whereas the second article is written by a video game company and published on the company website. What does it mean if a source is biased? Which article might be biased? How can you tell?</i> A: If a source is biased, it was written or designed using the authors' preconceived notions. This would give readers a distorted or altered view of the subject in question. In this example, the article written by the videogame company might be biased. The videogame company may have downplayed or disregarded any potential negative mental health impacts as these may negatively affect their profits.
4. Ask one student to share their answer. Once that student has shared, ask students to share anything else they know about bias to add onto the answer and start a discussion. This discussion should last approximately 5 minutes. To help facilitate this discussion, you may ask the following guiding questions: • What is the relationship between reliability and bias? • Is bias always intentional? • Why might someone not recognize their own bias? • Why might someone intentionally produce biased articles? • Why is bias dangerous? Students should leave this discussion with the ability to define bias and an understanding of how biased articles do not give accurate perspectives as they selectively choose the information they share, painting an unclear or distorted picture of the given topic.	4. One student will share their answer before other students build upon their answer. Students will answer any guiding questions.

5. Ask students to answer the next two questions about primary, secondary, and tertiary sources on their worksheet. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses. Share with students that they can use the URLs or the QR codes found on page 23 or can use the resource links on the STEM Challenge web page.	5. If applicable, students will discuss the questions within their STEM Challenge group. Students will answer questions 5 and 6 on their worksheet. <i>Look at the following sources:</i> <i>Primary Source: https://journals.biologists.com/jeb/article/226/22/jeb245845/334721/Passive-electroreception-in-bottlenose-dolphins</i> <i>Secondary Source: https://www.sciencenews.org/article/bottlenosed-dolphins-sense-electric-fields-hunt-prey</i> <i>Tertiary Source: https://seaworld.org/animals/all-about/bottlenose-dolphin/senses/</i> Q5: <i>Look at each of the provided sources and take note of any differences. Why might we designate sources as primary, secondary, or tertiary sources? What do you think these designations might mean?</i> A: Primary sources contain the first account of information. Secondary sources directly reference or interpret that information. Tertiary sources reference secondary sources. These designations indicate how close information is to the original source. Q6: <i>We often consider primary and secondary sources to be reliable sources. Why might we not consider tertiary sources reliable?</i> A: The information has been passed from source to source, so there is a higher chance of the information being misunderstood and altered as it is passed along.
6. Call on students to share their answers to questions 5 and 6. If students are struggling to answer question 5, use the following guiding questions: - Do you think the primary, secondary, or tertiary source would be the original source of information? - If the primary sources are the original source of information, what might it mean if something is a secondary source? - Using the same thought process, what might it mean if something is tertiary source?	6. Selected students will share their answers. Students will add onto or change their answers as they listen to student responses.
7. Ask students to answer questions 7-12 on their worksheet. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	7. If applicable, students will discuss the questions within their STEM Challenge group. Students will answer questions 7-12 on their worksheet. Q7: <i>What type of source are scientific articles? Why?</i> A: Scientific articles are primary sources because they contain raw data, an original source of unaltered information that is presented in full.

	Q8: What are the advantages of using scientific articles in your project? A: If using scientific articles, your project can be traced back to concrete data. While some articles may be secondary sources and cite the sources that provide data for their claims, many articles are tertiary sources. Q9: What must a scientific experiment do to be considered reliable and scientifically accurate? A: The scientific experiment must have control variables (except for observational studies), a sufficient sample size, must be replicable, and provide evidence. Q10: Can scientific articles be biased? If so, what might a biased scientific article look like? A: The researchers could have designed the study to make sure their hypothesis was accepted. The research study could also be funded by a company intending to have it advertise their product. Q11: How could a reliable, unbiased scientific article provide misinformation? A: The research study could come to a wrong conclusion. While the researchers were honest in their data collection and conclusions, there could be outside variables that created error in the study, or the scientists could have misinterpreted their data. Q12: What can you do to make sure that your sources, including any scientific articles, are providing accurate information? A: You can check them against other primary sources to make sure that they are not providing conflicting information.
8. Review the answers with students.	8. Students will add onto or change their answers.
9. Project your screen to guide students through the process of searching for reliable sources using Google Scholar. If students have access to their computers, ask students to follow along. Pick a search term for students to use while practicing. This term should be specific as students will be using this tutorial as a reference for how to look for scientific articles. For example, you could ask students to search for “coastal birds in southeast Florida.”	9. Students will listen and watch the projected image. If students have computers, they will follow along, searching for the designated term in Google Scholar.
10. Ask students why it is important to use a specific search query instead of something vague like “birds” or “birds on the beach?”	10. Students should be able to identify that using a specific search query will give them results that are closer to what they are looking for.
11. Continuing to use Google Scholar, direct students to use the available PDFs, which are shown on the right side of each search result. Using the PDFs allows students to bypass any potential paywalls. While research articles can sometimes be accessed through the website link, they are frequently either partially or fully locked behind a paywall.	11. Students will continue to follow along, exploring the available results for the given search query.

12. Ask students to answer the remaining questions on their worksheet in the Searching for Scientific Articles section of the activity.

As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.

12. If applicable, students will discuss the questions within their STEM Challenge group. Students will answer questions 13-16 on their worksheet.

Q13: *What kind of search query might you use to find scientific articles for your project?*

A: Student answers may vary. Example: Smartphone consumption and planned obsolescence.

Q14: *Using your search query, look at the titles of each study to find one you think would provide helpful information. Looking at this article, what is the purpose of the abstract?*

A: The abstract summarizes the entire article. This lets you know what the paper is about and can let you know if the research paper contains the type of information you need.

Q15: *After reading the abstract, there are two other sections of the research paper that are important to read. What sections do you think you may need to read to understand the study? Explain your answer.*

A: The introduction can tell you more about the topic of the paper and the conclusion/discussion can tell you in more detail the conclusions summarized in the abstract. We will not need to replicate the experiment and do not need to use the raw data, so the middle sections of the article are not as important for our project.

Q16: *In what situation would you sit down to read the remaining sections of the research paper?*

A: You would read the remaining sections of the paper if it looked like some of the methods used to conduct the experiment could be helpful in developing your solution for the STEM Challenge.

13. Select students to share their answers to questions 13-16. If students are struggling to answer questions 14 and 15, ask students the following guiding questions:

- What part of the article is going to give you the basic information needed to understand the article?
- What part of the article explores what the researchers learned from their experiment?

If asked the second guiding question, students may respond saying that the results section talks about what the researchers learned. Tell these students to go read the results section by itself and then ask them if it identified what the researchers learned.

13. Selected students will share their answers. Students will add to or change their answers as they listen to student responses.

CONCLUSION: *In this part of the activity, students will re-evaluate the reliability of the sources they are using for the STEM Challenge and learn the basics of APA formatting.*

TIME REQUIRED: 7 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to return to the list of 3 reliable and 3 unreliable sources they created at the beginning of the activity. Ask students to analyze their list and make corrections as needed.	1. Students will make any necessary changes to their lists of reliable and unreliable sources.
2. Ask students to turn and share two of their reliable sources and one of their unreliable sources with a partner. To share their resources, students should open each resource on their computer to show their partner. Like the game “two truths and a lie,” the partner will have to guess which source is the unreliable source. This could be a biased source or a tertiary source. As students share their answers, circulate the classroom to gauge how well students can identify unreliable sources.	2. Students will find a partner and share their two reliable and one unreliable source. Their partner will guess which source was unreliable and they will reveal their answer. The students will then switch roles.
3. Ask students to go through the sources they are using for the STEM Challenge and remove or replace any unreliable sources. If students have not started forming a list of sources for the STEM Challenge, ask students to begin searching for reliable sources. Encourage students to not immediately disregard tertiary sources of information as they may cite useful primary or secondary sources. As students begin to sort through their sources, encourage students to ask questions about any source they are not sure is reliable. Help answer student questions about their STEM Challenge sources.	3. Individually or in groups, students should begin looking for reliable sources for their STEM Challenge or should sort through the sources they are using for the STEM Challenge, removing or replacing any unreliable sources.
4. Direct students to review the information on page 53 in their guidebook about how to appropriately cite sources in APA format. Ask students to use this information to cite the reliable sources they are using for their project.	4. Students will read the section on APA formatting and cite their sources using APA formatting.
5. If there is any additional time, direct students to continue looking for new sources for their STEM Challenge projects.	5. Students will continue searching for reliable sources for their STEM Challenge projects.

Notes/Considerations

Students should be allowed to ask clarifying questions at any time during the lesson.

This optional activity can be taught in part or in full to adjust for different class lengths. If the activity is too long for a designated class period, class discussions can be omitted, or the activity can be taught in several sections over the course of a few class periods. If discussions are omitted, the answers to each question should be reviewed for students.

If you have more than 40 minutes to complete this activity, give students more time during group discussions.



Activity 2: Sound Sources

Instructions: Answer the questions below to learn how to identify reliable sources.

Reliable Source (Examples):	Unreliable Source (Examples):
1. Justification: 	1. Justification:
2. Justification: 	2. Justification:
3. Justification: 	3. Justification:

Reliable vs. Unreliable Sources

Refer to the STEM Challenge resource page and click the items named “Unreliable Source” and “Reliable Source.” Alternatively, use the URLs or QR codes found below.

Unreliable Source:

<https://en.wikipedia.org/wiki/Dolphin>



Reliable Source:

<https://www.fisheries.noaa.gov/dolphins-porpoises>





1. How can you tell which source is reliable and which source is unreliable? What sets the reliable source apart from the unreliable source?

The reliable source is published by a well-known organization, the National Oceanic and Atmospheric Administration (NOAA), which is part of the US government and employs scientific experts. Wikipedia is maintained by volunteers who may or may not be experts in the designated field. The content on Wikipedia is also not fact-checked and could contain misinformation. While both sources cite scientific articles, we know all of NOAA's sources are cited. We do not know if Wikipedia has cited all their sources.

2. What does it mean if something is reliable?

It is trustworthy. You can take what it says at face value without having to worry about any intentional or accidental misinformation.

3. What is the importance of using reliable sources in your STEM Challenge?

We want our solution to be realistic and based on accurate information so that it can potentially solve our identified issue. A solution built on misinformation may not be realistic or applicable.





4. Reliable sources should remain unbiased. Imagine that you are researching the relationship between screen-time and mental health and find two articles of interest. One article is written by a psychologist and published in a medical journal, whereas the second article is written by a video game company and published on the company website. What does it mean if a source is biased? Which article might be biased? How can you tell?

If a source is biased, it was written or designed using the authors' preconceived notions. This would give readers a distorted or altered view of the subject in question. In this example, the article written by the videogame company might be biased. The videogame company may have downplayed or disregarded any potential negative mental health impacts as these may negatively affect their profits.



Primary, Secondary and Tertiary Sources

Refer to the STEM Challenge resource page and click the items named, "Primary Source," "Secondary Source," and "Tertiary Source." Alternatively, use the URLs or QR codes found below.

Primary Source:

<https://journals.biologists.com/jeb/article/226/22/jeb245845/334721/Passive-electroreception-in-bottlenose-dolphins>



Secondary Source:

<https://www.sciencenews.org/article/bottlenosed-dolphins-sense-electric-fields-hunt-prey>



Tertiary Source:

<https://seaworld.org/animals/all-about/bottlenose-dolphin/senses/>





5. Look at each of the provided sources and take note of any differences. Why might we designate sources as primary, secondary or tertiary sources? What do you think these designations might mean?

Primary sources contain the first account of information. Secondary sources directly reference or interpret that information. Tertiary sources reference secondary sources. These designations indicate how close information is to the original source.

6. We often consider primary and secondary sources to be reliable sources. Why might we not consider tertiary sources reliable?

The information has been passed from source to source, so there is a higher chance of the information being misunderstood and altered as it is passed along.





Understanding Scientific Articles

7. What type of source are scientific articles? Why?

Scientific articles are primary sources because they contain raw data, an original source of unaltered information that is presented in full.

8. What are the advantages of using scientific articles in your project?

If using scientific articles, your project can be traced back to concrete data. While some articles may be secondary sources and cite the sources that provide data for their claims, many articles are tertiary sources.

9. What must a scientific experiment do to be considered reliable and scientifically accurate?

The scientific experiment must have control variables (except for observational studies), a sufficient sample size, must be replicable, and provide evidence.



10. Can scientific articles be biased? If so, what might a biased scientific article look like?

The researchers could have designed the study to make sure their hypothesis was accepted. The research study could also be funded by a company intending to have it advertise their product.

11. How could a reliable, unbiased scientific article provide misinformation?

The research study could come to a wrong conclusion. While the researchers were honest in their data collection and conclusions, there could be outside variables that created error in the study, or the scientists could have misinterpreted their data.

12. What can you do to make sure that your sources, including any scientific articles, are providing accurate information?

You can check them against other primary sources to make sure that they are not providing conflicting information.





Searching for Scientific Articles

13. What kind of search query might you use to find scientific articles for your project?

Student answers may vary. Example: Smartphone consumption and planned obsolescence.

14. Using your search query, look at the titles of each study to find one you think would provide helpful information. Looking at this article, what is the purpose of the abstract?

The abstract summarizes the entire article. This lets you know what the paper is about and can let you know if the research paper contains the type of information you need.

15. After reading the abstract, there are two other sections of the research paper that are important to read. What sections do you think you may need to read to understand the study? Explain your answer.

The introduction can tell you more about the topic of the paper and the conclusion/discussion can tell you in more detail the conclusions summarized in the abstract. We will not need to replicate the experiment and do not need to use the raw data, so the middle sections of the article are not as important for our project.



16. In what situation would you sit down to read the remaining sections of the research paper?

You would read the remaining sections of the paper if it looked like some of the methods used to conduct the experiment could be helpful in developing your solution for the STEM Challenge.



Iterative Ideas: Activity 3

Overview

Students will individually brainstorm the steps of the engineering design process before collaborating and exchanging ideas to create an engineering design workflow. Then, students will analyze how the engineering design process can be used in their STEM Challenge projects to iterate upon their solutions.

Objectives

By the end of this activity, students will be able to:

- Define the steps of the engineering design process.
- Recognize how creativity is used to construct scientific questions, methods and explanations by understanding how the engineering design process encourages iterating upon an idea or solution.
- Describe how collaboration can be used to help identify areas for improvement.
- Determine when to focus on continuing to develop a solution in the STEM Challenge instead of iterating upon it.

Key Messages

- The engineering design process generally consists of the following steps: Identify a real world problem → Plan a solution → Prototype your solution → Test your solution → Redesign your solution → Communicate your solution.
- The engineering design process is cyclical and can continue indefinitely until a high quality solution is achieved.
- Using the engineering design process results in multiple iterations of the same idea or solution.

Time Needed: 50+ minutes

Standards

NGSSS Gifted Learners Benchmarks

G.K12.7.2.3a, Praxis-Know: Generate multiple solutions to a given problem.

NGSSS Science Benchmarks

SC.912.N.1.7: Recognize the role of creativity in constructing scientific questions, methods and explanations.

- During *Activity 3: Iterative Ideas*, students are asked to reflect on a time of their life when they used their creativity to come up with a new, innovative idea or solution.
- Within the STEM Challenge, students have creative freedom to address a problem or issue related to their prompt of choice.

Background Information

Engineering Design

Engineers use the engineering design process to develop innovative solutions, procedures, and products. The exact steps to the process can vary slightly depending on who is applying it, but it always follows the same general pattern. The process starts by defining or identifying problems, then moves through a cycle of creating or designing solutions, modeling or testing solutions, and evaluating the solution to improve on it. This process almost always results in multiple iterations of the same solution, with each iteration producing a better solution to the original problem. In other words, the engineering design process encourages constant improvement upon solutions or ideas.

The engineering design process acknowledges that failure is part of the process. Many great ideas or solutions started with an idea or solution that failed. Failed ideas or solutions expose weaknesses in the ideas and therefore highlight opportunities for improvement. Failure does not always mean that the idea or solution was “bad”; instead, failure is considered an important step toward success.

Materials (per student)

- Student Guidebook
- Sticky Notes
- Pencil

Set-Up Procedure

1. Make sure that students have access to their Student Guidebooks and their in-progress STEM Challenge projects.
2. Make sure there is a large available space on an empty wall or whiteboard for the introduction to this activity. This will allow students to organize and display their engineering design process using sticky notes.
3. Optional: Open PowerPoint.

Activity Procedures

INTRODUCTION: This part of the activity will reveal any preconceived notions or assumptions students have about the engineering design process.	
TIME REQUIRED: 20 minutes	
What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to open their guidebooks to the “Iterative Ideas” student worksheet on page 31 .	1. Students will open their guidebook to the “Iterative Ideas” student worksheet.
2. Ask students to answer the first three questions on the student worksheet about innovation. If completing the “Iterative Ideas” activity after the “Sound Sources” activity, question 3 is designed to bridge both topics. This can be addressed in the next step of the activity. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	2. Students will answer the first three questions on their worksheet. Q1: Innovation is the process of creating something new and unexpected. Why is it important to be innovative in the STEM Challenge? A: The STEM Challenge is all about coming up with new ideas and solutions to large-scale scientific problems. Innovative solutions set a project apart. Not only that, but they are much-needed to solve big scientific challenges that current ways of thinking or technical approaches have not been able to solve! Q2: Think back to a time in your life when you had creative freedom and came up with a new innovative idea. Describe this experience. A: Student answers may vary. Example: Last year I was given the creative freedom to design my room at home. My parents said that I could do anything I wanted to my room but could not make any large structural changes. For example, I was able to paint my walls, but I was not allowed to rip up and install new flooring. While I did not rip up the floor, I did find a way to install new flooring by placing underlayment down over the existing floor and installing removable flooring on top.

	While I am not the first person to do this, I did come up with the idea of installing removable flooring over the existing floor on my own. Q3: <i>How do you use sources to figure out if your solution is new and innovative?</i> A: If you can find sources that are already talking about implementing or using your exact solution, it is not new and innovative. If you cannot find any sources talking about your exact solution, it may be a great innovative idea!
3. Call on several students to share their answers to question 1. After students have answered question 1, ask for several students to share their answers to question 2 to start a discussion about innovation. In describing their experiences, students may describe their feelings during the innovation process, why the situation necessitated innovation, or the steps they took in their innovation process. This discussion should last approximately 5 minutes. If students are not describing their feelings, situations, and steps, use the following guiding questions: • Why were you innovating? • What did you do to innovate? • How did you feel while innovating? • Were there any challenges while innovating? • Was your innovation a success? Students should leave this discussion with an understanding that innovation is required to improve upon an idea and can be an exciting, satisfying, and occasionally stressful process marked by regular successes and failures.	3. Selected students will provide their answers to questions 1-2. Then, selected students will answer any provided follow-up questions.
4. Call on several students to answer question 3. If you have completed the “Sound Sources” activity, you may use a follow-up question that asks students to specify the kind of sources they should be using to determine if a solution is new and innovative. In their answers, students should be able to identify that they should use recent primary or secondary sources. While responding to the follow-up question, students may struggle to identify that the sources should also be recent. To help students identify that articles must also be recent, use the following guiding question: • When looking at an article, what piece of information can tell you if it is currently relevant to its field of study?	4. Selected students will provide their answers to question 3. The selected students will answer any provided follow-up questions.
5. Introduce students to the concept of using the engineering design process to create innovative solutions. The introduction should not dive into any steps of the engineering design process but should introduce it as multi-step process that engineers use to create and refine their solutions or products.	5. Students will listen to the teacher-provided description of the engineering design process.

6. Provide students with sticky notes. Ask students to brainstorm the steps engineers may use in their engineering design process. This step should be completed individually. Once students have brainstormed several connected steps, ask students to write each step of their engineering design process on a separate sticky note. As students brainstorm the engineering design process, circulate the classroom looking for students who have less than 4 or more than 10 steps. Encourage these students to stay between 4-10 steps.	6. Students will brainstorm the steps for an engineering design process on paper. Once students are done brainstorming, they will write each step of their process on separate sticky notes.
7. Once students have recorded each step of their engineering design process on the sticky notes, ask students to work in small groups to create an engineering design flow. These groups should be separate from their STEM Challenge groups. Provide each group of students with an empty space to place their sticky notes. To help guide students, suggest that they group similar sticky notes together before putting them up. Once the sticky notes are grouped accordingly, students can identify the first step in the engineering design process and place it in the designated location. Circulate the classroom listening to student discussions and identifying which groups are struggling to simplify or group their steps. Encourage students to add sticky notes or throw away sticky notes as needed and to keep their engineering design process between 4-10 steps. Each group should agree on any additional sticky notes added to the engineering design process. As students organize each step into a design process, take note if the design looks linear or cyclical.	7. Students will form small groups and will share their design processes. As students share their design process, they will begin to group similar sticky notes, each group of sticky notes representing one step of the engineering design process. Students will then work together to organize each step into a logical engineering design flow. If needed, students will add new sticky notes to create new steps or will throw away sticky notes that they feel are unnecessary.
8. Once students have compiled their sticky notes, forming a single engineering design flow, discuss their design processes as a class. This discussion should last approximately 5 minutes. If any groups have created a linear design flow, ask students one of the following guiding questions: • Does anyone have a sticky note indicating a final product? If there are no “end” products, can you put your sticky notes in a straight line? • If there is a final product, do you think everyone in the room will agree that they cannot improve upon it? If the answer is no, then it is not a final product. Other guiding questions to facilitate the discussion are as follows: • Did everyone agree on each step of the engineering design process? • Did you remove or combine any steps when creating your engineering design process? • Did you add any steps when creating your engineering design process? • What steps were the most common among groups?	8. Students will discuss the process of working together to form the engineering design process.

Students should leave this discussion with an understanding that the engineering design process may vary slightly from source to source (or person to person) but has several shared traits in common. Students should also leave this discussion with the knowledge that the engineering design process is cyclical.	
9. Tell students that while the engineering design process varies slightly from place to place or person to person, it always has one thing in common: it is a cyclical process.	9. Students will listen to the teacher-provided description of the engineering design process.

BODY OF THE ACTIVITY: *In this part of the activity, students will learn about the common steps of the engineering design process and will identify how this process relates to the STEM Challenge.*

TIME REQUIRED: 30 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to record the following engineering design process steps in the designated location on the “Iterative Ideas” activity worksheet: Identify a real world problem → Plan a solution → Prototype your solution → Test your solution → Redesign your solution → Communicate your solution While the engineering design process varies from source to source, this example contains some of the most utilized steps. Some engineering design processes include steps that are not applicable to the STEM Challenge.	1. Students will record each step of the engineering design process on their worksheet.
2. Start a discussion by asking students how they might test their solution during the STEM Challenge. Remind students that they will not be performing experiments or implementing their solution in the STEM Challenge engineering design process. Select several students to share their answers. This discussion should last approximately 3 minutes. If students are struggling to answer the question, ask students one of the following guiding questions: • What might scientists or researchers do before starting an experiment? • How would a researcher “test” a design or solution for effectiveness before implementation? • What “tests” could identify problems within your solution? Students should leave this discussion with an understanding that there are other ways to “test” the validity and effectiveness of their solution. This may include researching similar or related solutions to see their effectiveness, modeling components of their solution to test material strength, etc., or performing other “tests.”	2. Students will discuss what it means to test their STEM Challenge solutions.

3. Ask students to discuss any similarities or differences between the engineering design process they created, and the engineering design process provided to them. This discussion should last approximately 5 minutes. Use the following guiding questions to help facilitate the discussion: • Are there any steps in this engineering design process that you did not include when brainstorming? • Are there any steps you brainstormed that are not present in this engineering design process? • Did you have a different number of steps than this engineering design process? If so, why do you think they might be different?	3. Students will discuss the differences between their brainstormed engineering design process and the engineering design process provided to them.
4. Ask students to break down the importance of the engineering design process by answering the next two questions in the “Iterative Ideas” activity worksheet. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	4. Students will answer questions 4-5 on their worksheet. Q4: <i>How does the engineering design process facilitate innovation?</i> A: In the engineering design process, you are constantly looking for new problems to address and are constantly refining your solution. By constantly refining your solutions you are more likely to come up with creative and innovative solutions. Q5: <i>What does it mean to have multiple iterations of something? Why is it important?</i> A: It means that you have created several versions of a solution or idea. It is important because every iteration should be an improved version of the previous design. With each iteration, your solution should become better.
5. Select students to share their answers to questions 4-5. If students do not provide full and complete answers, continue to call on students to add to or refine their responses.	5. Selected students will share their answers.
6. Ask students to move and sit with their STEM Challenge group if applicable. Students working on the STEM Challenge individually do not need to move.	6. Students completing the STEM Challenge in groups will move to sit with the rest of their group members.
7. Ask students to answer the remaining questions on the “Iterative Ideas” activity worksheet. Students may complete these questions in their groups. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	7. Students will answer questions 6-10 on their worksheet. Q6: <i>What part of the engineering design process are you currently on? If applicable, how many times have you been through the engineering design process?</i> A: Student answers may vary. Example: We are currently on the redesign portion of the engineering design process. We have already modified our solution two times and are in the middle of our third redesign. Q7: <i>Why is the engineering design process often collaborative?</i> A: Having more people look at a design means that there are more ideas and people can identify more problems. This can allow for more iterations of your solution. Q8: <i>How can a one-person project be made collaborative?</i> A: The project lead can reach out to their peers to receive feedback on their ideas or final products.

	Q9: How will you collaborate effectively? A: Student answers may vary. Example: We will make sure we record all our ideas in a central location. This way we can make sure everyone has a chance to consider every idea. Sometimes when we are working together, everyone shares their ideas at once and some ideas end up being overlooked. Q10: At what point do you decide you are done iterating on your solution? In theory, the engineering design process never ends. A: At a certain point you may have trouble finding a new problem to address. While you may be done with the engineering design process at this point, someone else may be able to identify a problem and create a new iteration of your idea. However, even if you receive feedback from a peer, you may not have time to iterate on your solution or may reach a point where there are no major identifiable problems.
8. Ask one student from each project to share their answers to question 9.	8. Selected students will share their answers to question 9. Students will listen to each response and take note of new ways they could ensure collaboration within or outside of their group.
9. Start a discussion with students about their answers to question 10. To start the discussion, ask for 3 students to share their answers. This discussion should last approximately 5 minutes. The following guiding questions may be used to facilitate the remainder of the discussion: • Is there a tangible end point to the engineering design process? • Is it possible to have a perfect solution? • Why is it important to find a temporary endpoint? • What might happen if you iterate on your solution indefinitely? Students should leave this discussion with the understanding that while the engineering design process is never-ending, students will have to find an endpoint for their STEM Challenge solution due to time-constraints.	9. Students will share their answers to question 10 and participate in the class discussion.

CONCLUSION: In this part of the activity, students will continue working on their STEM Challenge using what they learned about the engineering design process.

TIME REQUIRED: 0-20 minutes*

**This is independent work time for students*

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Give students time in class to work on their STEM Challenge. Take this time to ask students where they are in the engineering design process to assess their progress and pacing.	1. Students will continue working on their STEM Challenge using the engineering design process.

Notes/Considerations

Students should be allowed to ask clarifying questions at any time during the lesson.

This optional activity can be taught in part or in full to adjust for different class lengths. If the activity is too long for a designated class period, class discussions can be omitted. If discussions are omitted, the answers to each question should be reviewed for students.



Activity 3: Iterative Ideas

Instructions: Answer the questions below to identify how the engineering design process helps develop innovative solutions.

1. Innovation is the process of creating something new and unexpected. Why is it important to be innovative in the STEM Challenge?

The STEM Challenge is all about coming up with new ideas and solutions to large-scale scientific problems. Innovative solutions set a project apart. Not only that, but they are much-needed to solve big scientific challenges that current ways of thinking or technical approaches have not been able to solve!

2. Think back to a time in your life when you had creative freedom and came up with a new innovative idea. Describe this experience.

Student answers may vary. Example: Last year I was given the creative freedom to design my room at home. My parents said that I could do anything I wanted to my room but could not make any large structural changes. For example, I was able to paint my walls, but I was not allowed to rip up and install new flooring. While I did not rip up the floor, I did find a way to install new flooring by placing underlayment down over the existing floor and installing removable flooring on top. While I am not the first person to do this, I did come up with the idea of installing removable flooring over the existing floor on my own.

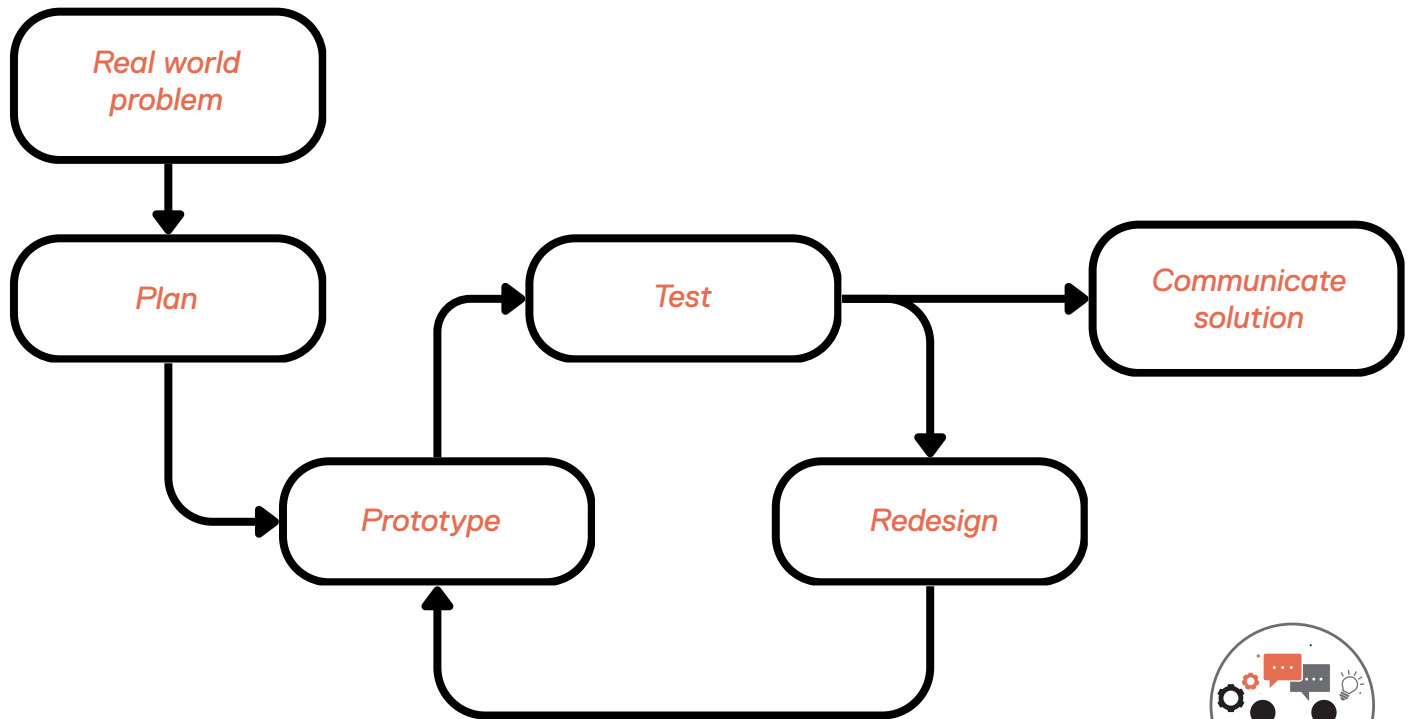
3. How do you use sources to figure out if your solution is new and innovative?

If you can find sources that are already talking about implementing or using your exact solution, it is not new and innovative. If you cannot find any sources talking about your exact solution, it may be a great innovative idea!





Instructions: Record the engineering design process steps in the chart below.



4. How does the engineering design process facilitate innovation?

In the engineering design process, you are constantly looking for new problems to address and are constantly refining your solution. By constantly refining your solutions you are more likely to come up with creative and innovative solutions.

5. What does it mean to make multiple iterations of something? Why is it important?

It means that you have created several versions of a solution or idea. It is important because every iteration should be an improved version of the previous design. With each iteration, your solution should become better.





6. What part of the engineering design process are you currently on? If applicable, how many times have you been through the engineering design process?

Student answers may vary. Example: We are currently on the redesign portion of the engineering design process. We have already modified our solution two times and are in the middle of our third redesign.

7. Why is the engineering design process often collaborative?

Having more people look at a design means that there are more ideas and people can identify more problems. This can allow for more iterations of your solution.

8. How can a one-person project be made collaborative?

The project lead can reach out to their peers to receive feedback on their ideas or final products.



9. How will you collaborate effectively?

Student answers may vary. Example: We will make sure we record all our ideas in a central location. This way we can make sure everyone has a chance to consider every idea. Sometimes when we are working together, everyone shares their ideas at once and some ideas end up being overlooked.

10. At what point do you decide you are done iterating on your solution? In theory, the engineering design process never ends.

At a certain point you may have trouble finding a new problem to address. While you may be done with the engineering design process at this point, someone else may be able to identify a problem and create a new iteration of your idea. However, even if you receive feedback from a peer, you may not have time to iterate on your solution or may reach a point where there are no major identifiable problems.



Pitch Your Point: Activity 4

Overview

Students will learn how to use ethos, logos, and pathos to create a strong and convincing argument. Using this knowledge, students will identify the importance of logos in a scientific presentation and will identify scientifically sound reasoning for each design consideration taken in the development of their solution. Students will finish this activity by constructing an argument in favor of implementing their solution.

Objectives

By the end of this activity, students will be able to:

- Identify the components of a strong pitch or argument.
- Evaluate the importance of utilizing ethos, logos, and pathos in an argument or presentation.
- Develop evidence that supports each design consideration used to develop their solution.

Key Messages

- A pitch is a type of argument designed to persuade an audience to accept or implement a solution or idea.
- Strong arguments use ethos, logos, and pathos.
- Ethos is an appeal to credibility established through the presenter's confidence and professionalism and by identifying the expertise of the presenter.
- Logos is an appeal to logic established by using reliable sources as evidence in support of the solution or idea being presented.
- Pathos is an appeal to emotion established by connecting the audience with the presentation's subject. This connection can be developed through personal stories or by identifying how the subject may impact the audience or the things they care about.
- Solution pitches should cover aspects of the problem the presenters considered when developing their solution. Each consideration should be clearly stated, with scientific reasoning backing up each design choice.

Time Needed: 60 minutes

Standards

B.E.S.T. Standards: English Language Arts

ELA.12.C.1.3: Write arguments to support claims based on an in-depth analysis of topics or texts using valid reasoning and credible evidence from sources, elaboration, and demonstrating a thorough understanding of the subject.

NGSSS Science Benchmarks

G.K12.5.3.2d, Communication-Accomplish: Analyze and synthesize the presentation skills necessary to communicate ideas, information, concerns, and solutions to a project goal.

G.K12.7.1.4d, Problem Solving-Accomplish: Address critics with prepared, defensible arguments that effectively defend solutions.

NGSSS Science Benchmarks

SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.

Background Information

Pitching a STEM Challenge Solution

At the STEM Challenge Expo, students will present their project and pitch their solution to an audience. A pitch is a type of argument designed to persuade an audience to accept or implement a solution of idea. As the audience of the STEM Challenge Expo may include judges who are active within the scientific community, students should pitch their solutions with the goal of having the judges consider their implementation.

Ethos, Logos, and Pathos

Strong pitches and arguments appeal to the audience using a mixture of ethos, an appeal to credibility; logos, an appeal to logic; and pathos, an appeal to emotion. Using each of these three factors strategically can engage the audience and motivate them to support the implementation of the solution or idea.

In a successful pitch, a presenter will first employ ethos, an appeal to credibility, by establishing themselves as an expert on the subject at hand and/or as a trustworthy or reliable source. As the students in the STEM Challenge are not experts within their field of study, students must focus on pitching their solution with confidence and professionalism.

Presenters should regularly invoke logos, an appeal to logic, throughout the presentation. A well-reasoned argument can also help a presenter establish their credibility. As students present their background information and pitch their solutions, they should regularly cite or refer to reliable sources. Using reliable sources helps the audience logically follow the solution's development and convince them that the solution is a reasonable response to the problem. In a scientific argument, it is vital that the information being presented is trustworthy and founded on accurate information. Without citing sources and appealing to logic, an argument can be baseless and unconvincing.

Finally, pathos, an appeal to emotion, helps establish a connection between the presenters and the audience. Students should be able to establish pathos through two different means, relatability and personal impact. One effective way to do this is by introducing their identified problem as an issue that affects them as young people, as residents of Miami and South Florida, or as people who depend on a healthy environment. Students can vocalize their passion for the topic and share any personal stories related to the issue at hand. As the audience for the STEM Challenge is primarily from Miami and South Florida, this directly connects the audience to the issue at hand and can increase their interest in the solution presented.

While using ethos, logos, and pathos is important in students' final presentations, each is a tool to be used in moderation. The primary focus of the presentation should remain the solution, with ethos, logos, and pathos employed strategically to enhance the solution's presentation.

Materials (per student)

- Student Guidebook
- Pencil
- Optional: Computer

Set-Up Procedure

1. Make sure that students have access to their Student Guidebooks and their in-progress STEM Challenge projects.
2. Optional: Open PowerPoint.

Activity Procedures

INTRODUCTION: <i>In this part of the activity, students will practice pitching an idea and begin thinking about the elements needed to compose a strong pitch or argument.</i>	
TIME REQUIRED: 15 minutes	
What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to find a partner and open their Student Guidebooks to the “Pitch Your Point” student worksheet on page 35 .	1. Students will find a partner and open their Student Guidebooks to the “Pitch Your Point” student worksheet.
2. Tell students that this lesson is all about learning how to “pitch your point” or argue for their solutions implementation. Without providing any additional context for the lesson, tell students about a new product. Describe the product and include the product’s cost, the advantages of using the product, etc. This pitch should be enthusiastic and compelling. The pitch should be about an unconventional product unfamiliar to most students. Get creative.	2-5. Students will listen and follow the instructions given. They will give a thumbs up or down when prompted.
3. Ask students if the pitch was convincing and if they feel compelled to go out and try or buy the product described in the pitch. Ask students to give a thumbs up if they are interested in trying or buying the product or a thumbs down if they are not interested in trying or buying the product.	
4. Tell students to share why they felt the pitch was convincing or unconvincing with their partner.	
5. Tell students to listen to the following scenario: You are an investor, and your goal is to make as much money as possible. With every investment, there is a chance that the product you have invested in does not sell and you will have to cut your losses.	
6. Tell students that they will take turns being an investor or an entrepreneur. The first entrepreneur will choose a scenario to present. Once the entrepreneur has presented their product, the investor will ask clarifying questions and tell the entrepreneur whether they plan to invest in their product. The scenarios can be found in the ‘Pitch Your Point’ student worksheet. Once the investor has made their final decision, students will switch roles. The new entrepreneur will have to present the unused scenario. The scenarios only provide basic information. Students cannot change the basic information presented in each scenario but should be encouraged to add to the information provided. The information students add to their scenario is up to their discretion. As students present their scenarios, circulate the classroom to make sure that the entrepreneurs are trying to convince the investors using more information than what was provided in the scenario. Encourage students to get creative!	
	6. Students will decide who starts as an investor and who starts as an entrepreneur. The entrepreneur will try to convince the investor to invest in their product. The investor will ask questions before identifying if they plan to invest in the product or reject the product. Students will then switch roles. Students will address both scenarios. Scenario 1: Reusable straw • Made of stainless steel • Includes a reusable straw and carrying bag • Production cost: \$3 per straw/bag • Minimum quantity produced: 100 • Selling price: \$10 per straw/bag Scenario 2: New phone model • Made of a wide variety of materials • Includes a “roll-up” phone and phone charger • Production cost: \$300 per phone and charger • Minimum quantity produced: 100 • Selling price: \$1,000 per phone and charger

Make sure students know that the investor may only ask questions after the entrepreneur has finished pitching their product. Optionally, set a time limit for each scenario and require the entrepreneur to use the entire time to pitch their idea. This portion of the activity should last at least 5 minutes.	
7. Ask students to give a thumbs up if they successfully convinced the investor to invest in their product and give a thumbs down if they were not successful in convincing the investor to invest in their product.	7. Students will give a thumbs up or a thumbs down.
8. Tell students to think from the perspective of the investor for the following discussion. This discussion should last approximately 5 minutes. To start the discussion, ask students the following question: What did the entrepreneur do to help you form your decision on whether to invest in the product? If students need more guidance in the discussion, use the following guiding questions: • Did the entrepreneur have a main point? • What type of information did they use to try and convince you? • Did you have any questions or concerns about what was presented to you? • What questions did you ask to figure out if the product was worth investing in? • Were they able to convince you? Why or why not? • If they did not convince you, do you think there is anything they could have done differently to convince you? Students should leave this discussion with an idea of what tactics helped sell their idea/product.	8. Students will discuss the tactics used by the entrepreneurs to sell their idea/product.
9. Ask students to think about the difficulty level of each scenario. Tell students to raise their hand when they agree with one of the following statements: Scenario 1 is more difficult to pitch, Scenario 2 is more difficult to pitch, or both scenarios are equally difficult.	9. Students will raise their hand when they agree with the statement presented.
10. Ask students to discuss their answers to the following question: Why might one of the scenarios be more difficult to pitch? This discussion should last approximately 3 minutes. If students need more guidance in the discussion, use the following guiding questions: • If you decided not to invest in scenario 1, what was holding you back? • If you decided not to invest in scenario 2, what was holding you back? • As an investor, what would happen if the product in scenario 1 failed to sell? • As an investor, what would happen if the product in scenario 2 failed to sell?	10. Students will participate in the class discussion.

Students should leave this discussion with an understanding that each scenario had a different risk level. While they could benefit the most from Scenario 2, they were also at a greater risk and would lose the most money if Scenario 2 were not successful. Students may also identify that Scenario 2 is a more innovative idea, with Scenario 1 pitching a product in an already saturated market.	
11. Ask students how this activity might relate to the STEM Challenge. Select students to share their answers. Students should be able to identify that they will have to present or “sell” their solution at the end of the year during the STEM Challenge Expo.	11. Selected students will share their answers.

WHY ARGUE: *In this section of the activity, students will analyze the relationship between arguments and pitches and identify how they can utilize ethos, logos, and pathos to create a strong pitch or argument.*

TIME REQUIRED: 15 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to answer the first 4 questions on the worksheet. Students should complete this activity individually. If any students respond to question 3 or 4 with that they, the student or group, should win the STEM Challenge, tell the students to go back and refine their answer. To help guide students, ask students how they would interpret an argument that is saying “I’m the best” and whether that is what they should be arguing in a presentation about their STEM Challenge project. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	1. Students will answer the first 4 questions on the student worksheet. Q1: <i>Making an argument means that you are communicating evidence or reasons in support of an idea. Why would you make an argument?</i> A: A well-constructed argument will give another party information about your view or idea and persuade them to share your view or support your solution or idea. Q2: <i>What is the relationship between an argument and a pitch?</i> A: A pitch is a type of argument that is attempting to persuade someone to adopt a solution or idea or persuade someone to purchase or invest in a product. Q3: <i>What will you have to pitch/argue in your final presentation?</i> A: I will have to argue that my solution would solve or reduce the impact of my identified issue, should be implemented, and deserves to earn first place in the STEM Challenge. Q4: <i>Who is your audience and why is it important that they are presented with a strong pitch/argument?</i> A: My audience will include museum guests and the judges. Some of these judges work in the field of my prompt and could theoretically adopt my solution. It is important to have a strong argument so that I can convince the judges that my solution can solve my identified issue and deserves to win.
2. Ask 1-2 students to share their answers for each question.	2. Selected students will share their answers.

3. Ask students to answer the next four questions. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses. • Play the Pepsi Commercial for students or share with students that they can use the URLs or the QR codes found on page 37 or can use the resource links on the STEM Challenge web page.	3. Students will answer questions 5-8. <i>Strong pitches/arguments include ethos, logos, and pathos.</i> <i>Ethos: An appeal to credibility</i> <i>Logos: An appeal to logic</i> <i>Pathos: An appeal to emotion</i> Q5: Watch the video and identify how ethos can be used in a pitch/argument to change how a statement is interpreted. <i>Pepsi Commercial: https://www.youtube.com/watch?v=I9jlc7E52m0</i> A: In the commercial, the speaker is trying to convince the server to speak with confidence. Speaking with confidence and authority help the speaker appear more credible. Q6: How can you use your identified issue and solution to evoke an emotional response in your audience (pathos)? A: You can explain how the identified issue may affect the audience and how your solution will minimize the impact of the issue and benefit your audience. This makes your solution relevant to your audience and can evoke an emotional response. Q7: What is the relationship between a strong pitch/argument and evidence (logos)? A: A strong pitch/argument has a lot of evidence to back up the main idea or claim. Weak pitches/arguments do not utilize as much evidence. Q8: What appeal is the most important in a scientific presentation? Why? A: Logos is the most important appeal for scientific pitches/arguments. This is because without logos, there is no basis for the information presented. An evidence-based scientific argument can lack ethos and pathos and still persuade the audience to agree with the information presented.
4. Select 2-3 students to share their answers to each question. If students are struggling to answer question 8, use the following guiding questions: • If you are being presented scientific information, but the speaker does not address you personally, can they give a convincing argument? • If you are being presented scientific information, but the speaker does identify themselves as an expert on the issue, can they give a convincing argument? • If you are being presented scientific information, but the speaker does not provide any evidence or data, can they give a convincing argument?	4. Selected students will share their answers.
5. Tell students to write “logos” or “evidence” in the blank on question 9. Ask students to answer the question. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	5. Students will write “logos” or “evidence” in the blank on question 9. Students will answer question 9. Q9: Think back to a time when you heard an argument that did not use any _____. Was it a strong or convincing argument? Why or why not? Be specific. How could they make the argument more convincing?

	A: Student answers may vary. Example: My parents implemented a new rule that stated I was not allowed to use my phone for an hour before bed. When I asked my parents why, they said, “because I say so.” This did not make me want to follow the rule because they did not provide any reasons for the rule. If my parents had told me that phones emit blue light and that seeing blue light before bed disrupts my sleep, I might have been more inclined to follow the rule.
6. Select students to share their answers to question 9. In their answers, students may reference the investor and entrepreneur activity used during the introduction. Additionally, students should identify that evidence is necessary to show that an idea is purposeful, based on accurate information, and can be successfully implemented.	6. Selected students will share their answers.

BUILDING EVIDENCE: In this part of the activity, students will identify the evidence they need to support and pitch their solution.	
TIME REQUIRED: 22 minutes	
What the Teacher Does	Anticipated Student Behaviors/Responses
1. Tell students that now that they have identified the importance of using evidence in a scientific argument, they must figure out what kind of evidence they need for their final presentations. Tell students that as they answer the questions in the “Building Evidence” section of the activity, they will need to think back to the engineering design process.	1. Students will listen.
2. Ask students to answer the first question in the “Building Evidence” section of the activity. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	2. Students will answer question 1. Q1: <i>What did you have to consider when designing a realistic solution?</i> A: We considered the cost and materials needed to implement the solution and we considered whether the solution was effective. On top of that, we had to consider whether there were any risks to the solution.
3. Tell students to discuss their answers. This discussion should last approximately 5 minutes. <i>Tell students that they will need to take notes during the discussion so they can make sure they address all their considerations in their final pitch/argument.</i> In the discussion, students need to identify that they considered cost, materials, effectiveness/functionality, and moral or ethical concerns. If students have difficulty identifying any of these considerations, use the associated guiding questions listed below. Cost Guiding Questions: • What goes into implementing this solution? Time? Money? • Is the only cost of implementation the cost of materials? • What other costs did you have to consider? • Are there any long term costs?	3. Students will discuss their answers and take notes.

Materials Guiding Questions: • How did you decide what materials to use? Effectiveness/Functionality Guiding Questions: • Why did you iterate on your solution? • What is the goal of the solution? Did you consider how well your solution met that goal? Moral or ethical concerns Guiding Questions: • Did you consider anything else besides cost, materials, and effectiveness/functionality? • Is there any risk to implementing the solution? • Could implementing this solution negatively affect anyone or anything, directly or indirectly? Students may have trouble identifying moral or ethical concerns or risks as an important consideration. Students may have also considered these things but may have trouble articulating an overarching term for these considerations. If students did not address any of these design considerations, remind students that they still have time to work on their project and iterate upon their idea.	
4. Ask students to answer the next question. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	4. Students will answer question 2. Q2: How can we use our design considerations as evidence in our argument? A: We can talk about how we minimized cost and risk, maximized efficiency, and considered the properties of the materials being used.
5. Ask 2-3 students to share their answers. If students provide specific evidence in their answers to question 2, ask them to summarize or generalize their answer.	5. Students will share their answers.
6. Once students have shared their answers to question 2, ask students how they can turn each of these considerations into an evidence-based statement that shows their solution is the best. This discussion should last approximately 5 minutes. <i>Tell students that they need to take notes during the discussion so that they know how to use evidence in their pitch/argument.</i> If students are struggling to turn considerations into evidence-based statements, provide an example. Example statements are provided below: Cost: • While our maintenance has a high cost, maintenance is rarely required, keeping the overall cost of our solution low.	6. Students will discuss how they can turn each consideration into an evidence-based statement for a pitch/argument. <i>Students will take notes.</i>

• While there is a high upfront cost, the maintenance cost is low, so our solution is great for long term implementation. Materials: • Our materials are carefully selected to be durable, so our solution is long lasting. • Our materials are made using other recycled materials, so our solution is eco-friendly. • Our materials are biodegradable, so they do not introduce any additional plastics or waste into the environment when the parts break down/degrade. Effectiveness/Functionality: This solution has a higher cost than other solutions, but is more effective/efficient/etc. because... Moral or ethical concerns: • Our solution only has minimal financial risk. • This solution has a risk, but this risk is less than the damage that would be caused by not implementing our solution.	
7. Ask students to answer question 3. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	7. Students will answer question 3. Q3: Why do we need to be specific in our evidence? A: Having specific evidence behind each part of your pitch/argument shows that your solution or claim is not baseless — you have done the necessary work to make sure you have a strong solution.
8. Ask 2-3 students to share their answers.	8. Students will share their answers.
9. Ask students to discuss how they can make their evidence-based statements specific to their solution. This discussion should last approximately 3 minutes. If students are struggling, use the following guiding questions: • Is saying someone did something similar that worked good enough? • How can you enhance this statement? • Is saying your solution is low-cost good enough? • What does low-cost mean? Your solution has a low-cost compared to what? • Is saying you picked the best material good enough? • Why is this material the best for your solution? • Is saying your solution has a low risk good enough? • What risks does your solution have? • How can you prove that your solution has a low risk compared to an alternative solution?	9. Students will discuss how they can make evidence-based statements specific to their solution. <i>Students will take notes.</i>

Students should leave this discussion with the knowledge that referencing specific data, facts, events, or implemented solutions strengthens their evidence-based statements and their argument. Students should also identify that evidence-based statements must be based on concrete information and use comparisons.	
10. Ask students to move and sit with their STEM Challenge group if applicable. Students working on the STEM Challenge individually do not need to move.	10. Students completing the STEM Challenge in groups will move to sit with the rest of their group members.
11. Ask students to write their design considerations as evidence-based statements for their pitch/argument on a separate piece of paper. Give students at least 3 minutes for this step of the activity.	11. Students will write their design considerations as evidence-based statements for their pitch/argument. Students will work in their STEM Challenge group if applicable. TIP: Do not only think about your solution. Compare it to other solutions! Why is your solution better than previous iterations of your solution or other solutions that have been used to manage your identified issue?
12. Ask students to answer questions 4-7. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	12. Students will answer questions 4-7. Q4: <i>What is the most convincing/important piece of evidence for your pitch/argument? This is your selling point.</i> A: Student answers may vary. Example: Our most convincing piece of evidence is that smartphones last about 2.5 years on average before they become outdated. If smartphones were modular, they could potentially double the length of time they are used before being discarded, reducing smartphone waste by approximately 75%. Q5: <i>Why might it be important to have a selling point?</i> A: The selling point is your most impressive piece of evidence that will convince your audience to believe in your solution. Having one main selling point can also make your solution more memorable. Q6: <i>How can you organize your evidence and use your selling point in a pitch/argument that fits naturally in your presentation?</i> A: Student answers may vary. Example: We can use evidence to explain how the solution directly reduces the impact of our identified problem. For example, we might say, “The primarily reasons users replace their smartphones is due to aesthetic or technical obsolescence. By having replaceable motherboards and housing, users are able to update the aesthetic of their smartphone and by having replaceable components, smartphones can stay up to date. As approximately 90% of users replace their smartphones for aesthetic or technical reasons, this could significantly reduce the amount of waste produced by the smartphone industry. However, the amount of waste modular smartphones would mitigate is entirely dependent on marketing and how frequently upgrades for individual components become available.”

	Q7: <i>When should you give your pitch/argument in your presentation?</i> A: You should give your pitch/argument towards the end of your presentation once your audience understands the basics of your solution. Your pitch/argument can be part of the explanation of your solution and may take place during the conclusion of your presentation, leaving the audience with the impression that you have a great solution that should be implemented.
13. Select several students to share their answers to questions 5 and 7.	13. Selected students will share their answers to questions 5 and 7.

CONCLUSION: <i>In this part of the activity, students will evaluate the importance of ethos and structure their pitch/argument.</i>	
TIME REQUIRED: 8 minutes	
What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to answer questions 8 and 9. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	1. Students will answer questions 8-9. Q8: <i>Think back to a time you heard someone argue for something they did not believe in. How could you tell they did not believe in their own argument?</i> A: Student answers may vary. Example: Last year we held a student debate in my English class where students were assigned to speak either for or against animal testing. During this debate, it was obvious that some of the students on the “pro-animal testing” side of the argument did not actually believe in their arguments. They sounded unsure of themselves and did not speak with confidence, saying “um,” hesitating, and struggling to maintain eye contact. Their statements were also vague. Q9: <i>Is confidence an appeal to ethos, logos, or pathos? Why?</i> A: Confidence is an appeal to credibility, or ethos. When you speak with confidence, you establish yourself as someone who knows what they are talking about and your audience is more likely to view you as a credible source of information.
2. Select one student to share their answer to question 8 and one student to share their answer to question 9. Ask students to add onto the shared answers to start a discussion about the importance of confidence and believing in the argument you are presenting. This discussion should last approximately 3 minutes. Students should leave this discussion with an understanding that if you do not believe in yourself, you cannot expect other people to believe your argument. Students may also identify that many people believe misinformation because it is presented with confidence.	2. The selected students will share their answer to question 8. Students will contribute their thoughts to start a discussion about confidence.

3. Tell students to work through how they want to structure their pitch/argument. Remind students that the pitch/argument should come towards the end of their presentation once their audience understands how their solution works. The argument can act as the conclusion to their presentation.	3. Students will organize their specific evidence-based statements into a cohesive pitch/argument for their solution.
4. If there is any additional time, tell students to practice their argument.	4. Students will practice their arguments.

Notes/Considerations

Students should be allowed to ask clarifying questions at any time during the lesson.

This optional activity can be taught in part or in full to adjust for different class lengths. If the activity is too long for a designated class period, class discussions can be omitted, or the activity can be taught in several sections over the course of a few class periods. If discussions are omitted, the answers to each question should be reviewed for students.

If you have more than 60 minutes to complete this activity, give students more time during group discussions.



Activity 4: Pitch Your Point

Instructions: Think about the STEM Challenge as you answer the questions below to learn about developing a pitch for your presentation.

Investor vs. Entrepreneur

Scenario 1: Reusable straw

Made of stainless steel

Includes a reusable straw and carrying bag

Production cost: \$3 per straw/bag

Minimum quantity produced: 100

Selling price: \$10 per straw/bag

Scenario 2: New phone manufacturer

Made of a wide variety of materials

Includes a “roll-up” phone and phone charger

Production cost: \$300 per phone and charger

Minimum quantity produced: 100

Selling price: \$1,000 per phone and charger



Why Argue

1. Making an argument means that you are communicating evidence or reasons in support of an idea. Why would you make an argument?

A well-constructed argument will give another party information about your view or idea and persuade them to share your view or support your idea.

2. What is the relationship between an argument and a pitch?

A pitch is a type of argument that is attempting to persuade someone to adopt an idea or solution or persuade someone to purchase or invest in a product.



3. What are you pitching/arguing in your final presentation?

You are arguing that your solution would solve or reduce the impact of your identified issue, should be implemented, and deserves to earn first place in the STEM Challenge.

4. Who is your audience and why is it important that they are presented with a strong pitch/argument?

My audience will include museum guests and the judges. Some of these judges work in the field of my prompt and could theoretically adopt my solution. It is important to have a strong argument so that I can convince the judges that my solution can solve my identified issue and deserves to win.





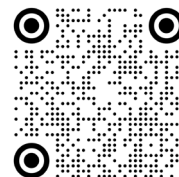
Strong pitches/arguments include ethos, logos, and pathos.

Ethos: An appeal to credibility

Logos: An appeal to logic

Pathos: An appeal to emotion

5. Refer to the STEM Challenge resource page and click the item named, “Example Pitch/Argument.” Alternatively, use the URL or QR code below. Watch the video and identify how ethos can be used in a pitch/argument to change how a statement is interpreted.



Pepsi Commercial: <https://www.youtube.com/watch?v=I9jlc7E52m0>

In the commercial, the speaker is trying to convince the server to speak with confidence. Speaking with confidence and authority help the speaker appear more credible.

6. How can you use your identified issue and solution to evoke an emotional response in your audience (pathos)?

You can explain how the identified issue may affect the audience and how your solution will minimize the impact of the issue and benefit your audience. This makes your solution relevant to your audience and can evoke an emotional response.

7. What is the relationship between a strong pitch/argument and evidence (logos)?

A strong pitch/argument has a lot of evidence to back up the main idea or claim. Weak pitches/arguments do not utilize as much evidence.



8. What appeal is the most important in a scientific presentation? Why?

Logos is the most important appeal for scientific pitches/arguments. This is because without logos, there is no basis for the information presented. An evidence-based scientific argument can lack ethos and pathos and still persuade the audience to agree with the information presented.



9. Think back to a time when you heard an argument that did not use any _____.
Was it a strong or convincing argument? Why or why not? Be specific.

Student answers may vary. Example: My parents implemented a new rule that stated I was not allowed to use my phone for an hour before bed. When I asked my parents why, they said, "because I say so." This did not make me want to follow the rule because they did not provide any reasons for the rule. If my parents had told me that phones emit blue light and that seeing blue light before bed disrupts my sleep, I might have been more inclined to follow the rule.





Building Evidence

1. What did you have to consider when designing a realistic solution?

We considered the cost and materials needed to implement the solution and we considered whether the solution was effective. On top of that, we had to consider whether there were any risks to the solution.

Notes:



2. How can we use our design considerations as evidence in our argument?

We can talk about how we minimized cost and risk, maximized efficiency, and considered the properties of the materials being used.

Notes:





3. Why do we need to be specific in our evidence?

Having specific evidence behind each part of your pitch/argument shows that your solution or claim is not baseless — you have done the necessary work to make sure you have a strong solution.

Notes:



Instructions: Write your design considerations as evidence-based statements for your pitch/argument.

TIP: Do not only think about your solution. Compare it to other solutions! Why is your solution better than previous iterations of your solution or other solutions that have been used to manage your identified issue?

4. What is the most convincing/important piece of evidence for your pitch/argument? This is your selling point.

Student answers may vary. Example: Our most convincing piece of evidence is that smartphones last about 2.5 years on average before they become outdated. If smartphones were modular, they could potentially double the length of time they are used before being discarded, reducing smartphone waste by approximately 75%.



5. Why might it be important to have a selling point?

The selling point is your most impressive piece of evidence that will convince your audience to believe in your solution. Having one main selling point can also make your solution more memorable.

6. How can you organize your evidence and use your selling point in a pitch/argument that fits naturally in your presentation?

Student answers may vary. Example: We can use evidence to explain how the solution directly reduces the impact of our identified problem. For example, we might say, "The primary reasons users replace their smartphones is due to aesthetic or technical obsolescence. By having replaceable motherboards and housing, users are able to update the aesthetic of their smartphone and by having replaceable components, smartphones can stay up to date. As approximately 90% of users replace their smartphones for aesthetic or technical reasons, this could significantly reduce the amount of waste produced by the smartphone industry. However, the amount of waste modular smartphones would mitigate is entirely dependent on marketing and how frequently upgrades for individual components become available."

7. When should you give your pitch/argument in your presentation?

You should give your pitch/argument towards the end of your presentation once your audience understands the basics of your solution. Your pitch/argument can be part of the explanation of your solution and may take place during the conclusion of your presentation, leaving the audience with the impression that you have a great solution that should be implemented.





8. Think back to a time you heard someone argue for something they did not believe in. How could you tell they did not believe in their own argument?

Student answers may vary. Example: Last year we held a student debate in my English class where students were assigned to speak either for or against animal testing. During this debate, it was obvious that some of the students on the “pro-animal testing” side of the argument did not actually believe in their arguments. They sounded unsure of themselves and did not speak with confidence, saying “um,” hesitating, and struggling to maintain eye contact. Their statements were also vague.

9. Is confidence an appeal to ethos, logos, or pathos? Why?

Confidence is an appeal to credibility, or ethos. When you speak with confidence, you establish yourself as someone who knows what they are talking about and your audience is more likely to view you as a credible source of information.



Mix-it-up: Multipurpose Activity

Overview

Students will develop outlines of their solution or pitch to present to their peers. After presenting their solution or pitch, students will receive feedback and refine their STEM Challenge project.

This activity can be used one or two times during the STEM Challenge. The “Mix-it-up” activity is multipurpose as it can be used to help students refine both their solutions and their pitches.

Objectives

By the end of this activity, students will be able to:

- Identify the key points they should address in their solution or pitch.
- Give and receive constructive criticism.
- Ask clarifying questions to deepen understanding.
- Refine their solution or pitch.

Key Messages

- Constructive criticism is a critique that points out areas of improvement for a product.
- Destructive criticism is a critique that tears down a product, pointing out the ways in which a product is bad. It can also target the person presenting the product.
- Presentations of STEM Challenge solutions should include an explanation of the solution and its effectiveness, efficiency, construction, materials, and cost. The presentation should also help the audience understand how the solution was designed and refined into its current iteration, including the scientific evidence underpinning it.
- STEM Challenge solution pitches should cover the importance of the solution and its implementation, upfront cost, maintenance cost and frequency, material selection, impact, and potential risk. The pitch should also back up all claims with evidence and include comparisons to other solutions or data.

Time Needed: 30+ minutes

Standards

NGSSS Gifted Learners Benchmarks

G.K12.4.1.4b, Solution Finding-Understand: Establish and apply criteria for evaluation of solutions.

Background Information

Types of Criticism

While many types of criticism exist, criticism can usually be categorized as either constructive or destructive. The main way to differentiate between constructive and destructive criticism is to identify the intent behind it.

Destructive criticism points out problems in a product without providing any actionable feedback and can be recognized by its vague identification of any problems in the product. For example, instead of stating, “The solution presented did not identify what specific materials were being used,” the criticism may be, “The solution is bad” or, “The materials aren’t good enough.” Providing vague feedback ensures that the problem is not identified and cannot be addressed or fixed and provides no suggestions on how to rectify the issue. Finally, destructive criticism also includes criticism aimed at the creator instead of the product.

Constructive criticism, on the other hand, aims to identify both the problems or areas for improvement in a product and provides suggestions on how to fix them. While constructive and destructive criticism can both point out and

identify the same problem, the difference lies in how the flaw is addressed. For example, while destructive criticism may state, “This solution’s risk is bad,” constructive criticism of the same problem may state, “The solution has a high financial risk. You should explain why this risk is worth taking.” While neither type of criticism fixed the problem, the constructive criticism provided a suggested direction that can be taken to solve the problem.

Materials (per student)

- Student Guidebook
- Solution or Pitch Checklists
- Pencil

Set-Up Procedure

1. Make sure that students have access to their Student Guidebooks and their in-progress STEM Challenge projects.
2. Let students know that they should have their solution or pitch fully drafted prior to the day of the “Mix-it-up” activity. Make sure students know that they will be presenting their draft to their peers for feedback, but it will not be in front of the entire class.
3. Checklists are not contained within the Student Guidebook. Print several copies of the desired solution or pitch checklist for each group. This way each group can receive feedback several times.
4. Optional: Open PowerPoint.

Activity Procedures

INTRODUCTION: <i>In this part of the activity, students will discuss the importance of receiving constructive criticism from their peers.</i>	
TIME REQUIRED: 8 minutes	
What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to open their Student Guidebooks to the “Mix-it-up” student worksheet on page 43 .	1. Students will open their guidebooks to the “Mix-it-up” student worksheet.
2. Ask students to answer the first two questions on their worksheet. If you have already used the “Mix-it-up” activity, you may review student answers to questions 1-2 and skip steps 3-6 in the “Introduction” of the activity. As students record their answers in their guidebooks, circulate the classroom looking for specificity. Encourage students with vague answers to go back and narrow down their responses.	2. Students will answer or review questions 1-2 on their student worksheet. Q1: <i>What is constructive criticism? How is it different from criticism?</i> A: Constructive criticism is when someone critiques a product by pointing out areas for improvement. It is done to help refine a product. Criticism just points out mistakes and does not help improve the product. Q2: <i>Give an example of constructive criticism and criticism. How might these sound?</i> A: Student answers may vary. Example: “Your solution does not sound like it is going to work” is an example of criticism. “Your solution sounds like a good idea, but it does not address X, Y, and Z. To make sure your solution works, you need to address these three points” is an example of constructive criticism

3. Select several students to share their answers to questions 1-2.	3. Selected students will share their answers to questions 1-2.
4. Tell students that the “Mix-it-up” activity is designed to give students a structured time to receive feedback on their STEM Challenge in class.	4. Students will listen.
5. Ask students to find a partner and discuss why it is important to only use constructive criticism when giving feedback on a STEM Challenge project. Students should discuss the importance of constructive criticism for approximately 3 minutes.	5. Students will find a partner and discuss the importance of using constructive criticism when giving feedback.
6. Select 2-3 student pairs to share what they discussed.	6. Selected student pairs will share what they discussed.

RECEIVING FEEDBACK: *In this part of the activity, students will identify the components they need to address in their solution or pitch before presenting it to their peers to receive constructive feedback.*

TIME REQUIRED: 22 minutes

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to move and sit with their STEM Challenge group if applicable. Students working on the STEM Challenge individually do not need to move.	1. Students completing the STEM Challenge in groups will move to sit with the rest of their group members.
2. Pass out either the solution or pitch checklist to students or student groups and tell students to take a minute to read over the components needed for a strong solution or pitch. These components are written in the solution or pitch checklist. Let students know that there may be components listed on the checklist that they had not considered prior to the “Mix-it-up” activity. This is okay and expected. They are still on the working/drafting process.	2-3. Students will read over the checklist and listen to the instructions.
3. Explain to students that in this activity, they will work with their peers to receive feedback on their solution or pitch using the checklist.	
4. Ask students to identify the goal of the activity and what they should be doing with the feedback they receive. Once students have been given time to formulate their answers, ask students to raise their hands. Selected students will share their answers. Students should be able to identify that this activity’s goal is to get an outside perspective on their project and identify areas where it may need to improve. Students should also understand that they should be using this time to refine or add to their project, not rework their solutions or pitches from scratch.	4. Students will raise their hands. Selected students will share their answers.

5. Tell students to use the draft of their solution or pitch to create a rough outline that addresses each item on the checklist. They will use this outline to present their solution or pitch to other students. Students should have at least 5 minutes to create their outline. Make sure students know that the outline should contain brief statements and not full sentences. Tell students that if they are missing an item on their checklist, they should develop a working draft. During their presentation, they should indicate they are still developing this item. Tell students that this is a good time to ask questions if they do not know what any of the items on the checklist mean. As students draft an outline, circulate the classroom. If students are writing detailed outlines, remind students that this should be a rough outline. When giving a presentation, they cannot read their outline word-for-word. The outline should only be used as a reminder for each talking point.	5. Students will create an outline that contains the main points of their solution or pitch. Students will ask questions if needed.
6. Tell students to practice presenting their outline. Suggest that groups use this time to identify which students will be presenting the information. Groups may choose to have one student present their solution or pitch or to break it into separate components presented by multiple group members. As students practice, circulate the classroom to provide general feedback.	6. Students will practice presenting the information contained in their outline.
7. Tell students to move and find an individual or group to present their solution or pitch. Ideally, groups should find another group to partner with while individual students should find another individual to be their partner. If there are an odd number of groups or individuals, groups may partner with an individual and vice versa. If needed, students can partner with more than one group.	7. Students will find a partner/group and will move to sit or stand with their partner/group.
8. Tell students to take turns and present their solution or pitch to each other. As one party presents, the other should review the solution or pitch and check items off of the checklist. The presenting individual or group should have at least 5 minutes to present their solution or pitch. Remind students that notes should be written with a constructive criticism mindset! As students present, circulate the classroom to provide general feedback. Do not interrupt student presentations and only provide general feedback when there is a natural pause in the presentation.	8. Students will either present their solution/pitch or review the presentation, checking items off the checklist.
9. Tell the reviewing students to take a moment and ask the presenters any clarifying questions.	9. Reviewing students will ask the presenting students questions about their solution or pitch.

10. Tell students that after the reviewers are done asking questions, they should evaluate the presentation and add any additional notes to the checklist. The presenting students should also take a moment to reflect on their presentation, taking note of any potential changes or areas for improvement using their outline. Tell the reviewers not to share their checklist and feedback until both parties have presented.	10. Reviewing students will consolidate their notes and discuss checklist items. Presenting students will take note of any areas where they feel like they struggled and identify what they want to change for their next presentation.
11. Tell students to switch roles and repeat the feedback process. The presenting individual or group should have at least 5 minutes to present their solution or pitch.	11. Students will switch roles and repeat steps 8-10.
12. Tell students to trade checklists and read their feedback. Students should not have given each other their checklists and feedback until both parties have completed their presentations.	12. Students will trade checklists and read over their feedback.
13. Tell students to ask any clarifying questions about their feedback.	13. Students will ask their reviewers any needed clarifying questions about the feedback they received.

CONCLUSION: *In this part of the activity, students will utilize the feedback they received to refine their solution or pitch.*

TIME REQUIRED: 0-30 minutes*

**The feedback process can repeat as long as time allows*

What the Teacher Does	Anticipated Student Behaviors/Responses
1. Ask students to refine their outlines, get a new checklist, find another partner/group, present their solution/pitch and provide feedback. Students should continue the process of presenting and giving feedback for as long as time allows.	1. Students will refine their outlines, get a new checklist, find another partner/group, present their solution/pitch and provide feedback. Students will continue to repeat this process.

Notes/Considerations

Students should be allowed to ask clarifying questions at any time during the lesson.

If students need additional time to “Mix-it-up,” you can optionally give students extra checklists to take home. These checklists can be given to family or friends outside of class to receive extra feedback on their solution or pitch. Alternatively, it can be given to students as a homework assignment.

Optionally, the “Mix-it-up” activity can also be held in class for students to receive feedback on their solutions and assigned as homework later in the year for students to receive feedback on their pitches.

STEM Challenge: Solution Checklist and Feedback Form

Presenter Name(s): _____

Reviewer Name(s): _____

Solution Checklist		
✓	Item Addressed	Notes
	Explanation of solution/Functionality	
	Effectiveness	
	Efficiency	
	Material identification	
	Material cost	
	Construction/Implementation	
	Identifies design considerations	
	References the engineering design process	
	Straightforward/Easy to understand	
Additional Notes: 		

Presenter Name(s):_____

Reviewer Name(s):_____



Multi-Purpose Activity: Mix-it-up!

Instructions: Answer the questions below about constructive criticism to prepare for today's activity.

1. What is constructive criticism? How is it different from criticism?

Constructive criticism is when someone critiques a product by pointing out areas for improvement. It is done to help refine a product. Criticism just points out mistakes and does not help improve the product.

2. Give an example of constructive criticism and criticism. How might these sound?

Student answers may vary. Example: "Your solution does not sound like it is going to work" is an example of criticism. "Your solution sounds like a good idea, but it does not address X, Y, and Z. To make sure your solution works, you need to address these three points" is an example of constructive criticism.





Field Trips: Resources

As part of the STEM Challenge, teachers may reserve a field trip to Frost Science. This field trip includes a self-guided tour of the museum and a STEM Challenge Learning Lab. To help guide students in their exploration of the museum, teachers may optionally provide STEM Challenge scavenger hunts of the museum. These scavenger hunts must be printed by the teacher prior to arrival at the museum; Frost Science will not provide copies on-site.

Each scavenger hunt is related to one of the STEM Challenge prompts. Students should receive the scavenger hunt associated with the prompt they are addressing in their STEM Challenge project. Each question in the scavenger hunts helps students identify how their prompts are related to emerging technologies. The scavenger hunts provide basic guidance on where in the museum students should look to find answers to each question.

“The best museums and museum exhibits about science or technology give you the feeling that, hey, this is interesting, but maybe I could do something here, too.”

– Paul Allen

Frost Science Scavenger Hunt: Marine Science

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and marine science.

1. **The Dive:** Find the overfishing interactive. Identify unsustainable fishing practices and describe what happens when you use unsustainable fishing practices. How might the government monitor local fishing operations?
2. **Power of Science:** Walk across the ramp in Power of Science, paying attention to each of the exhibits you pass. How can sonar be used to monitor and track changes in marine environments?
3. **Power of Science:** Walk across the ramp in Power of Science, paying attention to each of the exhibits you pass. What does Doppler radar track? What can it tell us about marine conditions?
4. **Power of Science:** Find the display labeled, "Our Oceans." How do ocean drifters help monitor and track changes in marine environments?
5. **Power of Science:** Find and watch the video titled, "Shark Tagging." Why would scientists need to monitor shark activity? How does understanding their activity help us learn about marine ecosystems?
6. **Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and marine science?

Frost Science Scavenger Hunt: Marine Science

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and marine science.

- The Dive:** Find the overfishing interactive. Identify unsustainable fishing practices and describe what happens when you use unsustainable fishing practices. How might the government monitor local fishing operations?

Some of the unsustainable fishing practices in this game include using a net, which produces a lot of bycatch, catching endangered species, and driving boats over coral reefs. When we used a lot of unsustainable fishing practices, we were arrested and fined. The government might monitor local fishing operations by monitoring areas with coral reefs and periodically checking the fishing gear used by fishing operations and inspecting their catch.
- Power of Science:** Walk across the ramp in Power of Science, paying attention to each of the exhibits you pass. How can sonar be used to monitor and track changes in marine environments?

Sonar can be used to measure water depth. This can give us a better understanding of seafloor spreading, sedimentation, and more.
- Power of Science:** Walk across the ramp in Power of Science, paying attention to each of the exhibits you pass. What does Doppler radar track? What can it tell us about marine conditions?

Doppler radar can be used to track storms, including hurricanes. Storms can influence surface currents, create large waves, and cause storm surge. This can make conditions hazardous for sailors and can impact marine life.
- Power of Science:** Find the display labeled, “Our Oceans.” How do ocean drifters help monitor and track changes in marine environments?

Drifters send location data and, when released, move with surface currents. This can give scientists a better understanding of surface currents, the migration of marine animals, the movement of debris, and more. Drifters can also be equipped with sensors that gather water quality data, like water temperature and pH. This can help scientists learn about regional differences in ocean conditions and water quality.
- Power of Science:** Find and watch the video titled, “Shark Tagging.” Why would scientists need to monitor shark activity? How does understanding their activity help us learn about marine ecosystems?

Tagging sharks helps scientists monitor shark activity and movement. This allows scientists to find areas that are important for shark reproduction and learn more about their behavior and ecology. Right now, shark populations are declining, and this data can be used to help inform policymakers when making marine decisions.
- Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and marine science?

Frost Science Scavenger Hunt: Astronomy

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and astronomy.

1. **Feathers to the Stars:** Find the digital interactive labeled, “Life on Mars.” How can we power the technology needed to sustain life on other planets? Why is it important to consider energy sources when designing life support systems and other technologies?
2. **Feathers to the Stars:** Find the digital interactive labeled, “Space Explorations Virtual Command Center.” From the home page, select, “Autopilot Flights” and “Journey to Int’l Space Station.” What do astronauts on the International Space Station (ISS) do in case of emergency? What constitutes an emergency?
3. **Power of Science:** Find the display labeled, “Can New Technology Help Us Live on Mars?” How is some space waste created? What problems are associated with space waste?
4. **Power of Science:** Find the display labeled, “Can New Technology Help Us Live on Mars?” What dangers are associated with solar and cosmic radiation in space? What are engineers trying to design to protect astronauts from solar and cosmic radiation on Mars?
5. **Power of Science:** Find and watch the video titled, “Hunting for Lunar Water.” Where can extraterrestrial water be found and is this enough water to sustain one or more astronauts? Why?
6. **Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and astronomy?

Frost Science Scavenger Hunt: Astronomy

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and astronomy.

- Feathers to the Stars:** Find the digital interactive labeled, “Life on Mars.” How can we power the technology needed to sustain life on other planets? Why is it important to consider energy sources when designing life support systems and other technologies?

Technology in space needs to be powered by sustainable and renewable energy sources, like solar power. Renewable energy sources are reliable and cannot run out, unlike fossil fuels. This is important because if a life support system were to stop receiving power, it could cost astronauts their lives.
- Feathers to the Stars:** Find the digital interactive labeled, “Space Explorations Virtual Command Center.” From the home page, select, “Autopilot Flights” and “Journey to Int’l Space Station.” What do astronauts on the International Space Station (ISS) do in case of emergency? What constitutes an emergency?

Astronauts on the ISS can evacuate using Soyuz spacecraft in case of an emergency. These emergencies may include depressurization, fires, or any other situation that may threaten their lives.
- Power of Science:** Find the display labeled, “Can New Technology Help Us Live on Mars?” How is some space waste created? What problems are associated with space waste?

Some space waste is created when old satellites collide and break. A lot of this waste moves fast enough that it could rip through spacecraft, making it dangerous to travel to other planets.
- Power of Science:** Find the display labeled, “Can New Technology Help Us Live on Mars?” What dangers are associated with solar and cosmic radiation in space? What are engineers trying to design to protect astronauts from solar and cosmic radiation on Mars?

Like on Earth, solar radiation in space can increase the likelihood that astronauts will develop certain cancers. However, unlike Earth, other planets do not have a protective magnetic field and therefore astronauts on other planets would experience higher levels of radiation. Currently, engineers are looking into trying to develop an artificial magnetic field, designed to mimic Earth’s magnetic field, that would protect astronauts on Mars.
- Power of Science:** Find and watch the video titled, “Hunting for Lunar Water.” Where can extraterrestrial water be found and is this enough water to sustain one or more astronauts? Why?

Extraterrestrial water can be found in the Moon’s polar regions. However, this is not enough water to sustain one or more astronauts. This is because the water here is frozen into the lunar surface, making it difficult to access and extract.
- Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and astronomy?

Frost Science Scavenger Hunt: Paleontology

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and paleontology.

1. **The Dig:** Look at the exhibits in The Dig. What tools do paleontologists use to access and extract fossils? Would you describe most of these tools as low-tech or high-tech? Why do you think paleontologists use these types of tools?
2. **The Dig:** Look at the exhibits in The Dig. What methods do paleontologists use to locate fossils in the field? Why might it sometimes be hard to find fossils?
3. **The Dig:** Look at the exhibits in The Dig. What is a jacket and what are jackets made of? Why are jackets used to preserve and transport fossils?
4. **The Dig:** Observe the fossil preparation laboratory. What do you notice about the fossils in the preparation laboratory? Do you think fossil preparation is a short or long process? Easy or hard? Why?
5. **The Dig:** Look at the exhibits in The Dig. Describe the disadvantages of current fossil preservation techniques.
6. **Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and paleontology?

Frost Science Scavenger Hunt: Paleontology

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and paleontology.

- The Dig:** Look at the exhibits in The Dig. What tools do paleontologists use to access and extract fossils? Would you describe most of these tools as low-tech or high-tech? Why do you think paleontologists use these types of tools?

Paleontologists use a wide variety of tools to access fossils, including rock hammers, chisels, awls, brushes, and brooms. These tools are primarily low-tech, which may be advantageous as remote areas often have limited access to power. In addition, low-tech tools allow paleontologists to have more control and extract fragile fossils slowly and carefully. In the laboratory, paleontologists can use more high-tech tools, like air scribes, to carefully remove the matrix surrounding fossils.
- The Dig:** Look at the exhibits in The Dig. What methods do paleontologists use to locate fossils in the field? Why might it sometimes be hard to find fossils?

Paleontologists use geologic maps that display rock ages to identify what areas are the correct age and may contain fossils. The geologic maps are created by scientists as they evaluate exposed rock to look for stable isotope ratios, paleomagnetism, radioactive isotopes, and index fossils. These all change over time and can be used to predict rock age.
- The Dig:** Look at the exhibits in The Dig. What is a jacket and what are jackets made of? Why are jackets used to preserve and transport fossils?

A jacket is the hard covering placed around fossils and the surrounding matrix in the field. It helps protect the fossils as they are transported from the field to a laboratory for extraction. These jackets are made of many layers of burlap soaked in plaster.
- The Dig:** Observe the fossil preparation laboratory. What do you notice about the fossils in the preparation laboratory? Do you think fossil preparation is a short or long process? Easy or hard? Why?

The fossils in the preparation laboratory have had the top of their jackets removed, exposing the fossil and surrounding matrix. The fossil preparation laboratory also has a lot of small boxes containing bone fragments. Based on these observations, it looks like fossil preparation is a long, difficult process. It looks like to remove the matrix, portions of the fossil also have to be removed. The paleontologist would then have to remember where each piece of the fossil came from to reconstruct the fossil at a later date.
- The Dig:** Look at the exhibits in The Dig. Describe the disadvantages of current fossil preservation techniques.

Current fossil preservation techniques are difficult and slow. They also require knowledge from paleontologists at every step along the way, from finding the fossils in the field to extracting fossils in the laboratory. The only part of the process that appears to directly use technology is some of the fossil preparation in the laboratory. This means that the paleontological field has room to become more efficient.
- Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and paleontology?

Frost Science Scavenger Hunt: Health

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and health.

1. **MeLab Level 2:** Find the digital interactive labeled, “Healthcare on Demand.” What are the advantages and disadvantages of telehealthcare?
2. **MeLab Level 3:** Find the “High-tech Medicine” videos and watch one video of your choice. What does this technology do? How does this technology make healthcare more accessible or efficient?
3. **Power of Science:** Find and watch the video titled, “Organs on a Chip.” Describe what scientists are doing in the video. What is the purpose of this technology?
4. **Power of Science:** Find and watch the video titled, “Helpful Robots in our Future.” How are these robots being used to treat or take care of people? Once they reach the manufacturing phase, do you believe these robots are accessible? Why?
5. **Power of Science:** Find the display labeled, “Can other animals help us understand our bodies?” What is CRISPR and how is it used?
6. **Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and health?

Frost Science Scavenger Hunt: Health

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between emerging technologies and health.

1. **MeLab Level 2:** Find the digital interactive labeled, “Healthcare on Demand.” What are the advantages and disadvantages of telehealthcare?

Telehealthcare allows patients to access healthcare from any location, making it more accessible for people who may otherwise be unable to travel to or take time off to see a healthcare professional. However, because telehealthcare is remote, it heavily relies on the dialogue between the patient and healthcare professional to provide a diagnosis and does not rely on any vitals or lab work, which may help healthcare professionals provide a more accurate diagnosis.

2. **MeLab Level 3:** Find the “High-tech Medicine” videos and watch one video of your choice. What does this technology do? How does this technology make healthcare more accessible or efficient?

There are four video topics: robotic surgery, 3D-printed medical models, interventional radiology, and awake craniotomy. In the 3D-printed medical model video, it talks about how doctors use medical scans to create 3D models. These models can then be used to practice surgeries before they are performed. This helps doctors prepare for more for unusual surgeries, making the surgery more efficient and reducing the room for error.

3. **Power of Science:** Find and watch the video titled, “Organs on a Chip.” Describe what scientists are doing in the video. What is the purpose of this technology?

Scientists are working to recreate human organs on the microscopic scale. These microscopic organs would be used to test the efficacy of different drugs. Right now, many drugs are tested on animals. This can provide a general idea about the efficacy of a drug, but the data collected using animals would produce results that do not directly translate to how human organs would respond.

4. **Power of Science:** Find and watch the video titled, “Helpful Robots in our Future.” How are these robots being used to treat or take care of people? Once they reach the manufacturing phase, do you believe these robots are accessible? Why?

The robots created by Toyota are being programmed to help elderly people at home. For example, the University of Miami is programming these robots to help retrieve items. Once these robots have been manufactured, they will probably have a high price point. This will make it inaccessible for most individuals.

5. **Power of Science:** Find the display labeled, “Can other animals help us understand our bodies?” What is CRISPR and how is it used?

CRISPR is a gene-editing tool that helps scientists make precise changes to DNA. This allows scientists to add genetic markers or change how organisms look, behave, or function.

6. **Bonus Question:** If you watched a planetarium show, what show did you watch? How can you connect what you learned to emerging technologies and health?



Meet the Museum Scientist: Resources

As part of the STEM Challenge, teachers may reserve virtual Meet the Museum Scientist opportunities through Frost Science. During the Meet the Museum Scientist opportunities, students will have a chance to learn about a scientist and their research. Students will also be able to ask this scientist questions.

Students should spend time prior to each Meet the Museum Scientist opportunity they attend to draft questions that may aid them in their STEM Challenge projects. To help students with this, the Meet the Museum Scientist activity sheet can optionally be provided to students before the virtual meeting. This activity sheet can be given to students to complete during class or may be assigned as homework. **The activity sheet is not contained within the Student Guidebook and must be printed for students.**

“Research is to see what everybody else has seen, and to think what nobody else has thought.”

– Albert Szent-Györgyi

Meet the Museum Scientist

Instructions: You will have an opportunity to talk with a scientist, learning about them and their research. Answer the questions below to prepare to meet the museum scientist. As you answer each question, consider how you can use the Meet the Museum Scientist opportunity to help you learn about what it means to be a scientist and develop your STEM Challenge project.

1. Write 3 questions for the scientist about how they got into their scientific field.
2. Scientists take a variety of educational journeys to start their career. As a student working to solve the same problems as scientists, why is it important for you to understand the steps scientists take to enter their field?
3. Write 3 questions for the scientist about how they communicate scientific concepts and their research to the public.
4. Why is it important to understand how to communicate scientific concepts to the public? How can you use the scientist's answers to develop your STEM Challenge project?
5. Write 3 questions for the scientist asking for advice on your STEM Challenge project. Focus on your procedures and the challenges you have encountered when completing your project.
6. Why is it important to get a scientist's perspective on your STEM Challenge project?

Meet the Museum Scientist

Instructions: You will have an opportunity to talk with a scientist, learning about them and their research. Answer the questions below to prepare to meet the museum scientist. As you answer each question, consider how you can use the Meet the Museum Scientist opportunity to help you learn about what it means to be a scientist and develop your STEM Challenge project.

- Write 3 questions for the scientist about how they got into their scientific field.
Student answers may vary. Example question: What school did you attend and what did you study?
- Scientists take a variety of educational journeys to start their career. As a student working to solve the same problems as scientists, why is it important for you to understand the steps scientists take to enter their field?
Student answers may vary. Example: As a student completing the STEM Challenge, I am working on the same problems as scientists without having the same background knowledge and experience. If scientists with more experience and education than me are struggling to solve this problem, this problem will likely be even more difficult for me to solve. Alternatively, because I have different experiences, I might have a fresh perspective on the problems presented by the STEM Challenge.
- Write 3 questions for the scientist about how they communicate scientific concepts and their research to the public.
Student answers may vary. Example question: How do you explain complicated scientific concepts to people that have no background knowledge?
- Why is it important to understand how to communicate scientific concepts to the public? How can you use the scientist's answers to develop your STEM Challenge project?
Student answers may vary. Example: People will not care about scientific topics unless they understand them. By communicating science with the public, they may begin to care about the topic and invest in the scientific field. In the STEM Challenge, I need to create a presentation that showcases our solution. This presentation should be understood by everyone listening to our presentation, not just scientists within the field. The scientist's answers will help me figure out how to filter through and communicate the information needed for my audience to understand my solution.
- Write 3 questions for the scientist asking for advice on your STEM Challenge project. Focus on your procedures and the challenges you have encountered when completing your project.
Student answers may vary. Example question: What do you do when you feel like you have hit a roadblock in your work? How do you get past your roadblock?
- Why is it important to get a scientist's perspective on your STEM Challenge project?
Student answers may vary. Example: Scientists use the same procedures as the ones I am using to complete the STEM Challenge. They may be able to give me a new perspective on the STEM Challenge or tips and tools that might help me accomplish my STEM Challenge project.

Section 3



Teacher Resources

The Teacher Guidebook provides a wide variety of resources to help teachers integrate the STEM Challenge into their curriculum and assist in guiding students through their STEM Challenge projects. This section provides an overview of each resource provided in Section 3 of the Teacher Guidebook. These resources are optional and provided to reduce the stress and workload of implementing the STEM Challenge on teachers. Teachers are encouraged to use and modify any of the provided resources as needed.

Content Connections

Teachers for select courses are provided content connections between STEM Challenge activities and prompts and Next Generation Sunshine State Standards or course standards. These can be used to help show students how STEM Challenge content is relevant to their coursework. They can also provide additional information about each STEM Challenge prompt, which may guide students in their solution and project design.

Pacing Guides

The pacing guides provided within this guidebook include two pacing guides specific to courses within M-DCPS and generic pacing guides for semester-long and year-long STEM Challenge projects.

Planning Space

Teachers are also provided with a calendar of the school year to begin planning the STEM Challenge within their classes, programs, or extracurriculars. This planning space can be used to schedule STEM Challenge activities or can be used in conjunction with the provided Content Connections and Pacing Guides to schedule other coursework.

Final Product

Section 3 also includes recommendations for how to submit and evaluate student projects. As part of this, a suggested rubric is provided. This rubric can be optionally used to assess student work after they have completed their STEM Challenge projects. Teachers can also adapt the Judging Rubrics to assess final products.

“What you do makes a difference, and you have to decide what kind of difference you want to make.”

– Jane Goodall

STEM Challenge 2025-2026 Content Connections

The STEM Challenge Teacher Guidebook provides recommended content connections for each of the four STEM Challenge prompts. These content connections are specific to the 2025-2026 prompts which reflect this year's emerging technologies focus. While content connections have been provided for select courses, they may be used for any class participating in the STEM Challenge. Content connections are provided for the following:

Next Generation Sunshine State Standards and Florida's State Academic Standards

- Health Education Standards
- Computer Science Standards
- Science Standards

Courses

- STEM Research Elective
- Earth and Space Science Honors
- Environmental Science Honors
- Advanced Placement (AP) Environmental Science
- Advanced Placement (AP) Biology

Students may select any prompt to complete the STEM Challenge, but each course has associated prompts. These prompts are identified as being closely related to each course's content. Depending on class structure, teachers may allow students to choose any prompt to complete the STEM Challenge or restrict students to the associated prompts for their course. Information on each prompt is paired with associated course topics/standards. To identify the information associated with each prompt, refer to the colored letters and symbols in the "Associated Prompts" column. The marine science prompt is denoted by **M** or 🐟, the health prompt by **H** or 🏥, the paleontology prompt by **P** or 🦕, and the astronomy prompt by **A** or 🌌.

The content connections provided here may include examples, data, or other information relevant to a prompt and to the identified course topic/standard. Teachers are welcome to use the content connections in class to underscore how class content is relevant to students' STEM Challenge projects.

Health Education Standards			
Associated Prompts: Health Along with associated prompts, some standards are paired with a STEM Challenge activity.			
Consumer Health			
Health Education Standard	Associated Prompts	Justification	Potential Connectors
Standard 1: Core Concepts			
HE.912.CH.1.1 Evaluate the relationship between access to health care and health status.		Access to health care is correlated with the health status of both individuals and communities. This access can be limited for a variety of reasons, from a lack of facilities and doctors within a community to individual financial barriers. For example, people may not be able to have regular health screenings because of their distance from facilities that have the necessary equipment or may be unable to afford regular health screenings due to the high cost without insurance. Making emerging technologies more affordable can increase their prevalence in areas with limited facilities and can decrease the cost of healthcare overall. This increases access to health care in areas with limited resources and therefore increases the health status of the area by helping provide earlier diagnoses for medical problems.	Ask students to describe the relationship between the cost of medical equipment or emerging technologies and the health status of low-income communities.
Standard 4: Advocacy			
HE.912.CH.4.1 Justify the use of valid technologies to gather health information.		Many emerging technologies in the medical field are used to help diagnose patients. However, the information collected by these technologies often needs to be interpreted by medical professionals before a diagnosis can be provided. These interpretations have room for error, and this can lead to inaccurate diagnoses and skewed community data. Emerging technologies could be used to support the medical professionals responsible for interpreting information and inputting data. This would allow us to have earlier, more accurate diagnoses and would provide more accurate data, which could lead to better predictions of community health.	Ask students to identify what types of emerging technologies could be used to help interpret data. If students identify Artificial Intelligence (AI) as a beneficial emerging technology for this task, ask students to identify the current benefits and disadvantages of using AI for disease diagnoses.
Resiliency			
Health Education Standard	Associated Activities	Justification	
Standard 4: Critical Thinking and Problem Solving			
HE.912.R.4.1 Analyze the importance of character and grit to achieve successful outcomes.	Activity 3	In discussing the engineering design process during <i>Activity 3: Iterative Ideas</i>, students will identify that they will encounter problems when designing their solutions. This activity guides students in thinking of these problems as a step in the engineering design process that they must push through to develop realistic, successful, and creative solutions.	
HE.912.R.4.2 Generate and apply alternative solutions when solving problems or resolving conflict.	Activity 1	While completing the practice debrief in <i>Activity 1: Let's Get Started</i>, students are asked to reflect on how generating and considering multiple solutions is advantageous in completing the STEM Challenge. Through their reflections, students should be able to identify that alternative solutions may be more realistic than the first solution they came up with to address their identified issue.	

Health Education Standard	Associated Activities	Justification
HE.912.R.4.4 Identify the importance of perseverance when facing difficulty solving a problem.	Activity 3	In completing <i>Activity 3: Iterative Ideas</i> activity, students will identify that the engineering design process is a cycle of trial and error through which they will improve upon their solutions. This cycle requires students to persevere and tackle each challenge that comes their way and encourages them to actively seek new challenges even when they are not immediately evident.
	Activity 4	<i>Activity 4: Pitch Your Point</i> communicates that students should call attention to each of the challenges they faced in designing their solution. Student presentations become stronger when students highlight their struggles and identify how overcoming them strengthened their project.
	Activity 5	In the <i>Multi-Purpose Activity: Mix-it-up!</i> , students must acknowledge the flaws within their solutions or pitches and address each issue as it arises.

Computer Science Standards			
Associated Prompts: Marine science, health, paleontology, astronomy			
Computational Thinking and Reasoning			
Computer Science Standard	Justification		
SC.K12.CTR.1.1 Actively participate in effortful learning both individually and collaboratively.	Students in the STEM Challenge can work individually or in groups to design solutions. In doing so, students must actively engage with materials related to their chosen topic. Additionally, students completing <i>Activity 5: Mix-it-up</i> will receive feedback from their peers, which they can then incorporate into their project solutions.		
SC.K12.CTR.2.1 Demonstrate understanding by decomposing a problem.	Students must break down the prompts provided by the STEM Challenge into smaller, more manageable parts. These smaller parts can then be addressed individually to begin building a solution.		
SC.K12.CTR.7.1 Solve real-life problems in science and engineering using computational thinking.	The prompts provided by the STEM Challenge address large-scale problems. In addressing the situations posed by the prompts, students will need to create or use programs and models. In <i>Activity 3: Iterative Ideas</i> , students will learn about the engineering design process and how to evaluate and redesign their solutions to improve their accuracy or efficiency.		
Communication and Collaboration			
Computer Science Standard	Justification		
	Standard 1: Formulate artifacts using collaboration.		
SC.912.CC.1.4 Create a digital artifact utilizing collaboration, reflection, analysis and iteration.	Students completing the STEM Challenge in groups will utilize collaboration throughout the engineering design process as they analyze and iterate upon their ideas. Students working on the STEM Challenge individually will also have the opportunity to collaborate with others during <i>Activity 5: Mix-it-up</i> . Using the feedback students receive on their solution, students can create or alter the digital models they created to display their 2025-2026 STEM Challenge solution.		
Technological Impact			
Computer Science Standard	Justification		
	Standard 1: Assess the impact of technological advancements.		
SC.912.TI.1.6 Describe how technology impacts personal life.	Students completing the 2025-2026 STEM Challenge will be working with emerging technologies, which includes wearables and Internet of Things devices. However, not all students may elect to design a wearable or Internet of Things device and may choose to engage with different types of emerging technologies.		
Emerging Technologies			
Computer Science Standard	Justification		
	Standard 1: Analyze the impact of emerging technologies on daily life		
SC.912.ET.1.1 Describe the emerging features of mobile devices, smart devices and vehicles.	While completing the 2025-2026 STEM Challenge, students will look at a wide variety of emerging technologies to identify what type of emerging technology can best address their identified issue. These emerging technologies can include mobile devices, smart devices, and vehicles. While students are less likely to focus on the use of mobile devices or vehicles in their STEM Challenge solutions, they may use them in conjunction with other types of emerging technologies, including Artificial Intelligence and smart devices. Smart devices are incredibly versatile and can be used for monitoring purposes or to remotely perform tasks. Wearables are a common type of smart device and are explicitly identified as an emerging technology in the 2025-2026 STEM Challenge.		

Computer Science Standard	Justification
SC.912.ET.1.5 Explore the concepts of virtual and augmented reality.	While completing the 2025-2026 STEM Challenge, students will look at a wide variety of emerging technologies to identify what type of emerging technology can best address their identified issue. These emerging technologies can include virtual, augmented and mixed reality. Each technology can be used to perform different tasks and therefore may be used in different ways within student solutions. For example, while virtual reality could be used to help a surgeon practice a particularly difficult or uncommon surgery, augmented reality could be used to help a paleontologist view the location of a scanned fossil within the surrounding matrix. Students will be less likely to use mixed reality within their solution as it borders both virtual and augmented reality, creating virtual elements that can be viewed and manipulated in the physical world.
Standard 2: Analyze the impact of Artificial Intelligence (AI) and its applications SC.912.ET.2.6 Describe how predictive Artificial Intelligence (AI) can be used to solve problems.	While completing the 2025-2026 STEM Challenge, students will look at a wide variety of emerging technologies to identify what type of emerging technology can best address their identified issue. These emerging technologies can include Artificial Intelligence (AI). Students using AI in their solution will either describe how AI can address their identified problem or will be training AI. AI can be used in a variety of different ways to solve problems, including for predictive, generative, or identification purposes.
SC.912.ET.3.2 Examine how robotics are used to address human challenges.	Standard 3: Analyze characteristics of robotics. While completing the 2025-2026 STEM Challenge, students will look at a wide variety of emerging technologies to identify what type of emerging technology can best address their identified issue. These emerging technologies can include robotics. Students can use robotics for a wide variety of different tasks in their STEM Challenge solutions. However, students will likely integrate robotics with other emerging technologies. For example, a robot can be programmed to perform one or more tasks, but it cannot modify or alter these tasks unless this information is specified in its programming. By integrating robots with other emerging technologies, like AI, these technologies can alter the robot's objectives, increasing the number of tasks the robot can perform.

Science Standards			
Associated Prompts: Marine science, health, paleontology, astronomy			
Life Science			
NGSSS Standard	Associated Prompts	Justification	Potential Connectors
Standard 16: Heredity and Reproduction			
SC.912.L.16.7 Describe how viruses and bacteria transfer genetic material between cells and the role of this process in biotechnology.		In part of the virus replication process, viruses inject their genetic material into a host cell. The host cell then reads this genetic material, creating more of the virus. By modifying viruses so that they inject specific genetic sequences, scientists can introduce healthy genes to patients that may either be missing or have damaged genes. In this way, gene therapy can be used to treat patients with genetic and infectious diseases or cancer.	Ask students to discuss the advantages of using biotechnology like viral vectors for treatments over more traditional treatment methods.
		Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) are genetic sequences found in bacteria. These bacteria contain an enzyme called Cas9, which uses matching RNA sequences to recognize CRISPR. Once Cas9 matches with the CRISPR sequences, it can cut the genetic material. Scientists are repurposing CRISPR-Cas9 to cut DNA and insert or remove specific genetic sequences. Treatments using CRISPR-Cas9 to modify human DNA are still undergoing clinical trials, but this technology may be used to help patients with genetic diseases or cancer.	Tell students that cancers and genetic diseases are the result of abnormalities in an organism's DNA. Ask students to describe how biotechnology that adds a DNA sequence to an organism's DNA could help treat cancer or genetic diseases.
		Restriction enzymes are proteins found in bacteria that can identify and cut specific DNA sequences, known as restriction sites. Scientists are using these proteins to edit, combine, clone, and sequence DNA.	Tell students that scientists can modify the genetic material of bacteria so that they produce specific proteins or hormones. Ask students how this biotechnology can be used to produce medicine.
		Restriction enzymes and CRISPR-Cas9 biotechnology can be used to genetically modify bacteria to produce medicines. These bacteria can produce proteins including hormones like insulin, which can then be collected and used to treat disease.	Ask students to recall any emerging biotechnologies that can be used to treat individual patients. If students are struggling to recall any emerging biotechnologies, tell students to try and recall any news articles they may have read that mention the "first person to..."
SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.		Biotechnology can be used to treat individuals with conditions and diseases that result in organ malfunction or failure. For example, individuals with heart conditions can use a titanium heart as a temporary replacement for diseased hearts until a donor heart becomes available. Along with mechanical replacements, scientists are also growing human tissues and organs in laboratory settings. While this is currently a biotechnology that remains in the early stages of development, some simple organs, like bladders, have already been grown in the laboratory and successfully implanted into human patients.	Ask students to identify how using emerging technologies to quickly and accurately diagnosis infectious diseases can help communities.
		Biotechnology includes laboratory techniques, including Polymerase Chain Reactions (PCR). Techniques like PCR can be used to amplify genetic material, which can then be used to identify tumors, contagious diseases, and genetic diseases. This identification can help medical professionals customize individual treatment plans and help scientists better understand disease prevalence.	

NGSSS Standard	Associated Prompts	Justification	Potential Connectors
SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues. (Cont.)		Wearables, including heart monitors, vary widely and can either be used by medical professionals to diagnose diseases or used recreationally by individuals to monitor their heart rate, sleep cycles, and more.	Ask students to identify a type of biotechnology that many people use on a daily basis. If students have trouble identifying wearables, look around the room to find one or more students who are using a wearable. Identify these students as individuals who are currently using this type of biotechnology.
Standard 17: Interdependence			
SC.912.L.17.3 Discuss how various oceanic and freshwater processes, such as currents, tides, and waves, affect the abundance of aquatic organisms.		Many marine species migrate using currents. By monitoring and tracking individuals in a migratory species, scientists can learn a lot about their migration patterns and how they use currents to travel. This information can then be used to inform policies and laws related to marine activities, including fishing and military operations. Scientists use tags or acoustic telemetry to track the migration of individual organisms.	Ask students to describe the relationship between animal migration patterns and currents and identify how and why oceanographers may use technology to monitor these migration patterns.
SC.912.L.17.8 Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.		Overfishing can result in the loss of biodiversity. By monitoring fishing vessels and the populations of different marine fish species, scientists can identify whether additional protections or regulations are needed to maintain healthy biodiversity. By monitoring the movement of shipping vessels, which may carry invasive and non-native species in their ballast water, and monitoring marine populations, scientists can identify how invasive and non-native species are introduced. Commercial fishing vessels are monitored using either the Automatic Identification System (AIS) or the Vessel Monitoring System (VMS).	Ask students to identify how different types of marine vessels might impact the biodiversity of marine ecosystems and to describe the importance of monitoring these vessels.
SC.912.L.17.11 Evaluate the costs and benefits of renewable and nonrenewable resources, such as water, energy, fossil fuels, wildlife, and forests.		Fish are considered a renewable resource that can be gained through both low-cost and high-cost operations. Many low-cost fishing operations operate on a smaller scale than high-cost operations. While small scale, recreational operations are often monitored periodically by state agencies, like the Florida Fish and Wildlife Conservation Commission, the large-scale operations are often monitored by federal agencies, like the National Marine Fisheries Service. Renewable resources can be overused and depleted without proper agency oversight.	Ask students to identify marine renewable resources and describe why agencies may want to monitor the use of these resources using both established and emerging technologies.
		Non-renewable marine resources include fossil fuels, which are extracted through offshore drilling or fracking. Many offshore drilling and fracking operations are used to access oil and natural gas reserves under the seafloor. While these operations have a high operational cost, they also have non-monetary costs as they can create oil leaks that cause environmental damage. Offshore drilling and fracking are monitored by the Bureau of Safety and Environmental Enforcement.	Ask students to identify non-renewable, offshore resources and describe why agencies may want to monitor the organizations accessing these resources.
		Renewable resources, like solar power, are easier to access in remote environments. For paleontologists, who often have to travel to remote areas to extract fossils, solar power can be used as an alternative to non-renewable resources like gas, coal, or oil. Non-renewable energy sources have to be carried out to the field station and can run out during expeditions.	Ask students to describe the benefits and drawbacks of using renewable and non-renewable energy sources in remote environments.

NGSSS Standard	Associated Prompts	Justification	Potential Connectors
SC.912.L.17.11 Evaluate the costs and benefits of renewable and nonrenewable resources, such as water, energy, fossil fuels, wildlife, and forests. (Cont.)		Renewable resources, like water and oxygen, have to be recycled for astronauts in space. While recycling processes happen naturally on Earth through biogeochemical cycles (e.g. the water cycle), they have to be manually recycled in space. The cost of the technology used to recycle these renewable resources is high, but it is necessary for astronaut survival. Non-renewable resources in space are limited to the materials that astronauts have brought with them. While scientists are currently looking for both renewable and non-renewable resources on celestial bodies other than Earth, scientists do not currently have a way to access these resources. Renewable energy resources, like solar power, are also easier to access in space and do not take up as much storage space as non-renewable resources. Non-renewable energy resources, like gas, coal, and oil, would have to be transported in high volumes into space. In addition to non-renewable resources taking up lots of space, non-renewable resources add additional weight to the spacecraft.	Ask students to describe why the International Space Station primarily relies on renewable energy sources instead of non-renewable energy sources.
SC.912.L.17.12 Discuss the political, social, and environmental consequences of sustainable use of land.		When fossils are excavated, paleontologists have to pay special attention to the excavation area to avoid damaging the surrounding environment. Many fossils are found in fragile ecosystems and if the fossils are found next to an endangered plant species, paleontologists will not excavate the fossil. Additionally, to lessen the impact they have on fragile ecosystems, paleontologists follow the principle of leaving no trace. While paleontologists carefully follow regulations for sustainable land use when extracting fossils on state and federal lands, these regulations do not always apply to fossils being extracted on private lands. The way fossils found on private land are extracted will instead be dependent on the landowner. For example, while fossils found on state and federal lands must be extracted with hand tools to avoid damaging the surrounding environment, a private landowner may choose to use bulldozers or other heavy machinery to extract the fossils from their land. Fossils found on private land can also be sold to private collectors whereas fossils found on state and federal lands must be made accessible to the public.	Tell students that paleontologists follow the principle of leave no trace while in the field. Ask students to explain how this principle promotes sustainable land use.
SC.912.L.17.13 Discuss the need for adequate monitoring of environmental parameters when making policy decisions.		Private, public, and government agencies collect data about the water quality, biodiversity, and resource use for different marine areas. This data is then used to determine what types of environmental policies and protections need to be put in place. Especially vulnerable areas may be turned into Marine Protected Areas (MPAs), which can have different names and levels of protection.	Tell students that some marine areas can be designated as Marine Protection Areas (MPAs). Ask students to describe the type of data they would want to collect to determine if a marine area needs additional protection.
SC.912.L.17.14 Assess the need for adequate waste management strategies.		When extracting a fossil, paleontologists have to remove the overlying rock and sediment. This discarded or waste rock and sediment, called overburden, is often kept next to the paleontological site and placed back in its original location once the fossil has been extracted. If the overburden is not returned to its original location, it can alter the natural habitat and may result in increased erosion. If paleontologists are unable to extract a fossil within the field season, they will also use overburden to rebury the fossils. By re-using the waste rock and sediment to cover the exposed fossil, they can protect the fossil until the following field season.	Tell students that paleontologists produce a type of waste called overburden, which is discarded rock and sediment. Ask campers to describe how they believe paleontologists manage this waste

NGSSS Standard	Associated Prompts	Justification	Potential Connectors
SC.912.L.17.14 Assess the need for adequate waste management strategies. (Cont.)		The waste produced by astronauts in space either has to be recycled or stored, where it can become a safety hazard. Currently, astronauts deal with waste by placing it in a separate spacecraft. This spacecraft is then launched into space and the waste either returns to Earth or burns up in Earth's atmosphere. For sustainable, long-term space missions, scientists will need to develop more long-term solutions to waste management. These solutions will need to focus on reusing or recycling waste. The ocean has large quantities of waste in its gyres. These gyres, or large circular currents, each contain a garbage patch. The majority of the waste that ends up in garbage patches comes from either litter carried by runoff into the ocean or from broken or discarded fishing gear. To avoid adding waste to the garbage patches, more waste management strategies need to be put in place to prevent waste from entering the ocean or to clean up marine debris before it has a chance to break down into microplastics or other small particles. Monitoring the type of debris prevalent in these garbage patches can be used to identify management strategies that may be more effective in reducing the amount of waste we contribute to marine ecosystems.	Ask students to discuss how they believe astronauts deal with waste in space. After students finish their discussion, tell students that the current waste management strategy in space is to launch waste using spacecraft into space or back towards Earth. Ask students to share what they know about the "Great Pacific Garbage Patch" and brainstorm the sources for the garbage within the North Pacific Gyre. Ask students how they believe monitoring the type of garbage in garbage patches could influence waste management strategies.
SC.912.L.17.15 Discuss the effects of technology on environmental quality.		Technology can be used to help monitor environmental quality. However, the addition of technology also has the ability to negatively impact marine environments. Not only can technology break, introducing waste to marine environments, but some technologies can actively cause environmental damage. For example, while Remotely Operated Vehicles (ROVs) can be used to observe deep sea ecosystems, they can introduce noise pollution or can run into delicate ecosystems, causing accidental damage.	Ask students to identify the types of technology that may be used to monitor marine environments. For each technology students identify, ask students to describe the type of information the technology may collect and any potential negative impacts the technology may have on the environment.
SC.912.L.17.16 Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.		Human activities are responsible for introducing waste to marine ecosystems. The environmental issues caused by waste depend on the type, volume, and concentration of waste. Some chemical waste, like pesticides, may negatively impact marine life and disrupt food chains while other chemical waste, like fertilizers, may cause harmful algal blooms and create mass-fish die-offs. The National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) monitor water parameters to evaluate the health of marine ecosystems. Based on the water parameters, NOAA, the EPA, and other organizations may regulate human marine activities. For example, during harmful algal blooms, like the red tide, the Department of Health (DOH) will issue health advisories and close affected beaches, the Florida Fish and Wildlife Conservation Commission (FWC) may restrict fishing, and the Department of Agriculture and Consumer Services may regulate shellfish harvesting.	Ask students to brainstorm how agencies may identify and respond to large-scale environmental disasters, particularly disasters caused by human activities.
SC.912.L.17.17 Assess the effectiveness of innovative methods of protecting the environment.		There are a lot of innovative methods that are currently being put in place to monitor and protect marine ecosystems. For example, the National Oceanic and Atmospheric Administration (NOAA) and Saildrone created solar-powered vessels that monitor a wide variety of environmental conditions. Not only is the data collected by these vessels used to inform and maintain sustainable fishing practices, but it can also help detect oil spills for a rapid response time, monitor threatened and endangered species, and more.	Ask students to discuss the advantages and disadvantages of using different energy sources to power marine monitoring systems.

NGSSS Standard	Associated Prompts	Justification	Potential Connectors
SC.912.L.17.17 Assess the effectiveness of innovative methods of protecting the environment. (Cont.)		While many paleontologists focus on excavating, moving, and preserving fossils for the purposes of research or reconstruction, other paleontologists work to preserve fossils in their natural state. By preserving fossils in their natural state, they can be used as a learning tool. One of the best examples of paleontologists preserving fossils in place is the Dinosaur National Monument, where people can observe a 150-foot-long section of the Carnegie Quarry that contains approximately 1,500 dinosaur bones. While the fossils on the surface of the wall have been exposed, paleontologists stopped excavations to preserve the wall as an educational tool despite the fact that there are more fossils lying below the surface. Unfortunately, Dinosaur National Monument is sliding as the Earth's surface shifts and settles. Scientists are currently in the process of documenting the monument in its current state using photogrammetry.	Tell students the provided information about the Dinosaur National Monument before asking students how they believe paleontologists balance preserving the environment and preserving fossils.
SC.912.L.17.19 Describe how different natural resources are produced and how their rates of use and renewal limit availability.		In space, astronauts are limited to the resources they have brought with them. While space is home to a variety of resources, including water, metals, and minerals, these resources are not currently accessible. Establishing a base in space will give scientists better access to these resources.	Ask students to describe the availability of different natural resources in space and on celestial bodies.
		The ocean contains a lot of different renewable and non-renewable resources. Food resources, including fish and seaweed, can be sourced from healthy marine ecosystems. While food resources are renewable, over-harvesting can impact the rate at which the harvested organism's population recovers and can negatively impact the populations of other marine organisms. By monitoring the population size of harvested organisms or by monitoring the number or volume of organisms harvested, policy makers can make informed decisions regarding harvest seasons, maximum harvest size, and more.	Ask students to brainstorm how agencies may monitor marine resource use.
Earth and Space Science			
NGSSS Standard	Associated Prompts	Justification	Potential Connectors
Standard 5: Earth in Space and Time			
SC.912.E.5.7 Relate the history of and explain the justification for future space exploration and continuing technology development.		NASA's Artemis Missions are designed to establish a lunar base. The first of these missions, Artemis I, was completed in 2022 and sent an uncrewed test flight into lunar orbit. This flight is the first of eight Artemis missions. Once a lunar base has been established, scientists will use what they learned to send astronauts to Mars. Having bases on celestial bodies other than Earth not only gives astronauts the ability to study and learn more about space but can also give humanity access to resources that may be limited on Earth.	Ask students to describe how establishing a lunar base paves the way for future space exploration. Ask students to identify what this lunar base would need to fill the basic needs of astronauts living in the base.
Standard 7: Earth Systems and Patterns			
SC.912.E.7.5 Predict future weather conditions based on present observations and conceptual models and recognize limitations and uncertainties of such predictions.		To predict and forecast the weather, scientists monitor parameters that include temperature, wind speed, and ocean currents. This data is then interpreted and compared to historical data to predict future weather conditions. While scientists can accurately predict weather in the short-term, long-term weather forecasts require scientists to make a lot of assumptions. These assumptions are necessary to make up for gaps in data and random atmospheric movement. No matter how much data scientists collect, they will never be able to monitor and predict all atmospheric movements. This means that weather forecasts are never guaranteed to be 100% accurate. However, increasing the amount of marine and atmospheric data collected can still increase the accuracy of weather forecasts.	Ask students to discuss the following question: Despite constantly monitoring marine temperature, wind speed, and ocean currents, meteorologists cannot predict the weather with 100% accuracy. Why?

			
STEM Research Elective			
Associated Prompts: Marine science, health, paleontology, astronomy			
Associated Prompts are not identified for STEM Research Elective Standards. Instead, each standard is paired with a STEM Challenge activity.			
Nature of Science			
Standard 1: The Practice of Science			
NGSSS Standard	Associated Activities	Justification	
SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science.	Activity 1	During <i>Activity 1: Let's Get Started</i> , students will work through a STEM Challenge practice project. As part of this practice, students discuss the importance of narrowing a wide breadth of information into a clearly defined, realistic, and solvable problem. Within the STEM Challenge, students will have to research the prompt's topic and define a specific problem to address.	
SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.	Activity 4	<i>Activity 4: Pitch Your Point</i> guides students through the basics of creating a strong 'pitch' or argument in favor of their solution. As part of this, students are asked to use logos, an appeal to logic, to support their claims. Students are also advised to include each of their design considerations, identifying how their solution is more realistic or implementable over alternative solutions.	
SC.912.N.1.4 Identify sources of information and assess their reliability according to the strict standards of scientific investigation.	Activity 2	<i>Activity 2: Sound Sources</i> helps students identify reliable sources as unbiased primary or secondary sources. It also teaches students how to read scientific articles.	
SC.912.N.1.5 Describe and provide examples of how similar investigations conducted in many parts of the world result in the same outcome.	Activity 2	While <i>Activity 2: Sound Sources</i> does not address this standard in depth, it discusses how reliable scientific investigations are replicable.	
SC.912.N.1.7 Recognize the role of creativity in constructing scientific questions, methods and explanations.	Activity 3	During <i>Activity 3: Iterative Ideas</i> , students are asked to reflect on a time of their life when they used their creativity to come up with a new, innovative idea or solution. Within the STEM Challenge, students have creative freedom to address a problem or issue related to their prompt of choice.	
Standard 3: The Role of Theories, Laws, Hypotheses, and Models			
SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in science.	Activity 1	In <i>Activity 1: Let's Get Started</i> , students are asked to describe how they could model a solution to the provided prompt in the STEM Challenge practice. The question provides several examples of how students may develop models that demonstrate their solution in part or in full.	
Standard 4: Science and Society			
SC.912.N.4.2 Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.	Activity 3	<i>Activity 3: Iterative Ideas</i> teaches students about the engineering design process and gives students a chance to continue to work on their STEM Challenge solutions to refine their ideas. While refining their ideas, students will have to evaluate their solution to look for potential issues or areas for improvement. To improve their solutions, students will have to compare their current solutions with potential alternatives that have different costs and benefits.	

Earth and Space Science Honors				
Associated Prompts: Marine science, paleontology, astronomy				
First Quarter				
Topic	Associated Prompts	Justification	Potential Connectors	
Characteristics of the Atmosphere	 A	Atmosphere		
		Earth's atmosphere is primarily composed of nitrogen gas (N ₂) and oxygen gas (O ₂) and contains ozone (O ₃), which helps reflect harmful UV radiation. In space, astronauts do not have access to the same protective and breathable gaseous atmosphere. Instead, oxygen is produced using a Sabatier reactor and electrolysis. The Sabatier reactor facilitates a chemical reaction that uses hydrogen gas (H ₂) and carbon dioxide (CO ₂) to produce water (H ₂ O) and methane (CH ₄), and electrolysis splits the resulting water back into hydrogen gas (H ₂) and oxygen gas. NASA's SpaceCraft Oxygen Recovery project is currently in development to increase the efficiency of current oxygen recovery methods. Without an atmosphere to protect astronauts from UV radiation, spacecraft and spacesuits have to be designed with materials that block the majority of UV radiation.		
Weather				
Storms and Severe Weather	 M	Meteorologists predict severe weather conditions, like hurricanes, by analyzing data to determine the size, intensity, and trajectory of the storm. Some of these forecast methods, including statistical-dynamical models, use marine data to help track the storm and predict changes in the storm's characteristics.	Ask students to discuss how meteorologists may use the data collected by monitoring marine conditions to help predict storm intensity.	
Collecting Weather Data	 M	A lot of marine data for the purposes of weather forecasts is collected using metocean buoys. Metocean is a term that refers to both meteorology and oceanography, so the data collected using metocean buoys can be used to learn more about both marine and weather conditions. To predict and forecast the weather, scientists monitor parameters that include temperature, wind speed, and ocean currents.	Tell students that meteorologists and oceanographers use metocean buoys to collect data about marine and weather conditions. Ask campers to describe how both meteorologists and oceanographers may use this data.	
Forecasting the Weather	 M	While scientists can accurately predict weather in the short-term using marine data, long-term weather forecasts require scientists to make a lot of assumptions. These assumptions are necessary to make up for gaps in data and random atmospheric movement. No matter how much data scientists collect, they will never be able to monitor and predict all atmospheric movements. This means that weather forecasts are never guaranteed to be 100% accurate. However, increasing the amount of marine and atmospheric data collected can still increase the accuracy of weather forecasts.	Ask students to discuss the following question: Despite constantly monitoring marine temperature, wind speed, and ocean currents, meteorologists cannot predict the weather with 100% accuracy. Why?	
Second Quarter				
Topic	Associated Prompts	Justification	Potential Connectors	
Energy Resources	 M	Environmental Science and Concerns		
		Fossil fuels can be extracted through offshore drilling or fracking. Many offshore drilling and fracking operations are used to access oil and natural gas reserves under the seafloor and are monitored by the Bureau of Safety and Environmental Enforcement. As part of this monitoring, the Bureau conducts regular inspections and monitors the water quality, air quality, marine ecology, and marine debris near offshore sites.		
After teaching students about fossil fuel extraction methods, ask students to describe the importance of monitoring offshore drilling or fracking operations.				

Topic	Associated Prompts	Justification	Potential Connectors
Burning of Fossil Fuels		Burning fossil fuels produces carbon dioxide which can dissolve into bodies of water, creating carbonic acid and lowering the water's pH. This chemical reaction is the main cause of ocean acidification. While carbon dioxide can dissolve into the ocean in any location, the pH of the ocean is not consistent and varies from location to location based on water temperatures, turbidity, and more. Ocean pH is monitored using sensors on ships, buoys, and underwater gliders.	Ask students to identify why scientists monitor ocean pH and describe the relationship between ocean pH and human activity.
Global Climate Change			
Effects of Global Climate Change		Ocean temperatures directly reflect changing climates, with rising temperatures resulting in warmer waters. These warmer waters can in turn influence acidification rates, algal blooms, water density, oxygen levels, storm strength, organism migration and ranges, and organism health. To monitor ocean temperatures, scientists use a wide variety of instruments including satellites and sensors attached to buoys and ships. While these tools are effective in monitoring sea surface temperatures, they are not able to measure deep sea water temperatures. Currently, scientists monitor deep sea water temperatures using Remotely Operated Vehicles (ROVs). However, these ROVs are not able to give scientists a broad picture of how deep sea water temperatures are changing at a global level. The lack of data regarding deep sea temperatures means that scientists do not fully understand how climate change is impacting deep sea organisms and environments.	After telling students about how climate change impacts ocean temperatures, ask the following question: Scientists primarily measure sea surface temperatures, not deep sea temperatures. Do you think climate change is impacting deep sea environments? If so, why do you think scientists do not typically measure deep sea temperatures?
Ocean Dynamics			
Ocean Movements		While ocean currents can be monitored using satellites and buoys, they are also monitored using Acoustic Doppler Current Profilers (ADCPs) or Radio Detecting and Ranging systems. These devices send out audio signals, which bounce off particles in the water and echo back towards the device. Depending on the direction and frequency of the returning sound wave, scientists are able to calculate the direction and speed of the surrounding currents. The ocean helps store solar radiation in the form of heat, distributing it globally via currents. These currents influence the weather of coastal areas. For example, warm currents not only raise the temperatures of nearby coasts but also bring higher humidity levels. Likewise, cool currents lower the temperature of nearby coasts and can create a drier climate. Changes to current temperatures, especially those near the coast, can drastically impact coastal weather and climate.	Tell students about how scientists use ADCPs and Radio Detecting and Ranging systems are used to monitor currents using the information provided. Ask students to describe the importance of monitoring ocean movement. Ask students to describe how monitoring coastal currents can be used to help inform meteorologists about coastal climates.
Ocean's Effect on Weather and Climate		Surface currents can sometimes change direction. For example, easterly trade winds usually push water in the Pacific Ocean away from South America and towards Australia. However, when these winds shift, it can change global weather and climate conditions. When the easterly trade winds weaken, the surface currents can move water in the opposite direction, from Australia back towards South America in a phenomenon called El Niño. El Niño years result in abnormal rainfall levels, causing flooding and droughts in areas that would otherwise not experience these conditions. El Niño years have less frequent and severe hurricanes. When the easterly trade winds strengthen, the surface winds push water from South America towards Australia at a faster rate in a phenomenon called La Niña. La Niña years result in more extreme weather conditions, increasing rainfall in rainy climates and causing more extreme droughts in dry climates. La Niña years have more frequent and severe hurricanes. Monitoring wind speeds and surface currents can help meteorologists accurately predict weather conditions.	Ask students to describe how monitoring surface current speeds can help meteorologists predict extreme weather.

Topic	Associated Prompts	Justification	Potential Connectors
Ocean Resources		The ocean contains a lot of different renewable resources, including food, and non-renewable resources, including minerals and fossil fuels. Food resources, including fish and seaweed, can be sourced from healthy marine ecosystems. While food resources are renewable, over-harvesting can impact the rate at which the harvested organisms's population recovers and can negatively impact the populations of other marine organisms. By monitoring the population size of harvested organisms or by monitoring the number or volume of organisms harvested, policy makers can make informed decisions regarding harvest seasons, maximum harvest size, and more.	Ask students to identify different renewable and non-renewable resources and describe why agencies may want to monitor ocean resource use.
Layers of Earth			
Layers of the Earth		Fossils are found in Earth's crust, which forms from the top down. The older fossils are, the deeper they are located within the crust. Tectonic activity can cause deeper layers of the crust to be exposed, revealing the fossils within them. The fossils that have been pushed up towards the surface by tectonic activity can then be excavated by paleontologists. While fossils can be found in the crust around the world, it can be difficult to find fossils unless they have already been partially exposed.	Ask students to identify the layer of the Earth where fossils are located and describe why paleontologists may have difficulty finding fossils that have not been exposed by natural processes.
Third Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Earthquakes			
Seismic Waves and the Transfer of Energy		Seismic waves, caused by earthquakes, are the primary cause of tsunamis. These waves are monitored by Deep-ocean Assessment and Reporting of Tsunami (DART) systems which collect sea level data. In normal conditions, DART systems report the rise and fall of waves and tides. When an earthquake occurs, scientists use the data collected by DART systems to create more accurate predictions regarding the source of a tsunami and area of potential landfall.	After teaching students how tsunamis are formed, tell students about DART systems using the provided information. Ask students to describe how the data collected by DART systems may change in the event of a tsunami.
Weathering and Erosion			
Landscape Features as a Result of Weathering, Erosion, and Deposition		Weathering and erosion can expose fossils located in the Earth's crust, where they can then be located and excavated by paleontologists. However, once a fossil has been exposed, continued weathering and erosion can damage exposed fossils. As fossils break down, they become increasingly difficult to successfully excavate and preserve. Furthermore, fossils that have experienced significant weathering and erosion have less scientific and monetary value and are less likely to be part of a complete specimen.	Ask students to describe how weathering and erosion can both help and hinder paleontologists in the field.
Paleontology			
Significance of Fossils		Studying fossils can tell us a lot of information about past climates and environments. Not only do paleontologist study vertebrate fossils, like dinosaurs, but they also study invertebrate fossils (like bugs), fossilized plants, and fossilized pollen. Along with looking at fossils, paleontologists also look at the type of rock surrounding the fossil as different types of rock form under different environmental conditions. For example, fossils found in sandstone may have formed in river channels and fossils found in mudstone may have formed in floodplains. When paleontologists are extracting fossils, they do not always know what information might be contained in the surrounding rock. This means that they have to be very careful when extracting and preserving specimens to avoid damaging fossils that may not be immediately visible.	Ask students to brainstorm things that can be fossilized and ask students to describe what these fossils can tell us about past climates and environments. After students have shared their answers, tell students about how the rock surrounding fossils can also inform us about past climates and environments using the information provided. While students are brainstorming things that can be fossilized, encourage students to think beyond animal bones, footprints, or plant impressions.

Fourth Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Instruments of Astronomy			
Spacecrafts and Probes		All spacecraft are designed to carry either human passengers, cargo, or scientific instruments through space. For example, the International Space Station (ISS) is a spacecraft designed to carry human passengers around Earth. While rockets are used to launch spacecraft into space, they are technically not part of the spacecraft. Once in space, spacecraft can detach from rockets to navigate on their own. Spacecraft designed to carry human passengers must protect them from the dangers of space and launch, reentry, or docking where applicable. In addition, it must be able to produce or store enough oxygen, food, and water for its passengers.	Tell students that to fill a basic human need in space, spacecraft must first be able to keep astronauts alive. Ask students to identify and describe the dangers of space and space travel.
Space Exploration			
The Future of Space Exploration		While space exploration has stayed in and around Earth, NASA's Artemis Missions are designed to establish a lunar base. The first of these missions, Artemis I, was completed in 2022 and sent an uncrewed test flight into lunar orbit. This flight is the first of eight Artemis missions. Once a lunar base has been established, scientists will use what they learned to send astronauts to Mars. Having bases on celestial bodies other than Earth not only gives astronauts the ability to study and learn more about space but can also give humanity access to resources that may be limited on Earth.	Ask students to describe how establishing a lunar base paves the way for future space exploration. Ask students to identify what this lunar base would need to fill the basic needs of astronauts living in the base.

			
Environmental Science Honors			
Associated Prompts: Marine science, health, paleontology, astronomy			
First Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Population and Community Ecology			
How do Ecosystems Respond to Changing Conditions?		How ecosystems respond to changing conditions heavily depends on how quickly the ecosystem is changing. While slow changes give organisms time to adapt over several generations, quick changes can stress or kill organisms. To monitor the changes in marine ecosystems, scientists collect data using a wide variety of tools, ranging from satellite imagery to portable sensors. Because the data is collected with different tools and recorded in different formats, it can be difficult to create a complete picture of and respond to ecosystem change. To help organize this data and get a more complete picture of ecosystem health, the National Oceanic and Atmospheric Administration (NOAA) established the U.S. Integrated Ocean Observing System (IOOS). This system collects, compiles, and shares data from participating global, national, regional, and local organizations, standardizing their format and helping scientists better monitor the conditions of different marine environments.	Ask students to describe the challenges of having different organizations monitor different marine conditions.
Second Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Water Quality			
Pollution		Pollution in marine ecosystems can range from debris to chemical pollutants. This means that the systems needed to monitor pollution levels also differ based on the pollutants type, size, and chemical makeup. Scientists can use currents to help model how different kinds of pollutants spread through marine ecosystems. This information can then be used to help them respond to man-made disasters.	Ask students to describe the importance of monitoring pollution levels in ocean currents.
Third Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Biodiversity			
Role of Humans in the Loss of Species		Overfishing can result in the loss of biodiversity. By monitoring fishing vessels and the populations of different marine fish species, scientists can identify whether additional protections or regulations are needed to maintain healthy biodiversity. By monitoring the movement of shipping vessels, which may carry invasive and non-native species in their ballast water, and monitoring marine populations, scientists can identify how invasive and non-native species are introduced. Commercial fishing vessels are monitored using either the Automatic Identification System (AIS) or the Vessel Monitoring System (VMS).	Ask students to identify how different types of marine vessels might impact the biodiversity of marine ecosystems and to describe the importance of monitoring these vessels.

Topic	Associated Prompts	Justification	Potential Connectors
Resources			
Renewable		Fish are considered a renewable resource that can be gained through both low-cost and high-cost operations. Many low-cost fishing operations operate on a smaller scale than high-cost operations. While small scale, recreational operations are often monitored periodically by state agencies, like the Florida Fish and Wildlife Conservation Commission, the large scale operations are often monitored by federal agencies, like the National Marine Fisheries Service.	Ask students to identify marine renewable resources and describe why agencies may want to monitor the use of these resources using both established and emerging technologies.
		Renewable resources, like water and oxygen, have to be recycled for astronauts in space. While recycling processes happen naturally on Earth through biogeochemical cycles (e.g. the water cycle), they have to be manually recycled in space. The cost of the technology used to recycle these renewable resources is high, but it is necessary for astronaut survival. Renewable energy resources, like solar power, are also easier to access in space and do not take up as much storage space as non-renewable resources.	Ask students to brainstorm how the International Space Station uses renewable resources like water, oxygen, and energy.
		Renewable resources, like solar power, are easier to access in remote environments. For paleontologists, who often have to travel to remote areas to extract fossils, solar power can be used as an alternative to non-renewable resources like gas, coal, or oil. Non-renewable energy sources have to be carried out to the field station and can run out during expeditions.	Ask students to describe the benefits and drawbacks of using renewable energy sources in remote environments.
Fourth Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Resources			
Non-Renewable		Non-renewable marine resources include fossil fuels, which are extracted through offshore drilling or fracking. Many offshore drilling and fracking operations are used to access oil and natural gas reserves under the seafloor. While these operations have a high operational cost, they also have non-monetary costs as they can create oil leaks that cause environmental damage. Offshore drilling and fracking are monitored by the Bureau of Safety and Environmental Enforcement.	Ask students to identify non-renewable, offshore resources and describe why agencies may want to monitor the organizations accessing these resources.
		Non-renewable resources in space are limited to the materials that astronauts have brought with them. While scientists are currently looking for both renewable and non-renewable resources on celestial bodies other than Earth, scientists do not currently have a way to access these resources. Non-renewable energy resources, like gas, coal, and oil, would have to be transported in high volumes into space.	Ask students to describe why the International Space Station primarily relies on renewable energy sources instead of non-renewable energy sources.
Food and Agriculture			
Biotechnology and GMOs		The Green Revolution introduced biotechnology that resulted in the production of Genetically Modified Organisms (GMOs). While many GMOs are designed to increase agricultural production, they can also be designed to increase the nutrient content of different agricultural products to combat nutrient deficiencies in developing countries. However, while GMOs can be designed to provide additional nutrients, these nutrients are not always accessible. For example, “golden rice” was a GMO designed to combat Vitamin A deficiencies, but the Vitamin A precursor contained in the rice, beta-carotene, requires fat to be converted into Vitamin A. Because fat is often absent in the diets of populations that struggle with Vitamin A deficiencies, the golden rice does not address the nutrient deficiency issue.	Tell students about golden rice using the information provided, emphasizing how it was unable to combat the issue it was developed to solve. Ask students to describe the challenges of developing GMOs that combat health problems.

Topic	Associated Prompts	Justification	Potential Connectors
		Waste	
Problems Related to Waste 1. Solid 2. Hazardous		The ocean has large quantities of solid waste in its gyres. These gyres, or large circular currents, each contain a garbage patch. To avoid adding waste to the garbage patches, more waste management strategies need to be put in place to prevent waste from entering the ocean or to clean up marine debris before it has a chance to break down into microplastics and other small particles. Once waste has broken down into small particles, it is much more difficult to clean up. Monitoring the type of debris prevalent in these garbage patches can be used to identify management strategies that may be more effective in reducing the amount of waste we contribute to marine ecosystems.	Ask students to share what they know about the “Great Pacific Garbage Patch” and brainstorm the sources for the garbage within the North Pacific Gyre. Ask students how they believe monitoring the type of garbage in garbage patches could influence waste management strategies.
		Human activities are responsible for introducing hazardous waste to marine ecosystems. The environmental issues caused by waste depend on the type, volume, and concentration of waste. Some chemical waste, like pesticides, may negatively impact marine life and disrupt food chains while other chemical waste, like fertilizers, may cause harmful algal blooms and create mass-fish die-offs. The National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) monitor water parameters to evaluate the health of marine ecosystems. Based on these water parameters, NOAA, the EPA, and other organizations may regulate human marine activities. For example, during harmful algal blooms, like the red tide, the Department of Health (DOH) will issue health advisories and close affected beaches, the Florida Fish and Wildlife Conservation Commission (FWC) may restrict fishing, and the Department of Agriculture and Consumer Services may regulate shellfish harvesting.	Ask students to brainstorm how agencies may identify and respond to large-scale environmental disasters, particularly disasters caused by hazardous waste.
		The solid and hazardous waste produced by astronauts in space either has to be recycled or stored, where it can become a safety hazard. Currently, astronauts deal with waste by placing it in a separate spacecraft. This spacecraft is then launched into space and the waste either returns to Earth or burns up in Earth’s atmosphere. For sustainable, long-term space missions, scientists will need to develop more long-term solutions to waste management. These solutions will need to focus on reusing or recycling waste.	Ask students to discuss how they believe astronauts deal with waste in space. After students finish their discussion, tell students that the current waste management strategy in space is to launch waste using spacecraft into space or back towards Earth.
		When extracting a fossil, paleontologists have to remove the overlying rock and sediment. This discarded rock and sediment, called overburden, is often kept directly next to the paleontological site. Once the fossil has been completely removed, paleontologists place the overburden back in its original location. As overburden is considered a type of waste, returning the overburden to its original location is a type of waste management. If the overburden is not returned to its original location, it can alter the natural habitat and may result in increased erosion.	Tell students that paleontologists produce a type of waste called overburden, which is discarded rock and sediment. Ask campers to describe how they believe paleontologists manage this waste.

AP Environmental Science				
Associated Prompts: Marine science, health, astronomy				
Unit 4: Earth Systems and Resources				
Topic	Associated Prompts	Justification	Potential Connectors	
4.4 Earth's Atmosphere	 A	Earth's atmosphere is 78% nitrogen gas (N ₂), 21% oxygen gas (O ₂), and 1% other gases. Not only does the troposphere have breathable air, but the ozone (O ₃) located in the stratosphere helps reflect harmful UV radiation. In space, astronauts do not have access to the same protective and breathable gaseous atmosphere. Instead, oxygen is produced using a Sabatier reactor and electrolysis. The Sabatier reactor facilitates a chemical reaction that uses hydrogen gas (H ₂) and carbon dioxide (CO ₂) to produce water and electrolysis splits the resulting water back into H ₂ and O ₂ . NASA's SpaceCraft Oxygen Recovery project is currently in development to increase the efficiency of current oxygen recovery methods.	After teaching students about the composition of Earth's atmosphere, use the information provided to teach students about how Sabatier reactor and electrolysis are used to produce oxygen for astronauts in space. Ask students to brainstorm the benefits and challenges of relying on an artificial process to produce oxygen.	
4.8 Earth's Geography and Climate	 M	Without an atmosphere to protect astronauts from UV radiation, spacecraft and spacesuits have to be designed with materials that block the majority of UV radiation. Ocean temperatures largely influence the climate of coastal ecosystems. While warm ocean currents create warmer, more humid climates, cool ocean currents create cooler, drier climates in coastal areas. By monitoring wind, surface current speeds, and temperatures, scientists can better understand the relationship between climate and marine environments and can track the impacts of climate change.	After teaching students about the characteristics of each layer of the atmosphere, ask students to describe how the lack of atmosphere in space may impact astronauts and future space travel. Ask students to describe how monitoring ocean currents can help inform scientists about coastal climates.	
Unit 5: Land and Water Use				
Topic	Associated Prompts	Justification	Potential Connectors	
5.1 The Tragedy of the Commons	 M	The Tragedy of the Commons occurs when people overuse and eventually deplete a common resource. In marine environments, these resources can include limestone, fossil fuels, and fish. By monitoring fishing vessels and the populations of different marine fish species, scientists can identify whether additional protections or regulations are needed to maintain healthy biodiversity.	Ask students to brainstorm how agencies may monitor marine resource use. In their explanations, students must identify how the monitoring practices can help avoid causing the Tragedy of the Commons.	
5.3 The Green Revolution	 H	The Green Revolution introduced biotechnology that resulted in the production of Genetically Modified Organisms (GMOs). While many GMOs are designed to increase agricultural production, they can also be designed to increase the nutrient content of different agricultural products to combat nutrient deficiencies in developing countries. However, while GMOs can be designed to provide additional nutrients, these nutrients are not always accessible. For example, "golden rice" was a GMO designed to combat Vitamin A deficiencies, but the Vitamin A precursor contained in the rice, beta-carotene, requires fat to be converted into Vitamin A. Because fat is often absent in the diets of populations that struggle with Vitamin A deficiencies, the golden rice does not address the nutrient deficiency issue.	Tell students about golden rice using the information provided, emphasizing how it was unable to combat the issue it was developed to solve. Ask students to describe the challenges of developing GMOs that combat health problems.	

Topic	Associated Prompts	Justification	Potential Connectors
5.8 Impacts of Overfishing		Overfishing can damage marine ecosystems, resulting in the loss of biodiversity. Depending on the species being overfished, it can also lead to a trophic cascade. In these situations, overfishing impacts the ecosystem as a whole and may reduce the availability of other species. This can have a significant impact on coastal communities that rely on healthy marine ecosystems for tourism, food, or commercial profit. By monitoring fishing vessels and regulating their catch, scientists and policy makers can protect marine ecosystems and coastal communities. Commercial fishing vessels are monitored using either the Automatic Identification System (AIS) or the Vessel Monitoring System (VMS).	Ask students to identify how overfishing impacts the biodiversity of marine ecosystems and the economy of local communities before describing the importance of monitoring fishing vessels.
Unit 6: Energy Resources and Consumption			
Topic	Associated Prompts	Justification	Potential Connectors
6.1 Renewable and Nonrenewable Resources		Fish are considered a renewable resource that can be gained through both low-cost and high-cost operations. Many low-cost fishing operations operate on a smaller scale than high-cost operations. While small scale, recreational operations are often monitored periodically by state agencies, like the Florida Fish and Wildlife Conservation Commission, the large scale operations are often monitored by federal agencies, like the National Marine Fisheries Service. Non-renewable marine resources include fossil fuels, which are extracted through offshore drilling or fracking. Many offshore drilling and fracking operations are used to access oil and natural gas reserves under the seafloor.	Ask students to identify marine renewable resources and describe why agencies may want to monitor the use of these resources using both established and emerging technologies. Ask students to identify non-renewable, offshore resources.
6.5 Fossil Fuels		Offshore drilling and fracking operations are used to access oil and natural gas reserves under the seafloor. While these operations have a high operational cost, they also have non-monetary costs as they can create oil leaks that cause environmental damage. In addition to leaking oil, fracking can also contaminate groundwater sources and release volatile organic compounds (VOCs). Offshore drilling and fracking are monitored by the Bureau of Safety and Environmental Enforcement.	Ask students to describe why agencies may want to monitor offshore drilling or fracking operations.
Unit 8: Aquatic & Terrestrial Pollution			
Topic	Associated Prompts	Justification	Potential Connectors
8.9 Solid Waste Disposal		The waste produced by astronauts in space either has to be recycled or stored, where it can become a safety hazard. Currently, astronauts deal with waste by placing it in a separate spacecraft. This spacecraft is then launched into space and the waste either returns to Earth or burns up in Earth's atmosphere. For sustainable, long-term space missions, scientists will need to develop more long-term solutions to waste management. These solutions will need to focus on reusing or recycling waste.	Ask students to discuss how they believe astronauts deal with waste in space. After students finish their discussion, tell students that the current waste management strategy in space is to launch waste using spacecraft into space or back towards Earth.
		The ocean has large quantities of waste in its gyres. These gyres, or large circular currents, each contain a garbage patch. The majority of the waste that ends up in garbage patches comes from either litter carried by runoff into the ocean or from broken or discarded fishing gear. However, some waste that enters the ocean is intentionally dumped. To avoid adding waste to the garbage patches, more waste management strategies need to be put in place to identify the source of waste, prevent waste from entering the ocean, and to clean up marine debris before it has a chance to break down into microplastics or other small particles. Monitoring the type of debris prevalent in these garbage patches can be used to identify management strategies that may be more effective in reducing the amount of waste we contribute to marine ecosystems.	Ask students to share what they know about the "Great Pacific Garbage Patch" and brainstorm the sources for the garbage within the North Pacific Gyre. Ask students how they believe monitoring the type of garbage in garbage patches could influence waste management strategies.

Topic	Associated Prompts	Justification	Potential Connectors
8.14 Pollution and Human Health	 H	Pollution, including both solid and hazardous waste, can negatively impact human health. While plastics can degrade into microplastics, which can be found throughout the human body, including in the heart, lung, and brain tissues, hazardous waste can have a more immediate impact on human health. However, people are exposed to a wide variety of pollutants, so it can be difficult to identify what health issues are caused by pollution. Some pollutants, including air pollution levels, are monitored by the National Institute of Environmental Health Sciences (NIEHS). However, beyond monitoring pollution levels and identifying correlations between health problems and pollutants, identifying exactly how pollutants impact human health can be difficult. While some programs can be used to predict health concerns based on environmental data, these programs have room for improvement. Disease diagnoses in the United States are entered into the National Notifiable Diseases Surveillance System (NNDS) by state health departments. The NNDS is then used to inform the Center for Disease Control (CDC) about the spread of diseases and can be used to coordinate disease responses within the United States. In countries that are part of the World Health Organization (WHO), WHO tracks the spread of different diseases in participating countries and coordinates a disease management response for its members. Currently, there is no database for disease data collected from every country. Without a global system for disease management, it is difficult to coordinate efficient global responses to disease outbreaks.	Ask students to identify a specific pollutant that impacts human health and describe how monitoring that pollutant can influence policy development.
8.15 Pathogens and Infectious Diseases	 H		Ask students to discuss the difficulties of coordinating a disease management response without freely sharing global disease data.
Unit 9: Global Change			
Topic	Associated Prompts	Justification	Potential Connectors
9.8 Invasive Species	 M	By monitoring the movement of shipping vessels, which may carry invasive and non-native species in their ballast water, and monitoring marine populations, scientists can identify how invasive and non-native species are introduced and spread throughout different ecosystems. The data collected by monitoring invasive species populations can then be used to inform scientists and policy makers regarding invasive species management. Monitoring endangered species populations is needed to manage the protections in place for different species. Population monitoring can help us understand whether the protections in place are sufficient, allowing populations to recover, or insufficient, maintaining low populations or allowing populations to continue declining. Insufficient protections may also result in the extinction of a species. One way that scientists monitor endangered species population is through tagging. Scientists use a wide variety of different tags for endangered species, but satellite tags are among the most common as they allow scientists to track each animal's movement. While different tagging systems are used to collect different types of data regarding endangered species, most tags are attached to animals using an adhesive. This means that the adhesive eventually can weaken, allowing the tag to fall off.	Ask students to identify how different types of marine vessels might impact the biodiversity of marine ecosystems and to describe the importance of monitoring these vessels.
9.9 Endangered Species	 M		Ask students to identify different methods scientists may use to monitor endangered species populations and describe the type of data each identified monitoring system collects.

			
AP Biology			
Associated Prompts: Marine science, health			
Unit 6: Gene expression and regulation			
Topic	Associated Prompts	Justification	Potential Connectors
6.8 Biotechnology		Polymerase Chain Reaction (PCR) uses polymerase to make copies of specific DNA sequences. By replicating and magnifying these sequences, scientists can detect DNA sequences that would otherwise be too small to observe. This allows scientists to quickly and accurately diagnose some genetic and contagious diseases. While PCR is widely used to diagnose patients, samples must be transported to a lab and it can take several hours to perform the test. PCR tests also do not have a 100% accuracy rate and can produce false positives or false negatives, leaving room for improvement.	Ask students to identify how using emerging technologies to quickly and accurately diagnosis infectious diseases can help communities.
		DNA sequencing is used by scientists to help identify and compare different DNA sequences, helping them identify which specific DNA sequences result in different traits and diseases. It can also be used to identify what DNA sequences have been passed down from parent to offspring and what DNA sequences are the result of genetic mutations. While DNA sequencing can be extremely useful, the human genome contains roughly 3 billion base pairs, so DNA sequencing is usually only conducted on small sections of DNA. The Human Genome Project started in 1990 with the goal of sequencing the entirety of the human genome. While the project concluded in 2003, it still had gaps in the human genome. These gaps were later filled by the Telomere to Telomere project which finished sequencing the human genome in 2022. The process of sequencing the entire human genome took 32 years. While scientists are now able to sequence genomes quicker and with higher accuracy, it is still a slow process.	Tell students that scientists finally finished sequencing the human genome in 2022 after 32 years of research. Ask students to discuss the importance and applications of DNA sequencing.
		Electrophoresis is a technology used to identify specific DNA sequences, RNA sequences, or proteins and is often used in conjunction with PCR. In electrophoresis, samples are processed and dyed before being placed in gel and separated by size using an electric current. Scientists can then compare the resulting patterns created by gel electrophoresis with known DNA sequences, RNA sequences, or proteins to identify the sample. Electrophoresis is also not effective in separating small samples or samples of sequences or proteins that are small in size or have similar weights.	Using the information provided, describe electrophoresis to students. Ask students to identify the disadvantages of using electrophoresis to identify an unknown DNA sequence, RNA sequence, or protein.
		Genetic engineering can be used to alter the genome of an organism. Once scientists identify a genetic sequence of interest, they can isolate, amplify, and insert the genetic sequence into the genome of the target organism. For bacteria, the genetic sequence can be inserted into plasmids using enzymes. For non-bacterial organisms, scientists can use repurposed viruses to insert the genetic sequence directly into the nucleus of the cell, where the inserted genetic sequence can be transcribed and translated. Using viruses to insert genetic sequences into cells is a core component of gene therapy and is considered an emerging technology.	Tell students that cancers and genetic diseases are the result of abnormalities in an organism's DNA. Ask students to describe how biotechnology that adds a DNA sequence to an organism's DNA could help treat cancer or genetic diseases.

Unit 8: Ecology

Topic	Associated Prompts	Justification	Potential Connectors
8.7 Disruptions to Ecosystems		By monitoring the movement of shipping vessels, which may carry invasive and non-native species in their ballast water, and monitoring marine populations, scientists can identify how invasive and non-native species are introduced and spread throughout different ecosystems. The data collected by monitoring invasive species populations can then be used to inform scientists and policy makers regarding invasive species management.	Ask students to identify how different types of marine vessels might impact the biodiversity of marine ecosystems and to describe the importance of monitoring these vessels.
		While there are many events that can result in disrupting ecosystems, direct harm to an ecosystem is one of the easiest disruptions to observe. Direct harm to marine ecosystems by causing physical damage, through grounding ships, unsustainable fishing practices, and more, can be monitored through routine surveys. These surveys are often conducted by Remotely Operated Vehicles (ROVs). The images captured by the cameras attached to the ROVs can be analyzed to identify trawling scars and other types of physical damage.	Ask students to describe how human activity can physically disrupt a marine ecosystem and identify how we can monitor these human activities.
		While direct harm to an ecosystem is easy to observe, not all causes of a disrupted ecosystem are easily identifiable. Indirect harm to marine ecosystems is often caused by pollution, which can range from debris to chemical pollutants. The systems needed to monitor pollution levels also differ based on the pollutants type, size, and chemical makeup, making it difficult to identify all pollutants present. Scientists can use currents to help model how different kinds of pollutants spread through marine ecosystems. This information can then be used to help them identify how humans are impacting marine ecosystems and organisms.	Ask students to describe how human activity can inadvertently disrupt a marine ecosystem and identify how we can monitor these human activities.

Pacing Guides

Targeted classrooms that use pacing guides are provided recommended pacing guides for the STEM Challenge. These are based on the M-DCPS 2025-2026 pacing guides, indicate relevant content connections with the STEM Challenge prompts, and provide suggested implementation timelines for the STEM Challenge Activities. Targeted classrooms with pacing guides include:

- Earth and Space Science Honors
- Environmental Science Honors

These pacing guides indicate which course topics/standards are paired with an “Associated Prompt.” To identify what topic/standard is associated with each prompt, refer to the colored letters and symbols. The Marine Science prompt is denoted by **M** 🐟, the Health prompt by **H** ⚕️, the Paleontology prompt by **P** 🦕, and the Astronomy prompt by **A** 🌌. The recommended pacing guides are flexible and should be adapted as needed. When adapting pacing guides, remember that STEM Challenge digital submissions are due by March 13, 2026. Students may continue to work on their oral presentations after this date, but their project, models, displays, and history design files must be completed.

For classes that do not use a M-DCPS pacing guide, suggested STEM Challenge activity pacing guides have been provided for both year-long and short-term STEM Challenge Projects. For short-term STEM Challenge projects, keep in mind that completed projects must be submitted before the start of the fourth quarter. These pacing guides are only meant to provide suggested pacing and are not intended to represent every possible pacing structure.

All pacing guides include recommendations for when to teach each STEM Challenge activity. While *Activity 1: Let’s Get Started* is the only required activity, utilizing all STEM Challenge activities is recommended to guide and support students in their STEM Challenge projects. Each activity is referred to in the pacing guide by number with “Let’s Get Started” denoted by **Activity 1**, “Sound Sources” denoted by **Activity 2**, “Iterative Ideas” denoted by **Activity 3**, “Pitch Your Point” denoted by **Activity 4**, and “Mix-it-up” denoted by **Activity 5**. Along with recommended pacing for activities, each pacing guide also includes a recommended number of blocks for students to work on their STEM Challenge in class. These block periods include suggested student focuses and should be used in addition to student worktime outside of class.

Earth and Space Science Honors Pacing Guide (M-DCPS)

M = Marine Science, H = Health, P = Paleontology, A = Astronomy

EARTH/SPACE SCIENCE HONORS				Course Code: 200132001
1st Nine Weeks	2nd Nine Weeks	3rd Nine Weeks	4th Nine Weeks	
I. Intro to Earth and Space Science 2 Blocks A. Branches of Earth Science B. Lab Safety C. SI System and Measurement D. Graphing E. Lab Report Format II. STEM Challenge: Introduction to the STEM Challenge 2 Blocks A. Activity 1 (<i>Required</i>) B. Initial Research III. Scientific Method 3 Blocks A. Experimental Design B. Measurements and Analysis C. Acceptance of Scientific Ideas IV. Chemistry for Earth Science 4 Blocks A. Identifying Matter B. Atomic Structure C. Elements, Ions, Isotopes D. Periodic Table E. Compounds and Equations F. Significant Elements, Compounds in Earth/Space Science V. STEM Challenge: Identifying Reliable Sources 2 Blocks A. Activity 2 B. Research / Gather Information VI. The Atmosphere 2 Blocks A. Understanding Systems B. Characteristics of the Atmosphere – A C. Solar Radiation D. Energy VII. Water in the Atmosphere 3 Blocks A. States of Matter B. Phase Changes of Water C. The Water Cycle D. Humidity E. Clouds VIII. Weather 3 Blocks A. Air Pressure and Air Masses B. Weather Fronts C. Storms and Severe Weather – M D. Collecting Weather Data – M E. Forecasting the Weather – M IX. Climate 3 Blocks A. Climate vs. Weather B. Climate Zones C. Factors that Affect Climate D. Earth's Spheres E. Energy and Climate	X. Environmental Science and Concerns 4 Blocks A. Earth's Geochemical Cycles B. Energy Resources – M C. Burning of Fossil Fuels – M D. Atmospheric Pollutants E. Human Impact XI. Global Climate Change 3 Blocks A. Evidence for Global Climate Change B. Causes for Global Climate Change C. Effects of Global Climate Change – M XII. STEM Challenge: Solution Development 2+Blocks XIII. The Oceans 3 Blocks A. Origin of the Oceans B. Major Oceans and Seas C. Seawater D. Topographic Features XIV. Ocean Dynamics 3 Blocks A. Ocean Movements – M B. Ocean Currents C. Ocean's Effect on Weather and Climate – M D. Ocean Resources – M E. Oceans as a Carbon Sink F. Impact of Oceans on Florida XV. STEM Challenge: Engineering Design Process 2 Blocks A. Activity 3 B. Solution Iteration XVI. Layers of Earth 2 Blocks A. Layers of the Earth – P B. Discovery of the Layers C. Magnetosphere XVII. Minerals and Rocks 3 Blocks A. Minerals B. Rocks C. The Rock Cycle	XVIII. Continental Drift and Plate Tectonics 2 Blocks A. Theory of Continental Drift B. Evidence Continents were Connected C. Plate Tectonics D. Mechanism for Movement E. Effects of Plate Movement XIX. Earthquakes 3 Blocks A. Why Earthquakes Happen B. Anatomy of Earthquakes C. Seismic Waves and the Transfer of Energy – M D. Structure of Earth's Interior E. Relationship to Plate Tectonics F. Measuring Earthquakes G. Earthquakes and Society XX. Volcanoes 3 Blocks A. Volcanic Relationship to Plate Tectonics B. Types of Volcanic Activity C. Types of Volcanoes D. Predicting Volcanic Eruptions E. Impact of Volcanic Activity on Society XXI. STEM Challenge: Finalizing Solution 2 Blocks A. Activity 5: Solution Review B. Solution Iteration XXII. Weathering and Erosion 1 Block A. Weathering B. Erosion and Deposition C. Soil Formation D. Landscape Features as a Result of Weathering, Erosion, and Deposition – P XXIII. Geology of Florida 2 Blocks A. Florida's Geologic Regions B. Geologic History of Florida C. Mineral Resources of Florida XXIV. Paleontology 2 Blocks A. Fossil Formation B. Significance of Fossils – P XXV. Geologic Time 2 Blocks A. Time Classification B. Geologic Time Scale XXVI. STEM Challenge: Modeling 2 Blocks A. Model Development B. Model Construction XXVII. History of Astronomy 2 Blocks A. Astronomy vs. Astrology B. Early Astronomers C. Modern Astronomers D. The Space Race E. The Space Program XXVIII. STEM Challenge: Display 2 Blocks A. Display Design B. Display Construction	XXIX. Instruments of Astronomy 2 Blocks A. Measuring Space B. Electromagnetic Spectrum C. Telescopes D. Artificial Satellites E. Spacecrafts and Probes – A XXX. Physics in Astronomy 2 Blocks A. Kepler's Laws B. Newton's Laws C. Law of Universal Gravitation XXXI. STEM Challenge: Presentation 2 Blocks A. Activity 4 B. Pitch/Presentation Development XXXII. STEM Challenge: Presentation Revisions 2 Blocks A. Activity 5: Pitch Review B. Refine Pitch/Presentation XXXIII. Origins of the Universe 2 Blocks A. Evidence for the Big Bang Theory B. Formation of the Solar System XXXIV. The Sun 2 Blocks A. Structure of the Sun B. Fusion and the Sun's Energy C. Solar Weather D. Impact of Solar Weather on Earth XXXV. Earth and Moon 3 Blocks A. Formation of the Moon B. Features of the Moon C. Motion of the Moon D. The Earth-Moon System XXXVI. The Solar System 2 Blocks A. Terrestrial/Inner Planets B. Gas Giants/Outer Planets C. Minor Bodies of the Solar System XXXVII. Stars 2 Blocks A. Characteristics of Stars B. Stellar Evolution C. Star Systems XXXVIII. Galaxies 1 Block A. Galaxies B. Anatomy of a Galaxy C. The Milky Way XXXIX. Space Exploration 1 Block A. Benefits of the Space Program B. Florida and the Space Program C. Search for Life Beyond Earth D. The Future of Space Exploration – A	

Environmental Science Honors Pacing Guide (M-DCPS)

M = Marine Science, H = Health, P = Paleontology, A = Astronomy

ENVIRONMENTAL SCIENCE HONORS				Course Code: 200134101
1st Nine Weeks	2nd Nine Weeks	3rd Nine Weeks	4th Nine Weeks	
I. Introduction to Environmental Science/Scientific Method 8 Blocks A. Lab Safety and Scientific Method B. The Environment and Sustainability 1. Key Factors of Sustainability 2. Ecological Footprint 3. Causes of Environmental Issues II. STEM Challenge: Introduction to the STEM Challenge 2 Blocks A. Activity 1 (<i>Required</i>) B. Initial Research III. Earth's Systems and Properties of Water 8 Blocks A. What are systems? 1. Earth's Major Spheres B. Energy Cycling C. Matter Cycling (Nutrient Cycling) D. Properties of Water IV. STEM Challenge: Identifying Reliable Sources 2 Blocks A. Activity 2 B. Research / Gather Information V. Population and Community Ecology 7 Blocks A. Interaction of Species B. Limitations in Population Growth C. How do Ecosystems Respond to Changing Conditions? – M	VI. STEM Challenge: Solution Development 2 Blocks VII. Climate Change 6 Blocks A. Factors that Influence Climate 1. Greenhouse Gases B. Effects of Climate Change C. Slowing Climate Change VIII. Water Quality 6 Blocks A. Resources B. Pollution – M C. Sustainable Use of Freshwater D. Reducing Water Pollution IX. Air Quality 6 Blocks A. Pollution B. Slowing Ozone Depletion X. STEM Challenge: Engineering Design Process 2 Blocks A. Activity 3 B. Solution Iteration	XI. Biomes and Aquatic Ecosystems 4 Blocks A. Major Types of Terrestrial Ecosystems B. Major Types of Marine Ecosystems C. Major Types of Freshwater Ecosystems XII. STEM Challenge: Finalizing Solution 2 Blocks A. Activity 5: Solution Review B. Solution Iteration XIII. Evolution 4 Blocks A. Macromolecules B. What Causes Extinction? C. Impacts of Extinction 1. Role of Species in Ecosystems XIV. STEM Challenge: Modeling 2 Blocks A. Model Development B. Model Construction XV. Biodiversity 4 Blocks A. What is Biodiversity? B. Factors That Affect Biodiversity C. Role of Humans in the Loss of Species – M D. Sustaining Wildlife Species and Services XVI. STEM Challenge: Display 2 Blocks A. Display Design B. Display Construction XVII. Resources 3 Blocks A. Renewable – M, A, P	XVIII. Resources 2 Blocks A. Non-Renewable – M, A XIX. Humans and the Environment 2 Blocks A. Effects of Urbanization on the Environment XX. STEM Challenge: Presentation 2 Blocks A. Activity 4 B. Pitch/Presentation Development XXI. Food and Agriculture 4 Blocks A. Food Security B. Sustainable Agriculture C. Biotechnology and GMOs – H XXII. Waste 4 Blocks A. Problems Related to Waste 1. Solid – M, A 2. Hazardous – M, A, P B. Waste Management 1. Bioplastics 2. Low-Waste Society 3. Eliminating Food Waste XXIII. STEM Challenge: Presentation Revisions 2 Blocks A. Activity 5: Pitch Review B. Refine Pitch/Presentation XXIV. Economics and the Environment 3 Blocks A. Use of Economic Tools to Address Environmental Issues B. Sustainable World	

Year-Long Pacing Guides

YEAR-LONG PACING GUIDE: Version 1					18+ Blocks
Use this pacing guide if you have a flexible class schedule and can afford to use ~4 weeks of class time for the STEM Challenge. This pacing guide prioritizes the completion of final products during the third quarter. Final products are due on March 13, 2026. During the fourth quarter, students will focus on developing their presentation.					
1st Nine Weeks	2nd Nine Weeks	3rd Nine Weeks	4th Nine Weeks		
Focus: Getting Started	Focus: Solution Development	Focus: Model and Display Construction	Focus: Presentation Development		
4 Blocks	6 Blocks	5 Blocks	3 Blocks		
Activity 1 1 Block (<i>Required</i>) Initial Research 1 Block Activity 2 1 Block Research/Gather Information 1+ Block	Solution Development 2+ Blocks Activity 3 1 Block Solution Iteration 1+ Block Activity 5: Solution Review 1 Block Solution Iteration 1+ Block	Model Development 1+ Block Model Construction 1+ Block Activity 4 1 Block Display Design 1+ Block Display Construction 1+ Block	Pitch/Presentation Development 1+ Block Activity 5: Pitch Review 1 Block Refine Pitch/Presentation 1+ Block		
Quarter Goal: Students will select a prompt, identify a specific issue related to their prompt that can be realistically solved, and gather information relevant to their identified issue.	Quarter Goal: Students will design a solution to their identified issue before learning each step in the engineering design process, receiving feedback on their solution, and utilizing the engineering design process to iterate upon their idea and finalize their solution.	Quarter Goal: Students will develop and construct a model of their designed solution before learning about the components of a strong presentation and constructing their STEM Challenge display.	Quarter Goal: Students will develop, receive feedback on, and refine a presentation for their STEM Challenge project.		

YEAR-LONG PACING GUIDE: Version 2 (Condensed)					16+ Blocks
Use this pacing guide if you have a flexible class schedule and can afford to use ~3 weeks of class time for the STEM Challenge. This pacing guide prioritizes solution development and completion of final products during the third quarter. Final products are due on March 13, 2026. During the fourth quarter, students will focus on developing their presentation. This pacing guide provides less class time for students to work on their models and displays in class.					
1st Nine Weeks	2nd Nine Weeks	3rd Nine Weeks	4th Nine Weeks		
Focus: Getting Started and Solution Development	Focus: Solution Development	Focus: Model and Display Construction	Focus: Presentation Development		
5 Blocks	5 Blocks	3 Blocks	3 Blocks		
Activity 1 1 Block (<i>Required</i>) Initial Research 1 Block Activity 2 1 Block Research/Gather Information 1+ Block Preliminary Solution Development 1+ Block	Continued Solution Development 1+ Blocks Activity 3 1 Block Solution Iteration 1+ Block Activity 5: Solution Review 1 Block Solution Iteration 1+ Block	Model Development and Construction 1+ Block Activity 4 1 Block Display Design and Construction 1+ Block	Pitch/Presentation Development 1+ Block Activity 5: Pitch Review 1 Block Refine Pitch/Presentation 1+ Block		
Quarter Goal: Students will select a prompt, identify a specific issue related to their prompt that can be realistically solved, gather information relevant to their identified issue, and begin to draft their solution.	Quarter Goal: Students will continue to design a solution to their identified issue before learning each step in the engineering design process, receiving feedback on their solution, and iterating upon their idea to finalize their solution.	Quarter Goal: Students will develop and construct a model of their designed solution before learning about the components of a strong presentation and constructing their STEM Challenge display.	Quarter Goal: Students will develop, receive feedback on, and refine a presentation for their STEM Challenge project.		

YEAR-LONG PACING GUIDE: Version 3 (Excluding Activity 5)					14+ Blocks
Use this pacing guide if you have a flexible class schedule and can afford to use ~3 weeks of class time for the STEM Challenge. This pacing guide prioritizes solution development and completion of solution final products during the third quarter. Final products are due on March 13, 2026. During the fourth quarter, students will focus on developing their presentation. This pacing guide omits Activity 5: Mix-it-up.					
1st Nine Weeks	2nd Nine Weeks	3rd Nine Weeks	4th Nine Weeks		
Focus: Getting Started	Focus: Solution Development	Focus: Model and Display Construction	Focus: Presentation Development		
4 Blocks	4 Blocks	4 Blocks	2 Blocks		
Activity 1 1 Block (Required) Initial Research 1 Block Activity 2 1 Block Research/Gather Information 1+ Block	Solution Development 2+ Blocks Activity 3 1 Block Solution Iteration 1+ Block	Model Development 1+ Block Model Construction 1+ Block Display Design 1+ Block Display Construction 1+ Block	Activity 4 1 Block Pitch/Presentation Development 1+ Block		
Quarter Goal: Students will select a prompt, identify a specific issue related to their prompt that can be realistically solved, and gather information relevant to their identified issue.	Quarter Goal: Students will design a solution to their identified issue before learning each step in the engineering design process, iterating upon and finalizing their solution.	Quarter Goal: Students will develop and construct a model of their designed solution and will design and construct their STEM Challenge display.	Quarter Goal: Students will learn about the components of a strong presentation before developing a presentation for their STEM Challenge project.		

YEAR-LONG PACING GUIDE: Version 4 (Excluding Activity 5, Condensed)					12+ Blocks
Use this pacing guide if you have a flexible class schedule and can afford to use ~2 weeks of class time for the STEM Challenge. This pacing guide prioritizes solution development and completion of final products during the third quarter. Final products are due on March 13, 2026. During the fourth quarter, students will focus on developing their presentation. This pacing guide provides less class time for students to work on their models and displays and omits Activity 5: Mix-it-up.					
1st Nine Weeks	2nd Nine Weeks	3rd Nine Weeks	4th Nine Weeks		
Focus: Getting Started	Focus: Solution Development	Focus: Model and Display Construction	Focus: Presentation Development		
4 Blocks	4 Blocks	2 Blocks	2 Blocks		
Activity 1 1 Block (Required) Initial Research 1 Block Activity 2 1 Block Research/Gather Information 1+ Block	Solution Development 2+ Blocks Activity 3 1 Block Solution Iteration 1+ Block	Model Development and Construction 1+ Block Display Design and Construction 1+ Block	Activity 4 1 Block Pitch/Presentation Development 1+ Block		
Quarter Goal: Students will select a prompt, identify a specific issue related to their prompt that can be realistically solved, and gather information relevant to their identified issue.	Quarter Goal: Students will design a solution to their identified issue before learning each step in the engineering design process and iterating upon and finalizing their solution.	Quarter Goal: Students will develop and construct a model of their designed solution and will design and construct their STEM Challenge display.	Quarter Goal: Students will learn about the components of a strong presentation before developing a presentation for their STEM Challenge project.		

Semester-Long Pacing Guides

SEMESTER-LONG PACING GUIDE: Version 1 (Condensed)		14+ Blocks
Use this pacing guide if you have a flexible class schedule and can afford to use ~3 weeks of class time for the STEM Challenge. This pacing guide prioritizes research and solution development and completion of final products during the third quarter. Final products are due on March 13, 2026. During the fourth quarter, students will focus on developing their presentation. This pacing guide provides less class time for students to develop their solution and work on their models and displays.		
2nd or 3rd Nine Weeks	3rd or 4th Nine Weeks	
Focus: Getting Started, Solution Development, and Model and Display Construction	Focus: Presentation Development	
10 Blocks	4 Blocks	
Activity 1 1 Block (Required) Activity 2 1 Block Research/Gather Information 1+ Block Solution Development 1+ Block Activity 3 1 Block Solution Iteration 1+ Block Activity 5: Solution Review 1 Block Solution Iteration 1+ Block Model Development and Construction 1+ Block Display Design and Construction 1+ Block	Activity 4 1 Block Pitch/Presentation Development 1+ Block Activity 5: Pitch Review 1 Block Refine Pitch/Presentation 1+ Block	
Quarter Goal: Students will select a prompt, identify a specific issue related to their prompt that can be realistically solved, gather information relevant to their identified issue, design a solution to their identified issue, learn each step in the engineering design process, receive feedback on their solution, and iterate upon and finalize their solution. Students will then develop and construct a model of their designed solution and design and construct their STEM Challenge display.		
Quarter Goal: Students will learn about the components of a strong presentation before they develop, receive feedback on, and refine a presentation for their STEM Challenge project.		

SEMESTER-LONG PACING GUIDE: Version 2 (Excluding Activity 5, Condensed)		11+ Blocks
Use this pacing guide if you have a flexible class schedule and can afford to use ~2 weeks of class time for the STEM Challenge. This pacing guide prioritizes research and solution development and completion of final products during the third quarter. Final products are due on March 13, 2026. During the fourth quarter, students will focus on developing their presentation. This pacing guide provides less class time for students to develop their solution and work on their models and displays and omits Activity 5: Mix-it-up.		
2nd or 3rd Nine Weeks	3rd or 4th Nine Weeks	
Focus: Getting Started, Solution Development, and Model and Display Construction	Focus: Presentation Development	
9 Blocks	2 Blocks	
Activity 1 1 Block (Required) Activity 2 1 Block Research/Gather Information 1+ Block Solution Development 1+ Block Activity 3 1 Block Solution Iteration 1+ Block Model Development and Construction 1+ Block Display Design and Construction 1+ Block	Activity 4 1 Block Pitch/Presentation Development 1+ Block	
Quarter Goal: Students will select a prompt, identify a specific issue related to their prompt that can be realistically solved, gather information relevant to their identified issue, design a solution to their identified issue, learn each step in the engineering design process, and iterate upon and finalize their solution. Students will then develop and construct a model of their designed solution and design and construct their STEM Challenge display.		
Quarter Goal: Students will learn about the components of a strong presentation before developing a presentation for their STEM Challenge project.		

STEM Challenge Planning

This planner can be used along with the pacing guides to schedule each STEM Challenge activity and can be used to record due dates for student work, field trips to Frost Science, and Meet the Museum Scientist opportunities. Each page directly corresponds to one quarter of the M-DCPS 2025-2026 school year, excluding December 23 – January 3.

	MON	TUE	WED	THU	FRI
AUGUST	11 	12 	13 	14	15
	18	19	20	21	22
	25	26	27	28	29
SEPTEMBER	SEPT. 1	2	3	4	5
	8	9	10	11	12
	15	16	17	18	19
	22	23 	24	25	26
	29	30	OCT. 1	2 	3
	6	7	8	9	10
OCTOBER	13	14	15	16	17
	Legal holiday		 M-DCPS Teacher planning day, professional learning day or recess day.		

OCTOBER

NOVEMBER

DECEMBER

JANUARY

MON	TUE	WED	THU	FRI
20	21	22	23	24
27	28	29	30	31
NOV. 3 	4	5	6	7
10	11	12	13	14
17	18	19	20	21
24 	25 	26 	27 	28 
DEC. 1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
JAN. 5, 2025	6	7	8	9
12	13	14	15	16 
Legal holiday		 M-DCPS Teacher planning day, professional learning day or recess day.		

JANUARY

FEBRUARY

MARCH

MON	TUE	WED	THU	FRI
19	20	21	22	23
26	27	28	29	30
FEB. 2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27
MAR. 2	3	4	5	6
9	10	11	12	13 STEM Challenge Project Deadline for Submissions
16	17	18	19	20 
23 	24 	25 	26 	27 
30	31	April 1	2	3 
Legal holiday		 M-DCPS Teacher planning day, professional learning day or recess day.		

APRIL

MON	TUE	WED	THU	FRI
6	7	8	9	10
13 	14	15	16	17
SATURDAY, APRIL 18  EXPO AT FROST SCIENCE				
20	21	22	23	24
 Legal holiday		 M-DCPS Teacher planning day, professional learning day or recess day.		

Submission Procedures

While all students can participate in the STEM Challenge, only select student projects will be judged as part of the STEM Challenge. Due to the size of the STEM Challenge, teachers will be asked to select their top student projects for entry into the first round of judging. Teachers may be limited to several submissions per class, program, or extracurricular activity and should use their discretion in selecting which projects to submit.

When selecting top student projects to submit for the STEM Challenge, avoid bias. Top student projects should only be selected based on the quality of student solutions, models, displays, and history design files as these will be the aspects evaluated during the first round of judging. All student projects should be considered for submission to the STEM Challenge if they are complete and high-quality. Complete and high-quality student projects should not be discarded from consideration based on student performance in class or school or based on student attendance.

Submitted student projects should be photographed or otherwise digitized by the student(s) or their teacher before being submitted on Fourwaves. In these digital files, student and school names should be hidden to avoid potential bias during the judging process. After all submissions have been judged, teachers will receive notification of whether any of their submitted student projects have passed the first round of judging. Students that have passed the first round of judging will be asked to attend the STEM Challenge Expo, where they will be judged in-person at Frost Science.

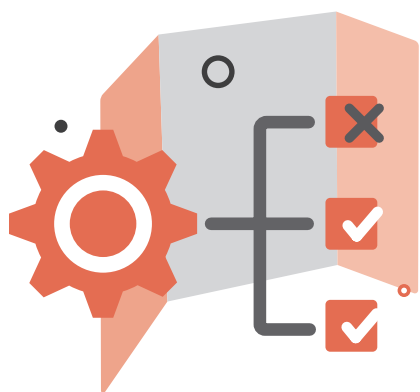
Additional information regarding project submissions will be provided to teachers closer to the STEM Challenge Expo.

STEM Challenge Grading Rubric

Teachers can assess student progress and projects at their discretion. The following rubric may be optionally used to assess student projects at the end of the STEM Challenge.

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)
Identification of Prompt/ Background Information	The prompt is not present on the student display. A) Students do not provide background knowledge about their prompt on their display. <u>OR</u> B) Students provide inaccurate background information.	A) The prompt is not easily identifiable when observing their display. <u>OR</u> B) Students clearly state the prompt on their display. Students provide background knowledge about their prompt on their display. The background knowledge is mostly accurate.	Students clearly state the prompt on their display. Students provide background knowledge about their prompt on their display. The background knowledge is accurate.
Identified Issue	A) Students identify a current issue, but the issues relevance to the prompt and provided background information is unclear. <u>OR</u> B) Students do not focus on one aspect of their prompt. Instead, they attempt to address the prompt in its entirety.	Students focus on one aspect of their prompt, addressing one specific and manageable issue. Students do not explain the connections between this issue, the prompt, and the provided background information.	Students focus on one aspect of their prompt, addressing one specific and manageable issue. Students explain how this issue is related to the prompt and provided background information.
Utilized Engineering Design Principles	Students do not design their solution to account for real world constraints, including cost and ease of implementation. The solution does not utilize modern technologies.	A) Students design their solution to account for real world constraints, including cost and ease of implementation. The solution does not utilize modern technologies. <u>OR</u> B) Students do not design their solution to account for real world constraints, including cost and ease of implementation. The solution utilizes modern technologies.	Students design their solution to account for real world constraints, including cost and ease of implementation. The solution utilizes modern technologies.
Developed Solution	A) Students did not develop a solution to their identified issue. <u>OR</u> B) Students developed a solution to their identified issue, but the solution is unrealistic or would have no impact on the identified issue.	Students developed a solution to their identified issue. This solution is clearly described and would solve or reduce the impact of the identified issue but is not practical or implementable.	Students developed a solution to their identified issue. This solution is clearly described, is practical, and students describe how the solution could be implemented to solve or reduce the impact of the identified issue.
Model of Solution	A) Students have not modeled their solution. <u>OR</u> B) Students have modeled their solution. The model is not easily understood even with a verbal explanation from student presenters.	Students have modeled their solution. This model is not easily understood and requires a verbal explanation from student presenters.	Students have modeled their solution. The model is easily understood when placed alongside the display. The model may utilize labels but should not need a verbal explanation from student presenters.

Sources	A) Students have listed and utilized 0-2 reputable sources. OR B) Students have listed 0-5+ sources, but none of the sources are reputable. In-text citations and sources may or may not be listed in APA format.	A) Students have listed and utilized 5+ sources. Some of these sources are not reputable. OR B) Students have listed 3-4 reputable sources. In-text citations and sources may or may not be listed in APA format.	Students have listed and utilized 5+ reputable sources. All sources have in-text citations and are listed in a references section. All citations and sources are in APA format.
Content	There are grammatical or spelling errors. Each section of content may or may not build upon one another to create a cohesive presentation. Some content feels extraneous or unneeded and is not relevant to the problem or identified solution.	A) There are a few grammatical or spelling errors. All content is connected, with each section of content building upon one another to create a cohesive presentation. No content feels extraneous or unneeded. OR B) There are no grammatical or spelling errors. Content is connected, with each section of content building upon one another to create a cohesive presentation. Some content feels extraneous or unneeded and is not relevant to the problem or identified solution.	There are no grammatical or spelling errors. All content is connected, with each section of content building upon one another to create a cohesive presentation. No content feels extraneous or unneeded.
Display	The display cannot be easily understood without an explanation from student presenters. The display looks rushed or thrown together.	A) The display cannot be easily understood without an explanation from student presenters. The display looks polished. OR B) The display is arranged logically and is easy to follow. The display can be easily understood without any verbal explanation from student presenters. The display looks polished.	The display is arranged logically and is easy to follow. The display can be easily understood without any verbal explanation from student presenters. The display looks polished.
Project Components	Student presentation covers 0-2 project components.	Student presentation covers 3 project components.	Student presentation covers all 4 project components: • Prompt • Background Information / Topic Introduction • Issue • Solution with model
Teamwork/Pacing	Student teams do not collaborate and do not distribute the workload evenly. Students do not make regular progress and may rush to finish their project. Students working individually do not make regular progress and may rush to finish their project. Students do not efficiently use class work time.	A) Student teams do not show much collaboration or do not distribute the workload evenly. Students make regular progress on their project. OR B) Student teams collaborate and distribute the workload evenly. Students do not make regular progress and may rush to finish their project. Students working individually complete their projects in bursts, occasionally making sudden progress after long periods of no progress. Students occasionally use class work time.	Student teams collaborate and distribute the workload evenly. Students make regular progress on their project. Students working individually make regular progress on their projects. Students efficiently use class work time.
Overall Score: _____/100			



Section 4

Final Products

Section 4 of the Teacher Guidebooks contains information about how STEM Challenge projects will be evaluated along with additional tips and resources for students. This includes descriptions and examples of final products and judging rubrics. This section also provides definitions for different technology terminology, guidance on how to evaluate STEM Challenge solutions, information about using Artificial Intelligence (AI), tips for students, and additional resources. While all materials in Section 4 were written for students and can be found in Section 3 of the Student Guidebook, they may also be beneficial for teachers.

Reviewing the section about AI is highly recommended. While the use of AI in student work is controversial, it is also becoming increasingly common and difficult to identify. If possible, teachers should encourage responsible AI use with their students. By allowing responsible AI use, teachers can monitor and provide feedback on how students use this technology. Teachers that do not allow AI use in the STEM Challenge project should be aware that their students may still use AI without proper guidance and that their students will be competing with other students who were allowed to use AI for their projects.

“Knowing is the key to caring, and with caring there is hope that people will be motivated to take positive actions. They might not care even if they know, but they can’t care if they are unaware.”

– Sylvia Earle



Technology Terminology

There are a wide variety of emerging technologies that may be used in the 2025-2026 STEM Challenge. While not an exhaustive list, these technologies include:

3-Dimensional (3D) Modeling: 3D models are designed or sculpted using 3D modeling software. These models occupy three planes and have a depth, width, and height.

3-Dimensional (3D) Printing: 3D models can be sliced using 3D printing software to create thin, printable layers. The 3D printer can then print each layer of the 3D model using plastic or resin.

Artificial Intelligence (AI): AI is a technology that allows computer systems to perform actions or tasks that would typically be performed by humans. To perform these tasks, AI pulls from provided data.

Machine Learning: Machine Learning is a type of AI that can analyze data to identify trends and predict results. As the Machine Learning AI is provided with more data, it can 'learn' and the processes it uses to make predictions will change.

Biotechnology: Biotechnology uses or simulates biological processes or structures. Processes are often used to create a product while structures are often integrated into the product structure.

Immersive Technologies: Immersive technologies simulate virtual elements that users can perceive as real.

Augmented Reality (AR): Augmented reality overlays virtual elements with physical elements in the real world. Users can interact with these virtual elements.

Mixed Reality (MR): Mixed reality integrates virtual elements into the physical environment of the real world. The virtual elements are fully interactive and can respond to changes in the physical environment.

Virtual Reality (VR): Virtual reality allows users to view and interact with an immersive virtual world.

Implantables: Implantables, or implantable devices, are any type of technology that is implanted directly into the body and include items like pacemakers and cochlear implants.

Nanotechnology: Nanotechnology is the modification of matter on the atomic and molecular level. These modifications result in altering existing, or creating new, materials or substances.

Robotics: Robotics is the field of science responsible for designing, building, and programming machines capable of complex actions.

Wearables: Wearables, or wearable devices, includes any type of technology that can be worn as an accessory or embedded in a clothing item. Wearables are diverse and include technologies used to monitor health data, make calls, and track locations.

Scientists use a variety of different terms and tools when planning, designing, or creating different technological products. The following terms can be used to help understand technologies:

Application Software (Apps): Application software includes all computer programs used to perform specific tasks.

Block-based coding: Block-based coding, or block coding, is a type of visual code used to program different technologies. Unlike programming languages, block-based code uses blocks of text pre-programmed with code. These blocks can be modified, moved, and rearranged to indicate the order of or the relationship between tasks. While block-based coding can be used to program computers, actions are limited by the type of available blocks.

Programming Languages: Programming languages describe the language used to code, or write instructions for, different technologies. Different programming languages have different syntax, or code structures, and may be used for different purposes. Three of the most common programming languages are:

C++: C++ is a general-purpose programming language that is frequently used to code computer systems and software. C++ is considered an advanced programming language.

JavaScript: JavaScript is a general-purpose programming language that is primarily used to code web-based software and websites.

Python: Python is a general-purpose programming language that is frequently used to code computer software and artificial intelligence. Python is often considered the best programming language for beginners.

Hardware: Hardware includes all physical components of a computer or related technology.

Open-source: The term open-source indicates that all users can use, modify, and redistribute the software or code. Users can use open-source software and code for any personal or commercial purpose.

Rendering: Rendering is the final process in developing computer generated 2-Dimensional or 3-Dimensional visuals. During this process, additional detail is added to the visual to indicate textures and light sources. This may include adding shadows and highlights to objects.

Software: Software includes all programs and code used by a computer or related technology.

User Experience (UX): User experience describes how people feel when interacting with a product. Successful technological products provide a positive user experience.

User Interface (UI): User's interact with technology using the user interface. This includes any user-facing dialogue boxes, buttons, or controls.



APA Format

American Psychological Association (APA) formatting is commonly used to cite scientific reviews and articles. Students must use APA formatting when citing sources, and in-text citations must be included within all STEM Challenge products, including STEM Challenge presentations. In-text citations identify information obtained from another source, helping you avoid plagiarism. Information obtained from other sources should be paraphrased and should not appear in quotes. Each in-text citation must have a corresponding citation in the references section on your STEM Challenge display.

While there are a variety of websites that can automatically produce citations for students, they do not produce in-text citations. In-text citations should be written as follows:

In-Text Citations	
No author	(Title of Source, Year)
One author	(Last name of Author, Year)
Two authors	(Last name of Author 1 & Last name of Author 2, Year)
More than one author	(Last name Author 1 et al., Year)
If citing multiple works	(In-text citation 1; In-text citation 2)

If students must use a direct quote, the page number of the quotation should be included at the end of the in-text citation in the following format: p. #

Most of the cited works used in the STEM Challenge will be websites. These websites can be cited as follows:

- Last name, F. M. (Year, Month Date). *Title of page*. Site name. URL

While many scientific articles may be found online, they use a different APA citation format than websites. Scientific articles can be cited as follows:

- Last name, F. M. (Year). Title of article. *Journal name*, volume number (issue number), pages. URL

For scientific articles, Google Scholar or the scientific journal may already provide a citation in APA format.

If one of the components, such as the author's middle name or the date published, are missing from the source material, they may be omitted from the in-text citations and the citation listed in the references section. Every in-text citation should have a corresponding citation listed in the references section. Citations listed in the references section should be listed in alphabetical order.

Non-website or scientific article sources use different APA citations formats. For referencing other sources, such as books or videos, students can reference apastyle.apa.org or use an online citation generator. If using an online citation generator, students must always check that the format is set correctly and double check the citation for any potential errors.

Models

As part of the STEM Challenge, students must produce a partial or full model of their solution that includes at least one physical or digital component. Purchased materials do not count as a component of the model unless they have been modified by students. For example, a student may purchase, modify, and use a radio-controlled car as part of their model, but may not use the radio-controlled car as purchased without modifying it in any way.

The model should be clearly and accurately described in the student's presentation and should not need a verbal explanation when placed alongside their display. The model may use labels for additional descriptions as needed. For example, a section of code could be placed alongside a description of its intended purpose. Because the code is clearly labelled in the display, it would not need a verbal explanation to be understood.

In addition to the model's ability to embody the solution, the model should also be well constructed. For physical models, this means that the model should not have any rough edges or parts and must not pose a safety hazard. For digital models, this means that rendered models should display clearly and accurately, while functional models should perform reliably without major bugs or errors.

All models must be accompanied by a Design History File.

Examples of Acceptable Models	Examples of Unacceptable Models
Blueprints of a robot with a student-made robot arm	Blueprints of a robot with no physical or digital component
Student-made or modified scale model of a robot that is 1/24 the size of the proposed product	Purchased 1/24 scale model of a robot that has not been modified
Student-made robot arm with labels that can be understood by a viewer without a verbal explanation	Student-made, unlabeled robot arm that needs an additional explanation to be understood by a viewer
Purchased robot arm that runs using a student-made or modified code	Purchased robot arm that runs using a pre-built code that has not been modified by students
Student-made robot arm that matches the robot as described in the display	Student-made robot arm that is different from the robot as described in the display
3D model of a robot with a good mesh	3D model of a robot that has mesh distortions
Code for a robot that has no syntax errors	Code for a robot that has a lot of syntax errors and bugs

The above examples of acceptable and unacceptable models are not meant to be all-inclusive. Students are encouraged to use their creativity when creating a model of their solution. If the model is understood when placed alongside other project components, does not need a verbal explanation, and contains a physical or digital component that has been modified in some way, it meets the criteria of a STEM Challenge model.

Design History Files

Each model created for the STEM Challenge must have an accompanying Design History File (DHF). DHFs are used to document the design of a product from start to finish and identify each iteration of the product as it is refined by the engineering design process.

For the purposes of the STEM Challenge, DHFs will be fairly simple and will be used by judges to assess physical and digital models.

Design History File Requirements
Any files or notes used to develop the model - DHFs may include code and 3D model files. - Not all notes regarding the solution need to be included, only notes related to model development.
Sketches, pictures, or screenshots of the model during the design process - For digital models, including code and 3D models, this includes several screenshots of the digital file during its development. - Pictures of 3D models being printed are only necessary to record printing errors as these may require adjusting the model or print settings.
Pictures or screenshots of any problems encountered during the design process - Pictures or screenshots showing problems must be included in the DHF. These are very important as fixing problems is a key part of the engineering design process. - Pictures may display broken models, components that did not work as intended, and more. - Screenshots may include error messages for digital models.
Each sketch, picture, screenshot, file, or notes must be accompanied by a short description - Descriptions must explain what was done to create the model or what changes were made to the model. - Descriptions should include reasoning for each design choice or modification.
DHFs can be saved as any file type Presentations are a recommended format for saving a DHF. Each sketch, picture, or screenshot can be placed along with their associated description on a separate slide.

Design History File: Example

The descriptions provided for each picture, screenshot, sketch, etc. will vary. The following example DHF descriptions are for a hypothetical color pencil-sorting robot. Please note that for the purposes of the STEM Challenge, the code or 3-Dimensional models would count as a digital model and likewise, the physical robot would count as a physical model. This example is intended to demonstrate a DHF for multiple model types.

Example 1: Digital 3D Model and Physical Robot Model

The 3D model and the physical robot model count as two separate models. Students would only need to submit one of these to fulfill the model requirement. This example details the production of both models.

[Sketch of robot with measurements]

This sketch shows the initial design for a color pencil sorter. This initial design includes a base for stability and a robotic arm. The end of the robotic arm is equipped with a small camera and a gripper. The robotic arm has two joints and can rotate on the base. Measurements for each component are included in the sketch.

[Screenshot of 3D modeling software]

This screenshot shows the basic shapes used to create each part of our robot. These shapes have not been fully designed.

[Screenshot of 3D modeling software]

This screenshot shows each part of our robot mid-design. The shapes have been merged to create each individual component.

[Photo of robot parts]

This photo shows the test print of our robot components. The parts fit together, but some parts had a really tight fit. This would prevent the robot from being able to move its arm joint.

[Screenshot of 3D modeling software]

This screenshot shows how we resized each of our robot components so that they have a loose, but still snug, fit.

[Photo of robot parts and wiring]

This photo shows the robotic arm under construction. You can see our wiring and where we attached the robotic arm to the base.

Example 2: Physical Robot Model and Digital Code

The physical robot model and the code count as two separate models. Students would only need to submit one of these to fulfill the model requirement. This example details the production of both models.

[Copy of code, 4 pages]

This is the first draft of our code. The code takes inputs from the camera and interprets them using “If-then” statements. Based on what colors the camera sees, the robot will move the color pencils until they create a ROYGBV gradient.

[Screenshot of code, 5 lines of code are highlighted]

The robotic arm did not work using the first draft of our code. This screenshot shows how we modified the code to make sure the input from the camera was being received by the robot’s computer.

[Photo of robot dropping a pencil and a screenshot of code with 1 line of code highlighted]

This photo shows a color pencil falling out of the gripper and the screenshot shows how we adjusted the code to increase the strength of the gripper.

[Photo of sorted color pencils]

This photo shows the results of our first test. The robot did not correctly sort the color pencils into ROYGBV order as it had difficulty sorting the darker shades of blue and violet.

[Photo of LED wiring]

This photo shows the installation of LED lights near the camera. These lights will help the camera differentiate between the darker shades of blue and violet.

[Photo of sorted color pencils]

This photo shows the results of our second test. The robot did a better job sorting the color pencils into ROYGBV order, but it still struggled with the darker shades of blue and violet.

[Screenshot of code, 3 lines of code are highlighted]

This screenshot shows how we increased the saturation of our camera input by adding three lines of code.

[Photo of sorted color pencils]

This photo shows the results of our third test. The robot was able to successfully sort the color pencils into ROYGBV order.

Presentation Displays

Students must create a display for their STEM Challenge project presentation. These displays must identify the chosen prompt, provide background information, identify a solvable issue related to the prompt, describe a solution, identify the solution's design considerations and list the sources used to develop the project. If students would like additional information about what their display should include, they should refer to the Project Completion Judging Rubric found on **page 168** in the Teacher Guidebook and **page 63** in the Student Guidebook. The display must also be used to support, not replace, student oral presentations and should look polished. The display's design must be purposeful and should contain no grammatical or spelling errors.

For the first round of judging, displays must be submitted digitally as photos, videos, or another file type. Projects that pass the first round of judging must also have a display that can be presented in-person at the STEM Challenge Expo. Students may modify their display between the first and second round of judging and should make sure that their display format lends itself to both digital submissions and in-person oral presentations. Students with video displays or other display formats are responsible for all equipment needed to give their presentations if they are invited to the STEM Challenge Expo.

While each STEM Challenge display must contain specific components and must act as a supporting element for oral presentations, a specific display design or structure is not required. In other words, students are encouraged to use their creativity in designing their display. As posters provide an easy way to organize and present information, they are a simple display type to use for the STEM Challenge, although other displays are still acceptable!

Posters and other written materials can be designed digitally. Canva is a free program that makes graphic design easy. To design a tri-fold poster in Canva, click "Create a Design" in the upper right corner of the website, select "Custom Size" from the drop-down menu, and set the width to 48 inches and height to 36 inches. To set up the panels on the tri-fold poster in Canva, add a "square" element to the document, resize the square to fill half of the poster, and center it to the middle of the document. Students can then design their tri-fold poster by adding additional elements to their page using the same procedure. The diagram on the next page provides an example layout for a tri-fold poster display as made in Canva.



Presentation Title Student Name(s)		Solution Implementation	
Selected Prompt Background Information Tell us about information related to your prompt and problem/issue. Page Size: 8.5X11 inches	Design What is your solution? How does it address the problem/issue? What does it look like? Page Size: 11X5 inches	Stakeholders Who are your stakeholders? How are they invested in helping solve the problem/issue? Page Size: 8.5X8.5 inches	Sources List all of your sources in APA format. Page Size: 8.5X11 inches
		Innovation How is your solution new and innovative? Page Size: 11X5 inches	
Additional Information Page Size: 8.5X8.5 inches	Impact Will your solution partially or fully fix the problem/issue? How effective is your solution? Page Size: 11X6 inches	Implementation Procedure How can your solution be implemented? What is the implementation timeline? Page Size: 8.5X11 inches	Design Considerations Materials What materials are you using in your solution? How and why are you using these materials? Page Size: 7x11 inches
		Additional Considerations What else did you have to consider when designing your solution? Page Size: 7x11 inches	
Problem/Issue Identify your problem/issue. Why did you choose this problem/issue? Page Size: 8.5X11 inches	Cost How much does your solution cost to implement and maintain? Page Size: 7x11 inches		



Evaluating Solutions

The following questions are designed to help students evaluate and review their solution. Students can use these questions during each step of the engineering design process, using their responses to help guide them through revising their solutions.

Does your solution involve implementing a new technology or updating a system already in place?

The theme of the 2025-2026 STEM Challenge is “Innovating with Technology to Advance Science.” If your solution does not involve an emerging technology, revise your solution.

Does your solution address the theme of the STEM Challenge and one of the four prompts?

The connection between your solution and the STEM Challenge theme and prompts should be easily identifiable. If your solution does not clearly address the marine science, astronomy, paleontology, or health prompt, revise your solution.

Does your solution have an engineered design?

The STEM Challenge is an engineering design challenge. If your solution involves social implementations and does not involve an engineered design, revise your solution.

If you do not know if your solution has an engineered design, ask the following questions:

- **Is your solution testable?** If so, it is probably an engineered design.
- **Does your solution involve people or marketing?** If so, it may not be an engineered design. Revise your solution.
- **Can your solution be measured objectively, independent of people and their thoughts or feelings?** If so, it is probably an engineered design.
- **Can you model your solution?** This model can be either digital or physical. If you cannot model your solution, it may not be an engineered design. Revise your solution.

How well does your solution solve your identified issue?

Not all solutions have to completely fix an issue. Some of the most innovative solutions may only reduce the impact of an issue. If your solution does not noticeably reduce the impact of your issue, revise your solution.

Is your solution innovative? Is your solution something new, or has it been done before? If it has been done before, is it better than the current solution being used to solve your issue?

While there may be multiple ways to reduce the impact of your issue, your solution should require less resources or produce different results from the current solutions already in place. If your solution does not, revise your solution.

What problems might be caused by the implementation of your solution?

No solution is completely risk-free. If the problems caused by the implementation of your solution are bigger than the issue your solution is designed to solve, revise your solution. Problems caused by implementing your solution may include human health, data safety, or environmental safety issues.

**How well does your solution work? Is your solution reliable?**

Your solution should work to reduce the issue the majority of the time. If your solution is not consistently effective, revise your solution.

Is your solution replicable? Could it be manufactured or otherwise reproduced?

If your solution only works for one extremely-specific situation and is not replicable, revise your solution.

Have you revised or changed any of your solution?

Make sure you are using the engineering design process to improve your solution. Keep in mind that it is highly unlikely that a solution created for the STEM Challenge will be perfect. Look for areas to revise your solution.

Do you have evidence that your solution will work? What is your evidence?

If possible, use data from reliable sources, like scientific articles, to support your solution. If you have no evidence your solution will work, either find evidence or revise your solution. Your evidence should be as specific as possible and you should always cite your sources.

What might prevent you from implementing your solution? Is it primarily cost, or are there other factors?

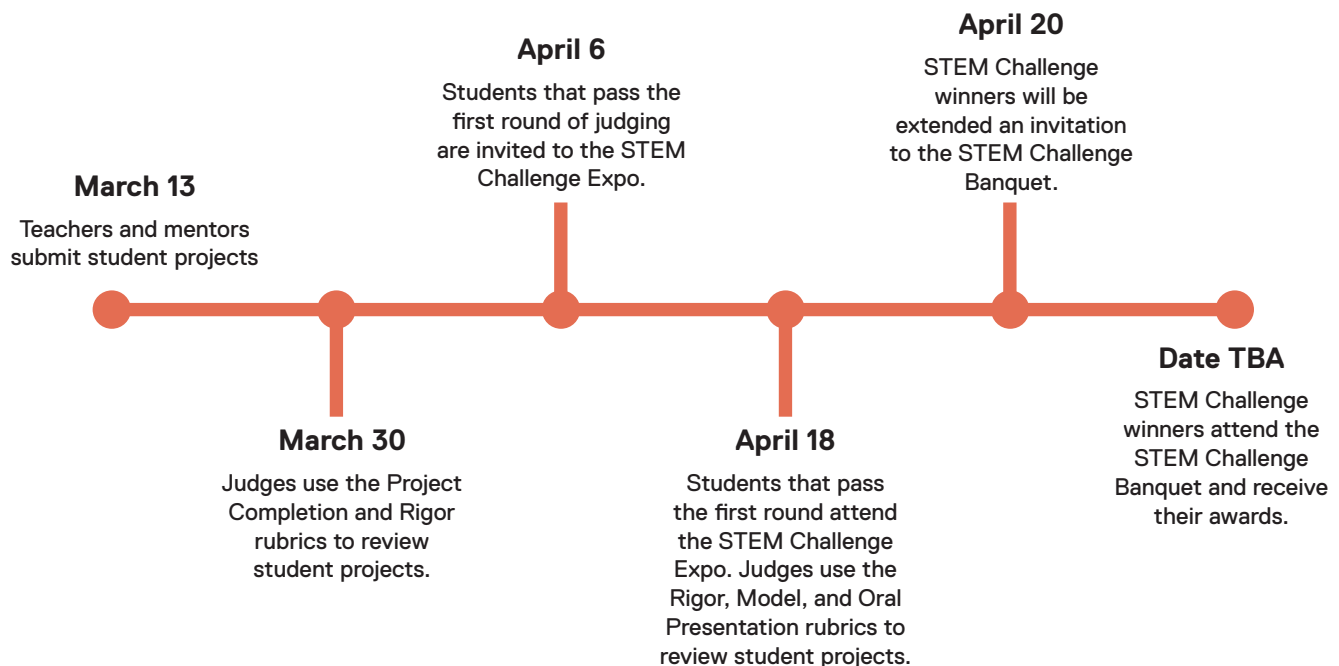
Make sure you address any major real-world constraints. These may include:

- Cost of implementation
- Cost of maintenance
- Stakeholders who may be against solution's implementation
- Laws and regulations

If you have not addressed real world constraints, revise your solution.

Judging Guidelines

Submitted student projects are subject to two separate rounds of judging. The first round of judging will occur virtually, with judges scoring digital submissions of each STEM Challenge project using the Project Completion and Rigor rubrics. The judges will then meet to discuss student projects and select which projects will be invited to the STEM Challenge Expo at Frost Science. For projects that are invited to the STEM Challenge Expo, judges will watch student presentations in person, scoring each project using the 1) Rigor, 2) Oral Presentation, and 3) Model rubrics. After watching student presentations, judges will meet to discuss student scores and will determine Individual, Group, and Junior STEM Challenge winners.



Judging rubrics should be used to self-evaluate STEM Challenge projects and may be used to identify areas for improvement. When using a rubric to self-evaluate a STEM Challenge project, students should first read the section of the rubric labeled “Excellent.” Students should aim to fulfill the qualifications of an “Excellent” project. If a student sees that their project most likely falls into the “Satisfactory” or “Room to Improve” categories, they should try to modify their project until it meets the “Excellent” project criteria.

Frost Science STEM Challenge Rubric for Assessing Project Completion: Digital Submissions

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
IDENTIFICATION OF PROMPT/BACKGROUND INFORMATION	The prompt is not present on the student display. A) Students do not provide background knowledge about their prompt on their display. OR B) Students provide inaccurate background information on their display.	A) The prompt is not easily identifiable when observing their display. OR B) Students do not clearly state the prompt on their display. Students provide background knowledge about their prompt on their display. The background knowledge is mostly accurate.	Students clearly state the prompt on their display. Students provide background knowledge about their prompt on their display. The background knowledge is accurate.	
IDENTIFIED ISSUE	A) Students identify a current issue, but the issue's relevance to the prompt is unclear. OR B) Students do not focus on one identifiable issue related to their prompt and instead attempt to address the prompt in its entirety.	A) Students identify a current issue that is tangentially related to the prompt. OR B) Students focus on one aspect of their prompt, but the issue is not specific or manageable.	Students focus on one specific and manageable issue.	
APPLIED ENGINEERING DESIGN PRINCIPLES Engineering Design Principles: • Functionality • Safety • Reliability • Manufacturability	Students do not design their solution to account for real world constraints. Students do not address cost or ease of implementation. The solution does not utilize modern technologies.	A) Students design their solution to account for real world constraints. Students address cost or ease of implementation. The solution does not utilize modern technologies. OR B) Students do not design their solution to account for real world constraints. Students do not address cost or ease of implementation. The solution utilizes modern technologies.	Students design their solution to account for real world constraints, including cost and ease of implementation. The solution utilizes modern technologies.	

Frost Science STEM Challenge Rubric for Assessing Project Completion: Digital Submissions (continued)

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
DEVELOPED SOLUTION	A) Students did not develop a solution to their identified issue. <u>OR</u> B) Students developed a solution to their identified issue, but the solution is unrealistic or would have no impact on the identified issue.	Students developed a solution to their identified issue. This solution is clearly described and would solve or reduce the impact of the identified issue but is not practical or implementable.	Students developed a solution to their identified issue. This solution is clearly described, is practical, and students describe how the solution could be implemented to solve or reduce the impact of the identified issue.	
MODEL OF SOLUTION	A) Students have not modeled their solution. <u>OR</u> B) Students have modeled their solution, but it does not contain a physical or digital component. <u>OR</u> C) The model is not easily understood. The model may or may not maximize the use of an emerging technology.	A) The model is not easily understood but contains a physical or digital component that has been constructed to partially or fully model the solution. <u>OR</u> B) The model is easily understood when placed alongside the display. The model may or may not maximize the use of an emerging technology.	The model is easily understood when placed alongside the display and contains either physical or digital components. These physical or digital components have been constructed to partially or fully model the solution. The model maximizes the use of an emerging technology.	
SOURCES	A) Students have listed and utilized 0-2 reputable sources. <u>OR</u> B) Students have listed 0-5+ sources, but none of the sources are reputable.	A) Students have listed and utilized 5+ sources. Some of these sources are not reputable. <u>OR</u> B) Students have listed 3-4 reputable sources.	Students have listed and utilized 5+ reputable sources.	
APA FORMATTING Junior STEM Challenge projects will not be judged on their use of in-text citations but will be judged on their use of APA format within their references section.	The in-text citations do not match the sources. Some citations and sources are not in APA format.	A) The in-text citations do not match the sources. All citations and sources are in APA format. <u>OR</u> B) All in-text citations have an accompanying source in the references section. Some citations and sources are not in APA format.	All in-text citations have an accompanying source in the references section. All citations and sources are in APA format.	



Frost Science STEM Challenge Rubric for Assessing Project Completion: Digital Submissions (continued)

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
CONTENT	There are grammatical or spelling errors. Each section of content may or may not build upon one another to create a cohesive presentation. Some content feels extraneous or unnecessary and is not relevant to the problem or identified solution.	1) There are a few grammatical or spelling errors. All content is connected, with each section of content building upon one another to create a cohesive presentation. No content feels extraneous or unnecessary. <u>OR</u> 2) There are no grammatical or spelling errors. Content is connected, with each section of content building upon one another to create a cohesive presentation. Some content feels extraneous or unnecessary and is not relevant to the problem or identified solution.	There are no grammatical or spelling errors. All content is connected, with each section of content building upon one another to create a cohesive presentation. No content feels extraneous or unnecessary.	
DISPLAY	The display looks rushed or thrown together.	The display looks polished but is not arranged logically.	The display is arranged logically and is easy to follow. The display looks polished.	
PROJECT COMPONENTS	Student presentation covers 0-2 project components.	Student presentation covers 3-4 project components.	Student presentation covers all 5 project components: • Prompt • Background Information • Issue • Solution with model • Sources	
Overall Score:				/100



Frost Science STEM Challenge Rubric for Assessing Rigor: Digital Submissions and In-Person Judging

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
IDEATION AND ITERATION PROCESS / ENGINEERING DESIGN	Students do not explain what challenges they encountered when designing a solution and do not explain how they designed their solution.	Students explain what challenges they encountered when designing a solution but did not explain how they adjusted their solution to account for each challenge. Students do not explain each step in their iteration process.	Students explain what challenges they encountered when designing a solution and identify how they adjusted their solution to account for each challenge. Students explain each step in their iteration process.	
EVIDENCE	Students do not explain why their solution is viable.	Students explain why their solution is viable, but do not use specific pieces of evidence.	Students explain why their solution is viable using specific pieces of evidence. This evidence may be scientific, experiential, or anecdotal.	
SOLUTION	A) The solution is specific to the identified issue but is not new or innovative. The solution is already being implemented by another party OR B) The solution is not specific to the identified issue.	The solution is specific to the identified issue. Students use current techniques and practices within their solution, but they are not being used to achieve a different result. The solution has been used elsewhere.	The solution is specific to the identified issue and is new and innovative. Students may use current techniques and practices within their solution, but these techniques and practices must be used to achieve a different result.	
USE OF MODERN TECHNOLOGY	A) Students identify and utilize modern technology in their solutions. Students do not explain the advantages of using this technology and are not specific in identifying any materials or equipment used. OR B) Students do not identify or utilize modern technology in their solutions.	A) Students identify and utilize modern technology in their solutions. Students explain the advantages of using this technology but are not specific in identifying any materials or equipment used. OR B) Students identify and utilize modern technology in their solutions. Students are specific in identifying any materials or equipment used but do not explain the advantages of using this technology. For example, non-specific modern technology may include composite, plastic, chemicals, drones, 3D printers, etc.	Students identify and utilize modern technology in their solutions. Students are specific in identifying any materials or equipment used and explain the advantages of using this technology. For example, specific modern technology may include cellulose-based composite (a plastic substitute), High-Density Polyethylene (a type of plastic), 95% ethanol, fixed-wing drones, fused deposition modeling (a type of 3D printing), etc.	



Frost Science STEM Challenge Rubric for Assessing Rigor: Digital Submissions and In-Person Judging (continued)

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
INNOVATION / ENTHUSIASM	The solution is not new or innovative. Students do not present their ideas with enthusiasm and do not try to convince the audience that their solution is amazing.	A) The solution is not new or innovative. Students present their ideas with enthusiasm and try to convince the audience that their solution is amazing. OR B) The solution is new or innovative. The solution may be a completely new or unique solution or may be an unexpected iteration of a current innovation or solution. Students do not present their ideas with enthusiasm and do not try to convince the audience that their solution is amazing.	The solution is new or innovative. The solution may be a completely new or unique solution or may be an unexpected iteration of a current innovation or solution. Students present their ideas with enthusiasm and try to convince the audience that their solution is amazing.	
Overall Score:				/50



Frost Science STEM Challenge Rubric for Oral Presentations: In-Person Judging

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
INTRODUCTION	Students do not introduce themselves. Students do not state the prompt.	A) Students do not introduce themselves. Students clearly state the prompt at the beginning of their presentation. <u>OR</u> B) Students introduce themselves. Students do not clearly state the prompt.	Students introduce themselves. Students clearly state the prompt at the beginning of their presentation. The introduction includes an attention grabber and utilizes ethos, logos, and/or pathos.	
BACKGROUND INFORMATION/ISSUE CONNECTIONS	Students do not provide background knowledge about their prompt and do not identify one specific issue.	Students provide background knowledge about their prompt. The background knowledge does not provide all the information needed to introduce their identified issue.	Students provide background knowledge about their prompt. The background knowledge provides the information needed to seamlessly introduce their identified issue.	
DEVELOPED SOLUTION	A) Students do not explain their solution. <u>OR</u> B) Students explain their solution, but do not explain how it solves the identified issue or how it accounts for real world constraints.	A) Students explain how their solution solves the identified issue, but do not explain how the solution accounts for real world constraints. <u>OR</u> B) Students do not explain how their solution solves the identified issue. Students do explain how the solution accounts for real world constraints.	Students explain how their solution solves the identified issue and how the solution accounts for real world constraints, including cost and ease of implementation.	
MODEL OF SOLUTION	Students do not explain how the model represents or shows their solution.	Students partially explain how the model represents or shows their solution. The purpose of parts of the model remains unclear even after student explanation.	Students fully explain how the model represents or shows their solution.	
PRESENTATION	Students do not maintain eye contact with their audience and frequently read off their display. At the end of the presentation, students may or may not invite their audience to ask questions.	Students do not maintain eye contact with their audience and may occasionally read off their display. At the end of the presentation, students may or may not invite their audience to ask questions.	Students maintain eye contact with their audience and do not read off their display. At the end of the presentation, students invite their audience to ask questions.	

Overall Score:



Frost Science STEM Challenge Rubric for Models: In-Person Judging

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
DESIGN HISTORY FILE	A) There is no physical or digital component. OR B) The model is not accompanied by a Design History File.	A) The model is accompanied by a Design History File. The Design History File has records of the model at each stage of development but does not contain any descriptions. OR B) The Design History File has descriptions of the model's development but does not have any record of the model during each developmental stage. The Design History File may or may not show the planning, prototyping, testing (where applicable), and redesigning steps of the engineering design process.	The model is accompanied by a Design History File. The Design History File has records of the model at each stage of development. These pictures are accompanied by brief descriptions about the model's initial construction and any modifications made during the engineering design process. The Design History File clearly shows the planning, prototyping, testing (where applicable), and redesigning steps of the engineering design process.	
RELEVANCE/DESIGN	A) There is no physical or digital component. OR B) The model varies from the solution's description. There are differences in material or structure. These differences are not identified and affect the degree to which the model embodies the solution.	A) The model varies slightly from the solution's description. There are differences in material or structure. These differences are not identified, but they do not affect the degree to which the model embodies the solution. OR B) The model varies slightly from the solution's description. There are differences in material or structure. These differences are clearly identified, but they affect the degree to which the model embodies the solution.	The model does not differ from the solution's description. If there are any differences in material or structure, these differences are clearly identified and do not affect the degree to which the model embodies the solution.	
CLARITY	A) There is no physical or digital component. OR B) The components of the model are not identifiable or easily understood based on the description of the solution and any provided labels. The model cannot be understood without a verbal explanation.	Some components of the model are easily identifiable, but other components are not identifiable or easily understood based on the description of the solution and any provided labels. The model cannot be fully understood without a verbal explanation.	All components of the model are easily identifiable based on the description of the solution and any provided labels. The model can be understood without a verbal explanation.	

Frost Science STEM Challenge Rubric for Models: In-Person Judging (continued)

Criteria	Room to Improve (0-3)	Satisfactory (4-6)	Excellent (7-10)	Score (0-10)
STRUCTURE	A) There is no physical or digital component. OR B) The model presents a safety hazard. OR C) The physical component of the model is an item that can be purchased online or in-store. It has not been modified in any way and is not a custom component.	The model contains components that have been altered or made to model the specific solution. The model has some loose parts or rough edges. The model presents no safety hazards.	The model contains multiple physical components that have been altered or made to model the specific solution. The model has no loose parts or rough edges. The model presents no safety hazards.	
WOW FACTOR! While this criterion is more subjective, the ability for a model to leave a lasting impression is important in assessing a model's quality. The "Wow Factor!" often reflects the time and care taken to create the model.	A) There is no physical or digital component OR B) The model does not catch the judges attention or interest through its design or function.	The model catches the judges interest through its design or function and leaves a positive impression. While impressive, the model does not leave the judges thinking, "Wow!"	The model catches the judges attention and interest through its design or function, leaves a positive impression, and leaves the judges thinking, "Wow!"	
Note: If a physical model broke in transit, students should have made a clear attempt to repair the model. Accidental breaks should not influence scores. Models that have visible repairs and have been identified as broken by students will be judged as if they are fully intact.				
Overall Score:				/50





Using Artificial Intelligence

About Artificial Intelligence

Artificial intelligence (AI) is becoming increasingly common in schools and the workplace. While AI can be used as a tool in the STEM Challenge, it should not be used in place of student work. AI may also only be used in the STEM Challenge if AI use is allowed under school policy and is permitted by the teacher facilitating the STEM Challenge.

How to Use Artificial Intelligence

As AI becomes more common, AI misuse is also becoming more common. When choosing to use AI for a STEM Challenge project or other work, make sure to follow proper protocol for using AI. AI should be treated as a tool to create content, not as a replacement for work, and all AI generated content must be checked. AI programs draw information from a variety of sources. This means that even the best AI may provide unreliable or biased information. Because of this, AI is better used to generate and refine ideas, find sources, and sort through information than it is to write content or tell you how to create a display or model.

If using AI for the STEM Challenge, do not rely on AI to generate STEM Challenge solutions. AI draw from information that is already available and are not capable of coming up with an original solution. However, AI can be used to learn about the solutions already being used to address the issues presented in the STEM Challenge. Remember, AI is just a tool and cannot replace creative thought.

Tips for using AI (OpenAI, 2023)*:

1. **Be Specific:** To use AI effectively, you should provide clear and specific prompts to get accurate and relevant responses.
2. **Use AI to Verify Information:** Ask AI to provide sources and cross-reference its responses with reliable, authoritative websites.
3. **Use AI to Learn About a New Topic:** Ask AI detailed questions on the topic you are interested in and request explanations or summaries to gain a better understanding of the topic.
4. **Use AI to Find Related Topics:** Ask AI to suggest topics or concepts related to your area of interest or initial query.

Good vs. Bad Artificial Intelligence

There are a wide range of AI programs that can be used online for free to generate text, art, code, and more. However, not all AI programs are created equally. While programs like Adobe Firefly and Canva can be used to generate AI art and images, some AI art programs generate art or images using copywritten source material as a base without permission from the original artist. AI programs like this are currently under scrutiny and should not be used for the STEM Challenge.



If you choose to use AI for any part of the STEM Challenge, make sure it is a reputable AI program. Some reputable and common AI programs include (Perplexity AI, 2022)**:

- **Adobe Firefly:** “Adobe’s family of generative AI models that can create images, text, videos and other content from natural language prompts and inputs.”
- **Canva:** “A graphic design platform that utilizes AI capabilities like text-to-image generation to help users create visuals like social media posts, presentations, and more.”
- **ChatGPT:** “An advanced language model developed by OpenAI that can engage in human-like conversations and assist with a wide range of tasks like writing, analysis, and coding.”
- **Gemini:** “Google DeepMind’s family of multimodal AI models designed to understand and generate text, images, code, and other content.”
- **Perplexity:** “A conversational AI search engine that generates natural language answers to queries by summarizing information from web sources and providing inline citations.”

Citing Artificial Intelligence

Whenever you use AI, you must cite the AI you used as a source. Like with any source, failure to cite AI can be considered plagiarism. AI citations in APA format should be written as follows:

Author. (Date). *Name* (Version) [Type of Artificial Intelligence]. URL

For example, ChatGPT may be cited as follows:

OpenAI. (2023). *ChatGPT* (April 29, 2024 version) [Large language model]. <https://chatgpt.com/>

If using the above citation to cite ChatGPT in a STEM Challenge project, make sure to update the version date or number. To find the version you are using, click the small question mark in the bottom right corner of ChatGPT and select “Release notes.” This will open a new page with the most recent version date listed at the top.

**The tips for this section of the guidebook were partially generated using AI. ChatGPT was given the following prompt, “How can you use ChatGPT to _____? Answer in one sentence.” This prompt was repeated for each of the tips provided. ChatGPT responses were then edited and refined.*

***The definitions for each of the recommended AI programs were generated using Perplexity and remain unedited.*

Sources:

OpenAI. (2023). *ChatGPT* (April 29, 2024 version) [Large language model]. <https://chatgpt.com/>

Perplexity AI. (2022). [Large language model]. Perplexity AI, Inc. <https://www.perplexity.ai>



Student Tips

The STEM Challenge is just that—a challenge. While completing the STEM Challenge, many students will encounter obstacles. When you encounter these obstacles, you may reference this page for tips on how to overcome them.

Feeling Stuck: How to Take a Break

If you feel stuck at any point during your STEM Challenge, take a break! During your break, try not to scroll social media or do any other activities that may give you information overload. Instead, find a part of your STEM Challenge project that you want to work on. This could be sketching part of your solution, doing additional research, or designing your presentation display. Your priority should be to do something productive and at least somewhat enjoyable; by doing this, you can actively reduce your stress levels and prepare yourself to jump back into the original task (“Taking Breaks,” 2024).

Feeling Frustrated: Finding Sources

If you are struggling to find reliable sources related to your prompt, check open-source websites. While open-source websites like Wikipedia should not be used as sources for your STEM Challenge project, they can be used to find reliable sources. First, search for your topic on the open-source website and look for information that may be relevant to your topic, issue, or solution, writing down any key terms you might be able to use in future searches. While on the open-source website, find the sources section and look for sources relevant to your topic. Some of these sources may be reliable sources you can use for your STEM Challenge project.

Feeling Rushed: Deadlines

During the STEM Challenge, you or your teacher may set deadlines for project tasks. While deadlines can be necessary for you to complete the STEM Challenge, they can also cause a lot of stress. If you feel stressed about meeting a deadline, break your task down into several smaller components. Identify how long it will take you to complete each component and focus on completing each component one at a time. Your goal should be completion, not perfection. Once you have completed each component, you can take any remaining time before the deadline to refine your product.

If you are unable to meet a deadline and the deadline was set by you or your group, adjust the deadline accordingly. Keep in mind that if you move a deadline by a considerable amount of time, you may struggle to meet any following deadlines. Always look forward and plan ahead. If you are unable to meet a deadline and the deadline was set by your teacher, be proactive and communicate your concerns with your teacher to explain why you are unable to meet the deadline and identify a time and date by which you believe you can finish the task. Work with your teacher to discuss your options.

Feeling Overwhelmed: Too Many Options

During the STEM Challenge, you may experience choice overload. Choice overload happens when you feel like you have too many options and struggle to make a decision. For your model and presentation, you can make whatever you want, but you have a set of guidelines to follow and have examples to use for inspiration. There is no shame in using the examples set within your Student Guidebook. If you are ever overwhelmed when designing your solution, learn more about your topic, list all your solution ideas, and pick one solution to focus on for your project. Once you have picked a solution, do not look back or reconsider your selection. Going



back and changing your mind repeatedly, reselecting your solution each time, can make you doubt yourself. You picked a solution, stick with it. Remember, you can still adjust your selected solution as you go—that is part of the engineering design process and part of the STEM Challenge (Chernev et al., 2015; Pilat & Krastev).

Feeling Exhausted: It's Too Hard

The STEM Challenge is not intended to be an easy project. There may be times where you feel exhausted and feel like the project is too hard and never-ending. When this happens, take a break and look at how much you have already accomplished. Remind yourself that everyone goes at their own pace and that the challenges you are facing are the same challenges scientists face everyday. It is okay to struggle. Keep in mind that no one expects your solution to fully solve your identified issue—if finding a perfect solution were that easy, scientists would have already done it.

Other Tips

Do not procrastinate: Not procrastinating is easier said than done. If you struggle with procrastination, there are a variety of tips and tricks you can use to avoid waiting until the last minute. For example, you can set one or several completion goals for your project or project components. These completion goals should be set a few days or a week before the project deadline. Tell someone you know, either a friend or family member, about your completion goals and ask them to hold you accountable or give you reminders. If you keep up with your completion goals, you will finish before your deadline and still have time to touch up your work.

List all your sources: Keep a list of all the sources you think might be relevant to your topic, even if you do not currently need them. It is much easier to remove an unused source from your list than it is to find a specific source you discarded.

Limit work time: Try to maintain a school-life balance. Like any project, the STEM Challenge can be as big or as small as you make it. Try to set STEM Challenge specific work times and only work on the STEM Challenge during these designated time periods. When these time periods are over, stop working on the STEM Challenge. The exception to this rule is when you have an upcoming deadline.

Take care of yourself: Like all work, you need to take care of yourself while completing the STEM Challenge. If you are struggling with any part of the STEM Challenge or with work or life outside of the STEM Challenge, confide in a peer or a mentor. This could be a friend, a teacher, a family member, or a counselor. Remember, while the STEM Challenge and school are important, you are more important. You need to prioritize your own mental and physical wellbeing.

Sources:

Chernev, A., Böckenholt, U., & Goodman, J. (2015). Choice overload: A conceptual review and meta-analysis. *Journal of Consumer Psychology*, 25(2), 333-358.

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Saunders, E. G. (2016, May 11). *If you dread deadlines, you're thinking about them all wrong*. Harvard Business Review. <https://hbr.org/2016/03/if-you-dread-deadlines-youre-thinking-about-them-all-wrong>

The University of North Carolina at Chapel Hill. (2024, February 19). *Taking Breaks*. The Learning Center. <https://learningcenter.unc.edu/tips-and-tools/taking-breaks/#:~:text=For%20this%20reason%2C%20while%20it,studying%20can%20even%20improve%20recall!>

Additional Resources

Free Resources

While some software and classes can be expensive or otherwise difficult to access, there are many high-quality free alternatives.

Frost Science

<https://www.frostscience.org/>



Frost Science will print 3D models for students participating in the STEM Challenge. These models will be printed on a small scale, and model files must be sent to Frost Science 2 months prior to the necessary in-hand date. If you are interested in printing your STEM Challenge models for free, please send your STL files to education@frostscience.org.

AutoDesk

<https://www.autodesk.com/education/home#students>



The AutoDesk Suite provides a wide variety of different software that range from simple 3D modeling to infrastructure design. Software provided in the AutoDesk suite are free for students with a valid school email address.

Tinkercad (Beginner)

<https://www.tinkercad.com/>



Tinkercad is a web-based AutoDesk software that allows users to create 3D models, circuits, and code. The circuits are compatible with Arduino and Micro:Bit and utilize block and Python coding. Tinkercad cannot be used to design circuits compatible with Raspberry Pi. Tinkercad is considered an easy-to-use software.

Blender (Advanced)

<https://www.blender.org/>



Blender is a 3D creation suite that has more capabilities than other 3D modeling software, like Tinkercad, and can create styled and photo-realistic 3D models, animations, simulations, and more. Because Blender has a lot of tools and settings, it also has a steep learning curve.

GitHub (Intermediate-Advanced)

<https://github.com/education/students>



GitHub is a platform where developers can create, store, manage, and share their code with other users. Like with any online download, code used for the STEM Challenge should only come from reliable sources to avoid encountering malware. The source for any code from GitHub used in a STEM Challenge project should be cited.

Google Earth Studio (Beginner-Intermediate)

<https://www.google.com/earth/studio/>



Google Earth Studio is an online software that can be used to create animations and Virtual Reality scenes. Google Earth Studio utilizes Google Earth satellite and Street View imagery along with 3D building models.

KIRI Engine (Beginner)

<https://www.kiriengine.app/>



KIRI Engine allows users to scan objects using their phone to create 3D models. The 3D models generated by KIRI Engine can then be exported and imported into other 3D modeling software, where the file can be edited.

QGIS (Intermediate-Advanced)

<https://qgis.org/>



QGIS is a geographic information system (GIS) software. As a GIS software, QGIS allows users to analyze, display, and map location data. Uses for GIS maps include displaying weather data, identifying flood zones, monitoring deforestation, and urban planning.

Teachable Machine (Beginner)

<https://teachablemachine.withgoogle.com/>



Teachable Machine is a machine learning AI program. Users provide images and sounds to the Teachable Machine, and the AI will learn how to identify and categorize the provided media. The Teachable Machine can be exported and used in conjunction with coding.

Unreal Engine (Advanced)

<https://www.unrealengine.com/>



Unreal Engine is a 3D graphics computer game engine. While this software is primarily used to create video games, it is also used to create simulations, VR/AR/MR, video, and more. Knowing C++ is advantageous when using the program.

Visual Studio Code (VSCode) (Intermediate-Advanced)

<https://code.visualstudio.com/>



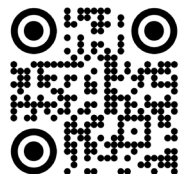
VSCode is an environment where users can write, debug, test, and compile code. VSCode requires a basic understanding of at least one programming language.

Online Courses (Beginner-Advanced)

Students can take free and paid courses that address a wide range of different topics, including coding, artificial intelligence, machine learning, and more.

Corsera

<https://www.coursera.org/>



Code Academy

<https://www.codecademy.com/>



Resources: STEM Challenge Website

<https://www.frostscience.org/frost-science-stem-challenge/>

Additional resources can be found on the STEM Challenge website. Resources listed on the STEM Challenge website may be modified over time.



This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, providing a template for handwriting practice or general note-taking. There are no margins, text, or other markings present.



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