



TEACHER GUIDEBOOK

2026 - 2027

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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 Virtual Meet the Museum Scientist opportunities.

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

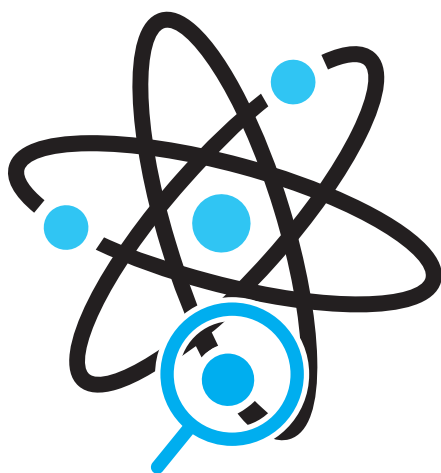


Resources: STEM Challenge Website

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 2026-2027 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, geology, 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 **April 3, 2027**
 - 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



2026 - 2027 STEM Challenge Theme

The STEM Challenge prompts will change each year of the STEM Challenge and are based around a central theme. The 2026-2027 STEM Challenge theme is “Sustainable Energy Generation and Use.”

Sustainable Energy Generation and Use

Energy makes modern life possible, powering our homes, technologies, transportation systems, and more. However, a lot of energy generation methods and energy use have negative impacts. The future of sustainable energy will be shaped by the next generation of problem-solvers. This year’s STEM Challenge encourages students to investigate, design, and innovate as they explore what the future of sustainable energy could look like.

2026 - 2027 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

There are many different ways that the ocean and its resources can be used to generate energy. However, accessing or generating energy can negatively impact marine ecosystems. Create a way to reduce or mitigate negative environmental impacts caused by energy production or create a more sustainable alternative to current energy generation methods in marine environments.



Astronomy

In space, access to Earth-based energy sources, like fossil fuels, is limited. Because of this, scientists are looking for new ways to study and use space-based energy sources as an alternative. Develop a way to expand our ability to observe, capture, or use energy in space.



Geology

Places that experience frequent tectonic activity can use the heat generated by the Earth's core to produce geothermal energy. However, not all places on Earth have access to this energy. Develop a way that places with less tectonic activity can gain access to geothermal energy. This can include new methods or more sustainable versions of current methods used for energy generation and transfer.



Health

Hospitals require constant energy to sustain vital support systems. Currently, hospitals primarily rely on generators in case of power shortages or emergencies. Create a way for hospitals to become more self-sustaining and off-the-grid in case of wide-spread or long-term power outages.

Why Should You Participate in the STEM Challenge?

As part of the STEM Challenge, teachers who attend the Professional Learning experience on August 10, 2026 and submit student projects by April 3, 2027 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 at \$10 per student. Likewise, planetarium shows are \$2 per student.

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.

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 August 10, 2026.
- Scheduling and attending a field trip to Frost Science.
- 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.



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 AGREEMENT

Purpose

This agreement defines the roles and responsibilities of teachers participating in the STEM Challenge during the 2026-2027 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 2026-2027 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 April 3, 2027.
5. Understand that I can 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 August 10, 2026, engagement with the field trip and Meet the Museum Scientist opportunities, and attendance at the STEM Challenge Expo day on May 1, 2027.
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 August 10, 2026 and teachers must submit student STEM Challenge projects by April 3, 2027.
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 or Program Name	Analisa Duran, Ph.D. <i>Knight Director of Science Education</i> <i>Phillip and Patricia Frost Museum of Science</i>
Teacher Name	Signature
Date	
Signature	

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 geology. 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: There are many different ways that the ocean and its resources can be used to generate energy. However, accessing or generating energy can negatively impact marine ecosystems. Create a way to reduce or mitigate negative environmental impacts caused by energy production or create a more sustainable alternative to current energy generation methods in marine environments.

Astronomy: In space, access to Earth-based energy sources, like fossil fuels, is limited. Because of this, scientists are looking for new ways to study and use space-based energy sources as an alternative. Develop a way to expand our ability to observe, capture, or use energy in space.

Geology: Places that experience frequent tectonic activity can use the heat generated by the Earth's core to produce geothermal energy. However, not all places on Earth have access to this energy. Develop a way that places with less tectonic activity can gain access to geothermal energy. This can include new methods or more sustainable versions of current methods used for energy generation and transfer.

Health: Hospitals require constant energy to sustain vital support systems. Currently, hospitals primarily rely on generators in case of power shortages or emergencies. Create a way for hospitals to become more self-sustaining and off-the-grid in case of wide-spread or long-term power outages.

Materials (per student)

- Student Guidebook
- Computer
- Pencil

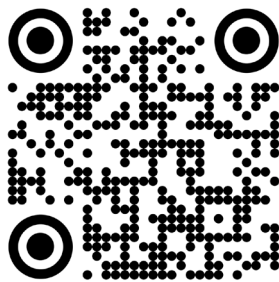
Set-Up Procedure

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-Participation Survey during the STEM Challenge Professional Learning experience should complete the survey at this time. Teacher Pre-Participation Survey https://forms.office.com/r/hrRiMbKUFr	
	

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: <i>Brainstorm at least one solution for each of the problems you identified.</i> 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: <i>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?</i> 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: <i>How can this solution be implemented? Be as detailed as possible.</i> 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.
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	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: <i>What was the most challenging part of creating a solution for the provided prompt? Why?</i> 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: <i>Why is it important to brainstorm more than one issue and solution associated with the prompt?</i> 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: <i>What are the advantages of brainstorming more than one solution for each issue?</i> 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: <i>What is the importance of explaining every detail behind the implementation of your solution? Why is it important to be as specific as possible?</i> 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: <i>Why is it important to consider your stakeholders?</i> 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 2026-2027 STEM Challenge prompts. Which prompt interests you the most? Why? A: Student answers may vary. Example: I am most interested in the marine science prompt. This is because I live in a coastal area and would like to learn more about tidal energy. 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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Environmental Protection Agency (EPA) (n.d.). *Cleaning Up Electronic Waste (E-Waste)*. US EPA. Retrieved July 11, 2025, from <https://www.epa.gov/international-cooperation/cleaning-electronic-waste-e-waste>

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))



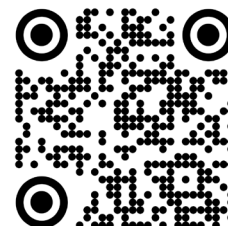
Activity 1

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/9PuriKKRMM>



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 2026-2027 STEM Challenge prompts. Which prompt interests you the most? Why?

Student answers may vary. Example: I am most interested in the marine science prompt. This is because I live in a coastal area and would like to learn more about tidal energy

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



OCTOBER

NOVEMBER

DECEMBER

JANUARY

MON	TUE	WED	THU	FRI
19	20	21	22	23
26	27	28	29	30
NOV. 2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27
30	DEC. 1	2	3	4
7	8	9	10	11
14	15	16	17	18
JAN. 4, 2027	5	6	7	8
11	12	13	14	15
Legal holiday		M-DCPS Teacher planning day, professional learning day or recess day.		

JANUARY

FEBRUARY

MARCH

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



MARCH

APRIL

MAY

MON	TUE	WED	THU	FRI
29 	30	31	APR. 1	2
5	6	7	8	9
12	13	14	15	16
19	20	21	22	23
26	27	28	29	30
SATURDAY, MAY 1, 2027				
 EXPO AT FROST SCIENCE				
 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 25 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:</i> https://journals.biologists.com/jeb/article/226/22/jeb245845/334721/Passive-electroreception-in-bottlenose-dolphins <i>Secondary Source:</i> https://www.sciencenews.org/article/bottlenosed-dolphins-sense-electric-fields-hunt-prey <i>Tertiary Source:</i> https://seaworld.org/animals/all-about/bottlenose-dolphin/senses/ 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: <i>What kind of search query might you use to find scientific articles for your project?</i> A: Student answers may vary. Example: Smartphone consumption and planned obsolescence. Q14: <i>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?</i> 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: <i>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.</i> 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: <i>In what situation would you sit down to read the remaining sections of the research paper?</i> 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 50 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.

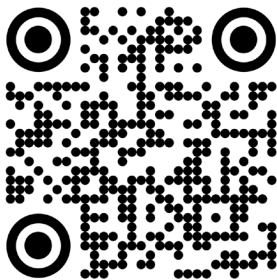
Reliable Source (Examples):	Unreliable Source (Examples):
1. Justification: 	1. Justification:
2. Justification: 	2. Justification:
3. Justification: 	3. Justification:

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.

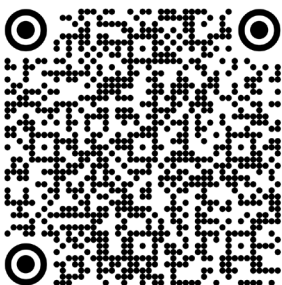


Primary, Secondary and Tertiary Sources

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.

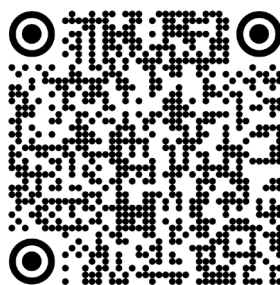
Primary Source:

<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: <i>Innovation is the process of creating something new and unexpected. Why is it important to be innovative in the STEM Challenge?</i> 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: <i>Think back to a time in your life when you had creative freedom and came up with a new innovative idea. Describe this experience.</i> 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.

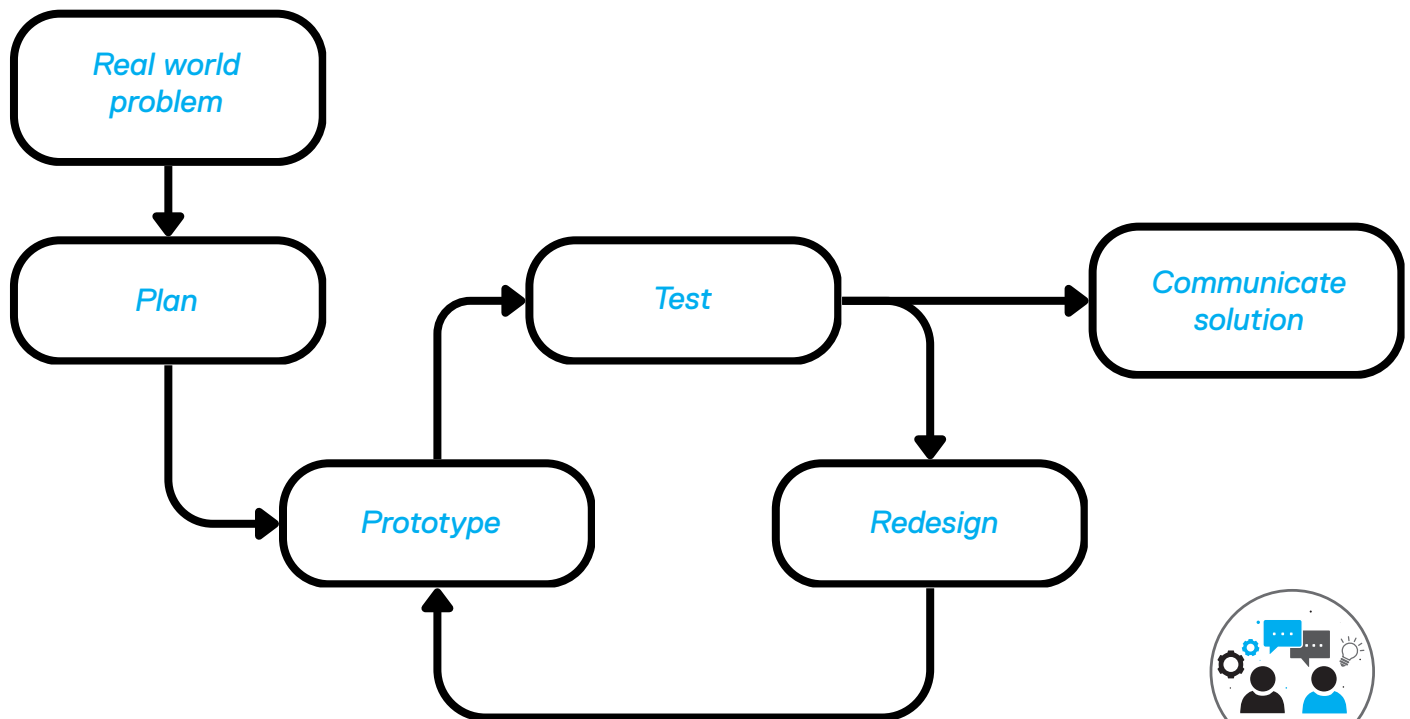
3. How do you use sources to figure out if your solution is new and innovative?

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.

Activity 4: Pitch Your Point 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.

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=l9jlc7E52m0>

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.

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:

STEM Challenge: Pitch Checklist and Feedback Form

Presenter Name(s):_____

Reviewer Name(s):_____

Pitch Checklist		
✓	Item Addressed	Notes
	Importance/Relevance to audience (Pathos)	
	Time to implement	
	Upfront cost	
	Material properties	
	Maintenance frequency	
	Maintenance cost	
	Effectiveness/Efficiency	
	Risk/Ethical or moral concerns	
	Provides evidence (Logos)	
	Confidence/Belief in solution (Ethos)	

Additional Notes:



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 sustainable energy and marine science.

1. **The Dive:** Find the exhibit labeled, “ReeFL.” Tidal power uses the rise and fall of the ocean tides to generate electricity but must be built along coastlines. How might this type of power generation affect coral reefs?
2. **The Dive:** Find the display labeled, “Sea Turtles.” Submarine cables carry the electricity generated from offshore windfarms to land. All electrical conductors, like these cables, generate electric and magnetic fields. Why might this affect sea turtle migrations? How could this affect their nesting behaviors?
3. **Power of Science:** Find the display labeled, “Power of Science.” Where do coral settle and why should this information be considered when designing offshore energy infrastructure?

Frost Science Scavenger Hunt: Marine Science

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

1. **The Dive:** Find the exhibit labeled, “ReeFL.” Tidal power uses the rise and fall of the ocean tides to generate electricity but must be built along coastlines. How might this type of power generation affect coral reefs?

Construction of this type of energy infrastructure could cause water quality issues, negatively impacting species sensitive to changes in water chemistry, like corals

2. **The Dive:** Find the display labeled, “Sea Turtles.” Submarine cables carry the electricity generated from offshore windfarms to land. All electrical conductors, like these cables, generate electric and magnetic fields. Why might this affect sea turtle migrations? How could this affect their nesting behaviors?

Sea turtles can detect electromagnetic fields generated by the Earth. They can return to the nests they hatched by detecting that locations specific electromagnetic signature. If that is disrupted by nearby offshore windfarms, they avoid those beaches or even become confused and not be able to locate their nesting beaches.

3. **Power of Science:** Find the display labeled, “Power of Science.” Where do coral settle and why should this information be considered when designing offshore energy infrastructure?

Coral larvae settle on structures that most closely match the spectral signature, or color, of the corals preferred algae. When designing energy infrastructure, making the portion of the infrastructure in the water match the color of the most common corals in the area may help promote coral growth and create an artificial coral reef.

Frost Science Scavenger Hunt: Astronomy

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

1. ***Feathers to the Stars:*** Find the display labeled, “Stellar Beginnings & Endings.” What type of light does the James Webb telescope utilize to explore the universe, and how might this type of telescope help scientists search for new sources of energy in space?
2. ***Power of Science:*** Find and watch the video titled, “Looking for Lunar Water.” How are scientists hoping to utilize water ice they find below the lunar surface? How could this help revolutionize space travel?
3. ***The Sun Spot (Roof):*** Find the display labeled, “Feel the Heat.” What type of energy is emitted by the Sun and what portion of this energy has the highest amount of energy? What about the lowest? Why is this important to know when capturing energy in space?

Frost Science Scavenger Hunt: Astronomy

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

1. **Feathers to the Stars:** Find the display labeled, “Stellar Beginnings & Endings.” What type of light does the James Webb telescope utilize to explore the universe, and how might this type of telescope help scientists search for new sources of energy in space?

The James Webb telescope uses infrared light to explore the universe, which allows it to be able to see through clouds of gas and dust. This could make it possible to observe previously hidden objects in space.

2. **Power of Science:** Find and watch the video titled, “Looking for Lunar Water.” How are scientists hoping to utilize water ice they find below the lunar surface? How could this help revolutionize space travel?

Scientists are hoping to mine water ice to create rocket fuel. This could allow astronauts to use the Moon as a jumping off point to explore further into space than if they were to leave from Earth.

3. **The Sun Spot (Roof):** Find the display labeled, “Feel the Heat.”

- a. What type of energy is emitted by the Sun and what portion of this energy has the highest amount of energy?

The Sun emits radiation. The radiation with the highest amount of energy are gamma rays.

- b. What type of energy has the lowest amount of energy?

The radiation with the lowest amount of energy are radio waves.

- c. Why is it important to know about energy levels in space?

This is important to know when capturing energy in space because by expanding the range of wavelengths used to generate solar energy to shorter frequencies, we can capture more energy.

Frost Science Scavenger Hunt: Geology

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between sustainable energy and geology.

1. **The Dig:** Observe the fossil preparation laboratory. What is Laurasia and what areas of Laurasia do you think would have active volcanic activity?
2. **The Dig:** Look at the exhibits in The Dig. What tools do paleontologists use to excavate fossils? How do you think heavy machinery, like the drills used to access geothermal energy, may impact fossils?
3. **The Dig:** Observe the fossil preparation laboratory and look for two replica skulls in the back of the room. These skulls are replicas of ancient animals found in the La Brea Tar Pits in California. These tar pits often form in areas with tectonic activity, where lower layers of the Earth's crust are closer to the surface. Despite this, these areas are not suitable for geothermal energy generation. Use what you know about plate boundaries to hypothesize why these areas are not good for geothermal energy.

Frost Science Scavenger Hunt: Geology

Instructions: As you explore the museum, answer the questions below to learn more about the relationship between sustainable energy and geology.

1. **The Dig:** Observe the fossil preparation laboratory. What is Laurasia and what areas of Laurasia do you think would have active volcanic activity?

Laurasia is an ancient continent composed of North America, Europe, and Asia. The middle of this continent, where the plates border Europe, would have a lot of volcanic activity.

2. **The Dig:** Look at the exhibits in The Dig. What tools do paleontologists use to excavate fossils? How do you think heavy machinery, like the drills used to access geothermal energy, may impact fossils?

Paleontologists use a wide variety of tools to access fossils, including rock hammers, chisels, awls, brushes, and brooms. Because fossils are very fragile, heavy machinery like drills could destroy the fossil. Even if the drills are not used on top of the fossil, the vibrations created by the drill could damage any fossils in the surrounding area.

3. **The Dig:** Observe the fossil preparation laboratory and look for two replica skulls in the back of the room. These skulls are replicas of ancient animals found in the La Brea Tar Pits in California. These tar pits often form in areas with tectonic activity, where lower layers of the Earth's crust are closer to the surface. Despite this, these areas are not suitable for geothermal energy generation. Use what you know about plate boundaries to hypothesize why these areas are not good for geothermal energy.

While it is easier to access lower layers of the Earth's crust in these areas, having tectonic activity does not always mean that the area is suitable for geothermal energy. The plate boundary in this part of California, a transform boundary, does not result in a lot of volcanic activity and is much cooler than other types of plate boundaries, like convergent and divergent boundaries.

Frost Science Scavenger Hunt: Health

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

1. **The Sun Spot (Roof):** Find the display labeled, “Smart Delivery of Energy.” How might smart grid technology help keep hospitals operational during widespread or long-term power outages?
2. **The Sun Spot (Roof):** Find the display labeled, “Renewable Solutions.” Hospitals can receive power from sun and wind energy, but what are the limitations of this type of energy and how can hospitals overcome these limitations?
3. **MeLab Level 3:** Find the “High-tech Medicine” videos and watch one video of your choice. Does this technology rely on a constant power supply? If so, how could a disruption in power impact the use of this technology?

Frost Science Scavenger Hunt: Health

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

1. **The Sun Spot (Roof):** Find the display labeled, “Smart Delivery of Energy.” How might smart grid technology help keep hospitals operational during widespread or long-term power outages?

Smart grid technology can very quickly identify problems within a power grid and could divert power stored from solar energy to hospitals to keep them operational.

2. **The Sun Spot (Roof):** Find the display labeled, “Renewable Solutions.” Hospitals can receive power from sun and wind energy, but what are the limitations of this type of energy and how can hospitals overcome these limitations?

Solar and wind energy availability is based on weather conditions and cloudy, still days would not generate much energy. However, hospitals can use batteries to store any excess energy created from wind and solar energy to use during these cloudy, still days.

3. **MeLab Level 3:** Find the “High-tech Medicine” videos and watch one video of your choice. Does this technology rely on a constant power supply? If so, how could a disruption in power impact the use of this technology?

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. A disruption in power could disrupt the medical scan. Fortunately, this would not have any significant impacts as the scan could be repeated after power has been restored.



Virtual 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 worksheet can optionally be provided to students before the virtual meeting. This worksheet can be given to students to complete during class or may be assigned as homework. **The worksheet 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 2026-2027 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 2026-2027 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

- 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 geology prompt by **G** 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.

Computer Science Standards				
Associated Prompts: Health				
Computing Components				
Computer Science Standard	Associated Prompts	Justification	Potential Connectors	
Standard 2: Construct varying hardware configurations.				
SC.912.CO.2.4 Explore the role of a power supply unit (PSU) in relation to a computer system.		The Power Supply Unit (PSU) functions as the power supply of a computer or other large appliances. The PSU converts electricity to the correct voltage for the electronic device and helps regulate the amount of energy it receives. This helps prevent damage to the electronic device during power fluctuations. Because the PSU regulates power draw, it can make an electronic device more efficient. Most large hospital appliances, including CT scanners and x-ray machines, use a PSU to regulate the amount of energy they receive. While PSUs regulate power to electronic devices, they do not prevent loss of power to the device during power outages.	Ask students to describe what types of technology may use a PSU in hospitals.	
Technological Impact				
Computer Science Standard	Associated Prompts	Justification	Potential Connectors	
Standard 1: Assess the impact of technological advancements.				
SC.912.TI.1.1 Analyze historical trends in hardware and software.		Over time, technology has become more energy efficient while still producing more and more computing power. This trend of creating more energy efficient technology is beneficial for technology with heavy power draws, like CT scanners. While these technologies are being made more efficient, they still require massive amounts of power. In the event of a power outage, CT scanners and other technologies with a large power draw cannot be used.	Ask students to describe why energy efficiency is a priority for engineers developing medical equipment.	

			
Science Standards			
Associated Prompts: Marine science, health, geology, astronomy			
Life Science			
NGSSS Standard	Associated Prompts	Justification	Potential Connectors
Standard 14: Organization and Development of Living Organisms			
SC.912.L.14.34 Describe the composition and physiology of blood, including that of the plasma and the formed elements.		Blood and all of its components have specific shelf lives and storage requirements and must be kept within a certain temperature range. During power-outages, hospitals have to direct some of their limited power supply to refrigeration units to keep red blood cells and plasma from spoiling. In the event that backup power supplies, like generators, stop working, these resources can spoil and may need to be discarded. Platelets do not require refrigeration.	Ask students to explain how power outages in hospitals can impact the quality of stored blood components.
SC.912.L.14.37 Explain the components of an electrocardiogram.		An electrocardiogram (ECG/EKG) monitors the heart's electrical activity. This process requires a constant, stable electrical supply to function accurately. If there is an interruption to its power supply, like during the switch to an emergency power supply during a power outage, the data collected could have gaps or otherwise present errors. Most modern ECGs/EKGs have an internal battery in case of power interruptions.	Ask students to explain how a disruption in power could impact an electrocardiogram.
Standard 16: Heredity and Reproduction			
SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.		Biotechnology, including gene therapy, insulin production, and mRNA vaccines, have revolutionized healthcare. However, these advancements often introduce new ethical dilemmas regarding access, especially for energy-intensive biotechnologies. Increased energy needs often contribute towards a higher cost for consumers, making the technology less accessible for lower-income patients.	Ask students to discuss the relationship between energy use and access to affordable healthcare.
SC.912.L.17.2 Explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity, and temperature.		Energy generation methods that use marine resources can alter marine environments and therefore impact the normal distribution of marine organisms. For example, offshore wind farms and fracking operations can impact water chemistry during construction and can reduce the amount of available light for benthic organisms. Wind farms and fracking operations also provide new substrates for marine organisms, increasing the population of some species. Both increased and decreased populations are deviations from normal distributions and can have significant impacts on marine environments.	Identify one type of energy infrastructure in marine environments and ask students to describe how installing the energy infrastructure may impact the distribution of species.
SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycle.		Fossil fuels, one of the main ingredients in rocket fuels, are produced when carbon is sequestered during the carbon cycle. There is currently no evidence to show that the carbon cycle includes photosynthesis, cellular respiration, and decomposition on other celestial bodies. However, while other celestial bodies may not have fossil fuels are not a reliable source of energy for long-distance space travel. Finding renewable energy sources in space is essential for long-distance missions.	Ask students to explain why, as far as we know, fossil fuels can only be found on Earth and not on other celestial bodies.

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.		Renewable marine resources include tidal, wind, and solar energy. While these resources are renewable, they are expensive to set up and install, can still negatively impact wildlife by altering habitats, migration patterns, and behaviors, and disrupt ocean views.	Ask students to identify what types of renewable energy can be produced in marine ecosystems.
		Non-renewable marine resources include fossil fuels, which can be found in deep-sea reserves. While fossil fuels are reliable and relatively affordable, they are limited and reserves can run out. Furthermore, accessing these reserves requires fracking, which can release chemicals into the environment. Oil spills can also result from fracking, which can contaminate the surrounding ecosystems and harm wildlife.	Ask students to identify what types of non-renewable energy can be produced in marine ecosystems.
		While hospitals are transitioning to renewable resources like solar energy and wind farms in case of power disruptions, they are still heavily reliant on the energy produced by fossil fuels at power stations. While fossil fuels have a significant environmental impact and are a finite resource, relying on current power grid infrastructure has a low monetary cost in comparison to building renewable energy infrastructure capable of supporting a hospital.	Ask students to discuss why hospitals primarily rely on fossil fuels even though they are a nonrenewable resource. As students discuss their answers, direct them to think about the financial cost of using renewable and nonrenewable resources.
		Non-renewable resources in space, including fossil fuels, are not a reliable solution for long-distance space travel. Not only can fossil fuels be heavy, but they can also run out, making travel and landing impossible. In comparison, renewable resources in space, including solar energy, can be used to propel spacecraft indefinitely.	Ask students to describe why non-renewable resources are not suitable for long-distance space travel.
		Geothermal energy is one of the most consistent and reliable renewable resources. However, for areas without much tectonic activity, it can be difficult to access and utilize the heat of Earth's core for energy generation. While deep-drilling techniques can be used to access geothermal energy in areas without much tectonic activity, it is not often used because of the high infrastructure cost.	Ask students to discuss why some places use geothermal energy while other places do not, or cannot, use any geothermal energy.
SC.912.L.17.12 Discuss the political, social, and environmental consequences of sustainable use of land.		The installation of marine energy infrastructure in coastal areas requires engineers to evaluate local city, state, and country policies. Many offshore energy infrastructure, including offshore wind farms, can be restricted by protected marine areas. Offshore infrastructure can also cause social backlash as it is often considered a form of "visual pollution" because it can disrupt scenic views of the ocean. While Florida does not have winds that are well-suited for offshore wind farms, they have still been banned within one mile of the Florida coast. This ban was in part the result of public opinion on the appearance of offshore wind farms.	Ask students why a community would not like a wind farm off their coast.
		While geothermal energy has a small geographical footprint, engineers still need to assess the impact of geothermal energy infrastructure on local environments. This includes testing groundwater for any pollutants that may be caused by geothermal energy production.	Ask students to describe how even sustainable energies like geothermal energy can impact the environment.

NGSSS Standard	Associated Prompts	Justification	Potential Connectors
SC.912.L.17.13 Discuss the need for adequate monitoring of environmental parameters when making policy decisions.		Data monitoring is essential for sustainable marine policies. When it comes to using marine resources for energy production, historical and current environmental quality data can determine how, when, and the scale to which offshore energy infrastructure is used. As more offshore energy infrastructure is used around the world, the data collected about the infrastructure and its environmental impacts can shape future policy and use.	Ask students to identify what water parameters they would want to monitor for different types of energy infrastructure: wind energy, tidal energy, and fossil fuels.
		Effective policy regarding geothermal energy depends on how the geothermal plants impact local environmental parameters, including ground stability, water table levels, and groundwater quality. Any changes to these parameters may result in the creation of new policies that limit the use of local geothermal plants.	Ask students to identify three parameters that may change as a result of local geothermal energy production. Ask students to describe how policy could be used to slow or stop changes to these parameters.
		The extraction of fossil fuels on offshore oil rigs can result in oil spills. Oil can quickly disperse across water, so they need to be contained quickly. Depending on the situation, oil spills are usually treated with sorbents or dispersants, contained using booms, and cleaned up using skimmers.	Ask students to describe the kinds of waste that may be produced by fracking before brainstorming how each type of waste can be managed on offshore oil rigs.
SC.912.L.17.14 Assess the need for adequate waste management strategies.		All energy generations methods produce waste. Even for sustainable energy sources that produce no waste while in-use, the production of infrastructure needed for clean energy has waste byproducts and the eventual deterioration of infrastructure when it reaches the end of its lifespan can also result in waste. Waste produced when accessing or using an energy source in space can accumulate over time.	Tell students to imagine that humanity finds energy resources on another celestial body. Ask students to discuss humanity's role in monitoring waste production from energy production in space.
		While geothermal is considered a “clean” energy, it still produces waste products. The water used for geothermal energy can carry gases, minerals, and heavy metals from deep underground. This toxic mineral and metal laden water cannot be released into the surrounding environment and must be treated, properly disposed of, or used for other energy production methods.	Tell students that water pumped up from deep underground sources, like those used in geothermal energy production, can be hazardous. Ask students to identify why naturally occurring minerals and metals from deep underground can make water unsafe.
		All energy production methods, including sustainable energy, can affect environmental quality. For example, all energy production methods take up space and can block light from reaching the ground, affecting the organisms that live there. Energy infrastructure can also create noise pollution that may disturb wildlife. As with any environmental shift, changing the population of different species can affect their ability to fulfill their ecological role and impact environmental quality.	Ask students to compare the environmental impacts of small-scale tidal energy infrastructure to a small offshore windfarm. For student reference, tidal energy has a smaller geographical footprint than wind energy for the same power output.
SC.912.L.17.15 Discuss the effects of technology on environmental quality.		Many hospital technologies require a lot of energy. By improving the efficiency of these technologies, hospitals can lower their energy consumption, reduce their environmental impact, and extend the amount of time they can be powered by nonrenewable resources during large-scale power outages.	Ask students to describe how the use of energy-efficient technologies can help hospitals during power outages.
		Geothermal plants produce wastewater in the form of gaseous, mineral, and heavy metal laden water. This wastewater is often either pumped back into the ground or treated and released into local watersheds. Without following proper protocol and monitoring environmental parameters, the wastewater could introduce toxic gases, minerals, and heavy metals into groundwater and watersheds.	Ask students to describe how pumping highly pressurized water through the ground for geothermal energy can result in toxic, contaminated water.

NGSSS Standard	Associated Prompts	Justification	Potential Connectors
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.		Offshore fossil fuel production can result in marine oil spills, which can have large-scale environmental impacts. The most recent major oil spill occurred on the Deepwater Horizon rig in the Gulf of Mexico on April 20, 2010. During this oil spill, the rig exploded, damaging the well and releasing the equivalent of four million barrels of oil over the course of 87 days. Dispersants, booms, and skimmers were used to contain the spill and remove some of the oil, but over 1,000 miles of coastline was still contaminated by the spill. This spill had drastic environmental consequences and had significant impacts on fish, marine mammal, and seabird populations.	Describe the Deepwater Horizon oil spill to students. Ask students to discuss the potential environmental impacts of a spill of this size. After the discussion, show students pictures of the Deepwater Horizon oil spill and its environmental impacts.
		Geothermal wastewater is toxic and has the potential to pollute groundwater. This can occur when geothermal wastewater is pumped back into the ground and the well fails, or the injection deposits water into the wrong area.	Describe the two ways geothermal energy infrastructure can fail as listed in the “Justification” section. Ask students to debate whether these failures would result in large-scale or small-scale environmental impacts.
SC.912.L.17.18 Describe how human population size and resource use relate to environmental quality.		Larger populations require larger hospitals, and large hospitals typically have more complex equipment with higher power draws. This means that larger hospitals need more energy to run and will need more supportive infrastructure in case of long-term power outages. Many hospitals rely on diesel generators during power outages. While diesel is very energy efficient, it produces more pollutants than generators that use gas and therefore have a larger negative impact on air quality.	Ask students to explain the relationship between a hospital’s size, available equipment, and power needs.
		Fossil fuels, like those accessed by offshore oil rigs, take millions of years to form, and we are using fossil fuels far quicker than their rate of formation. This makes fossil fuels a non-renewable resource and unsustainable for long-term use as they are finite in nature and can run out.	Ask students to explain why offshore fossil fuel reserves are not a strong long-term solution for meeting global energy needs.
SC.912.L.17.19 Describe how different natural resources are produced and how their rates of use and renewal limit availability.		Fossil fuels are a non-renewable resource. Fossil fuel products, like diesel, are often used to power backup generators at hospitals in the event of long-term power outages. If fossil fuels run out during a multi-day disaster, a hospital could become inoperable and life-sustaining equipment may stop working, putting the lives of patients at risk.	Ask students to compare and contrast the advantages and disadvantages of a hospital using generators or a renewable energy source during a long-term power outage.
		Earth-based resources are limited in space. Because transporting energy resources, like fossil fuels, from Earth is heavy and expensive, finding ways to capture and use space-based energy sources is essential for future space travel and establishing bases on other celestial bodies.	Ask students to identify why we cannot use Earth-based energy resources to establish and power a base on another celestial body.
		Earth’s core continuously produces heat through radioactive decay, making this heat a renewable resource. Like sunlight and wind, the heat of Earth’s core cannot be used up or run out.	Ask students to explain why geothermal energy is considered a more sustainable energy source than fossil fuels, despite both energy sources requiring similar access methods.

Physical Science			
NGSSS Standard	Associated Prompts	Justification	Potential Connectors
Standard 10: Energy			
SC.912.P.10.1 Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.		In tidal energy production, a turbine is used to turn the kinetic energy of waves into electrical energy.	Ask students to identify what types of energy are present during different offshore energy production methods.
		In offshore wind energy production, a turbine is used to turn the kinetic energy of waves into electrical energy.	
		In offshore energy production, the chemical energy contained in fossil fuels can be transformed into heat energy, which can then be transformed into electrical energy using a turbine.	
		In offshore solar energy production, light energy is captured by photovoltaic cells and transformed into electrical energy.	
		Spacecraft can transform light energy from a star into electrical energy using solar panels.	Ask students to describe how spacecraft can use light energy to generate electricity and to move.
		Spacecraft with solar sails can use the kinetic energy carried by photons in light to generate movement.	
		Geothermal energy production uses a turbine to transform the heat energy produced by Earth's core into electrical energy.	Ask students to identify what types of energy are present during geothermal energy production.
SC.912.P.10.8 Explain entropy's role in determining the efficiency of processes that convert energy to work.		The Second Law of Thermodynamics and entropy dictate that energy transformation is never 100% efficient. Energy is lost to the surrounding environment during every transformation. To reduce the amount of energy used by medical equipment and improve the equipment's efficiency, the amount of energy lost to the environment should be reduced. Improving the efficiency of hospital equipment can reduce the amount of energy needed to keep hospitals running during an emergency.	Ask students to describe how entropy and energy loss impact the efficiency of technology and can impact the energy use of a hospital.
SC.912.P.10.11 Explain and compare nuclear reactions (radioactive decay, fission and fusion), the energy changes associated with them and their associated safety issues.		Nuclear reactions do not require many materials to generate energy. However, they do require a lot of materials to keep reactions contained and safe. The reactions also produce radioactive byproducts, and nuclear technology is not currently stable enough for portable use in spacecraft.	Ask students to describe why nuclear reactions require stability and why nuclear energy cannot currently be used to power spacecraft.
SC.912.P.10.14 Differentiate among conductors, semiconductors, and insulators.		Different materials have different electrical conductivities. By altering the materials and structure of conductors, semiconductors, and insulators, hospital equipment can be made more energy efficient. During power outages, energy efficient equipment can reduce the amount of power drawn by the hospital and make energy stores last longer.	Ask students to explain how semiconductors can be used to make hospital equipment more energy efficient.
Standard 12: Motion			
SC.912.P.12.5 Apply the law of conservation of linear momentum to interactions, such as collisions between objects.		Solar sails use the linear momentum of photons to travel through space. These photons collide with solar sails, transferring their momentum to the solar sail and the attached spacecraft. While photons do not carry much linear momentum as they do not have a mass, they cumulatively can exert enough linear momentum on the solar sail to move the spacecraft through space.	Tell students that solar sails use photons to move and ask students to explain how the law of conservation of linear momentum helps move solar sails through space.

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.		Earth has finite fossil-fuel reserves and has a limited number of available renewable energy sources, including, but not limited to, wind, solar, tidal, and geothermal energy. As space exploration continues and expands, scientists are in search of new energy sources that can be used to either power technology or fuel future space travel. For distant space travel, Earth-based energy sources will also not be available due to distance from Earth.	Ask students to explain why scientists are looking for space-based energy sources.
SC.912.E.5.8 Connect the concepts of radiation and the electromagnetic spectrum to the use of historical and newly-developed observational tools.		Radiation and the electromagnetic spectrum are both forms of energy that can be studied using modern observation tools. These forms of energy are also widely available in space and are often studied using high-powered telescopes located in observatories and satellites. While these energies are studied to help us understand the universe, it may also help us identify different forms of usable energy.	Ask students why studying radiation and the electromagnetic spectrum is important for future space exploration. After students have had a chance to answer, ask students to describe how scientists observe these types of energy in space.
Standard 6: Earth Structures			
SC.912.E.6.1 Describe and differentiate the layers of Earth and the interactions among them.		Geothermal heat originates from the decay of radioactive isotopes located in the Earth's core. This heat then travels up through the mantle and crust. To access this heat energy, drills are used to create deep wells in the crust. It is not currently possible to access the mantle via drilling for geothermal energy.	Ask students to identify what layer of the Earth produces the heat used for geothermal energy and to describe the pathway that heat takes to the surface.
SC.912.E.6.6 Analyze past, present, and potential future consequences to the environment resulting from various energy production technologies.		Fracking for fossil fuels can disrupt benthic environments and carries the risk of oil spills. Oil spills can damage both local and distant marine environments, contaminating the water, clogging the gills of marine organisms, and coating the feathers of seabirds.	Ask students to evaluate the potential environmental impacts of different types of energy infrastructure including offshore fracking, tidal energy, offshore wind farms, and geothermal energy.
		Tidal energy can disrupt benthic environments and the movement of organisms in tidal zones. This includes organisms that may nest on beaches, like sea turtles, and organisms that use shallower waters as hunting grounds.	
		Offshore wind farms can disrupt benthic environments, create noise pollution, and harm seabirds.	
		While geothermal is sustainable, the use of fracking-like techniques in geothermal drilling can potentially contaminate water and cause ground instability.	



STEM Research Elective

Associated Prompts: Marine science, health, geology, astronomy

Associated Prompts are not identified for STEM Research Elective Standards. Instead, each standard is paired with a STEM Challenge activity.

Nature of Science

NGSSS Standard	Associated Activities	Justification
Standard 1: The Practice of Science		
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, health, geology, astronomy			
First Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
The Atmosphere			
Solar Radiation		Solar radiation can be used to generate energy for hospitals, which can be stored in batteries. This energy is generated when the photons carried by solar radiation hit a photovoltaic cell, dislodging electrons and creating an electrical current. Stored solar energy can allow hospitals to continue functioning at a limited capacity during long-term power outages.	Ask students to explain how solar radiation can be used to keep hospitals operating during a power outage. If students do not identify batteries in their responses, encourage students to think about energy storage and use.
Weather			
Air Pressure and Air Masses		Air pressure and global air pressure differences determine wind patterns, making wind energy more accessible in certain regions of the globe. While Florida is not well-suited for largescale wind energy production operations, some places that receive a lot of wind energy have large offshore windfarms. In the United States, Massachusetts, Virginia, and Rhode Island all have either constructed or are in the process of planning large offshore windfarms.	Ask students to explain the relationship between air pressure, wind, and the location and distribution of offshore wind farms.
Second Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Environmental Science and Concerns			
Energy Resources		Tidal energy converts the kinetic energy of ocean tides into electricity. Unlike wind and solar energy, tidal energy is not weather dependent, making it highly predictable and consistent.	Ask students to discuss the reliability of tidal energy compared to other renewable resources.
		Solar energy is increasingly used in marine environments to help power seafaring craft and platforms. Offshore solar energy operations are also being created using floating 'islands' of solar panels. Floating solar panels have been installed in lakes around the world.	Tell students the information contained in the "Justification" section before asking students to discuss the challenges of generating solar energy in marine environments.
		Fossil fuel reserves in the ocean are accessed through offshore fracking operations. These fracking operations drill a well to access oil and then pump large volumes of water into the well to force the oil out.	Ask students to compare the environmental costs of offshore fracking to other marine energy resources.
Human Impact		Geothermal energy uses the energy generated by the Earth's core to produce electricity. Unlike solar or wind energy, it provides a constant and consistent supply of energy.	Ask students to identify why geothermal energy provides a more consistent supply of energy than solar and wind energy sources.
		All offshore energy operations can impact their surrounding environment. Offshore wind farms replace benthic environments, create noise, and can alter current flow. Offshore fracking operations create noise, alter benthic environments, and increase risk of oil spills. Both operations alter the environment and have the potential to negatively impact marine life.	Ask students to weigh the costs and benefits of installing marine energy infrastructure. Student responses should include both anthropogenic and environmental impacts.

Topic	Associated Prompts	Justification	Potential Connectors
Ocean Dynamics			
Ocean Movements		Tidal energy systems rely on the principle of inertia and the moon's gravitational pull. These forces work together to create two large “bulges” of water, one on either side of the planet. Tidal energy systems work by holding back water with a barrage and releasing tidal water through an opening with a turbine. Tidal energy is more efficient in areas with large tidal changes.	Ask students to describe how the moon influences the movement of water in the ocean and how this movement can be used to generate energy.
Ocean Resources		Oil deposits, including those found in the ocean, are usually found along tectonic boundaries or continental shelves. Most offshore oil rigs access oil deposits located anywhere from immediately offshore to over 250 miles offshore.	Tell students to research how the movement of tectonic plates can create concentrated areas of natural resources like fossil fuels.
Layers of the Earth			
Layers of the Earth		Geothermal heat originates from the decay of radioactive isotopes located in the Earth's core. This heat then travels up through the mantle and crust. To access this heat energy, drills are used to create deep wells in the crust. It is not currently possible to access the mantle via drilling for geothermal energy.	Ask students to identify what layer of the Earth produces the heat used for geothermal energy and to describe the pathway that heat takes to the surface.
Third Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Volcanic Relationship to Plate Tectonics		The Earth's crust and upper mantle are separated into several plates that shift and glide over the softer mantle. In the space where plates meet, molten rock can rise to the Earth's surface, causing volcanic activity. Because these regions already have relatively easy access to the heat produced by Earth's core, the heat can also be easily accessed for geothermal energy.	Ask students to explain why geothermal energy is easily accessible at tectonic plate boundaries and hot spots.
Types of Volcanic Activity		Along with volcanoes, volcanic activity can also create other geological features including fumaroles and hot springs. All volcanic geological features indicate easy access points for geothermal energy generation. While volcanic activity and its related geological features are concentrated around plate boundaries, they can also be found at hot spots.	Ask students to research a country that uses a lot of geothermal energy and write a comparison between the benefits of using geothermal energy and the risks of living in an area with volcanic and tectonic activity.
Impact of Volcanic Activity on Society		Volcanic activity is great for easy access to geothermal energy. However, volcanic activity can also pose issues for people living in the region. Volcanic activity also increases the risk of an eruption, sulfuric acid contaminating the water, and sulfur dioxide gases in the air. These can all pose serious risks to human health. Additionally, if volcanic activity is caused by a plate boundary and not a hotspot, these regions may also experience earthquakes.	
Fourth Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Instruments of Astronomy			
Measuring Space		Scientists measure energy in space by detecting light, heat, and radiation. Understanding the strength of each source of energy can help scientists determine if a region of space has the potential to power spacecraft or bases on another celestial body.	Ask students to explain why measuring background energy levels in space is necessary for planning future space missions.
Electromagnetic Spectrum		Radiation in space can be harnessed as a form of energy. This includes radiation spanning the entire electromagnetic spectrum. Solar energy is the most common energy generation method that utilizes the electromagnetic spectrum. Photovoltaic cells use the photons contained in light to generate electricity. The amount of energy carried by each photon is determined by its wavelength on the electromagnetic spectrum, with the shortest wavelengths producing the strongest photons.	Ask students to identify the relationship between wavelength and energy level and to describe why understanding this relationship is important for understanding energy in space.

Topic	Associated Prompts	Justification	Potential Connectors
Telescopes		Telescopes in space require a consistent power supply and often rely on solar energy to function. While they require energy to function, telescopes are also used to help study energy in space.	Ask students to brainstorm a way to improve satellite telescopes in small groups. Students can either brainstorm ways to improve the telescope's energy efficiency, ability to generate energy, or ability to view space-based energy.
Artificial Satellites		Artificial satellites, spacecraft, and probes all require a consistent power supply and often rely on solar energy to function. However, they do require fossil fuels to be launched and to reposition themselves when in space. More sustainable energy sources may be used in the future to help them reposition themselves without the need for fossil fuels.	Ask students to identify all energy sources used by satellites.
Spacecraft and Probes			Ask students to brainstorm why fossil fuels may be used by a spacecraft traveling through space after it has been launched. Clarify for students that objects traveling in the vacuum of space will continue to travel in one direction without needing any additional energy.
The Sun			
Fusion and the Sun's Energy		The Sun produces energy through nuclear fusion reactions occurring in its core. When the nuclei of two atoms fuse, it releases photons. These photons have no mass and only exist while in motion but carry momentum. Solar sails utilize the momentum of these photons to propel spacecraft through space.	Ask students to describe how stars produce solar radiation.
Space Exploration			
The Future of Space Exploration		As fossil fuels are a non-renewable resource that cannot be generated on spacecraft, the future of space exploration will need to be powered by energy sources that can be found in space. Currently, the only space-based energy source used by scientists and engineers is solar energy.	Ask students to describe why learning about space-based energy sources is important for future space exploration.

Environmental Science Honors			
Associated Prompts: Marine science, geology, astronomy			
First Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Population and Community Ecology			
How do Ecosystems Respond to Changing Conditions?	 M	Offshore energy infrastructure, including oil rigs, tidal, and windfarms, can alter ecosystems by replacing habitats, introducing noise pollution, and adding pollutants to the ecosystem. Some ecosystems and organisms are resistant to these types of changes, but if the changes occur too quickly, they could negatively impact species populations. If the population of a keystone species is negatively impacted, this could cause a trophic cascade in the ecosystem.	Ask students to identify how the installation of offshore energy infrastructure can change a benthic environment. For each change student identify, ask students to explain how the change may impact benthic organisms.
Second Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Climate Change			
Slowing Climate Change	 M	The burning of fossil fuels releases carbon dioxide into the atmosphere. This carbon dioxide is one of the main drivers of climate change. Renewable resources, which still can impact climate through their construction and use, have comparatively less carbon dioxide emissions and in some cases produce no carbon dioxide. This makes switching from fossil fuels to renewable resources like geothermal, solar, tidal, and wind energy, a solution to mitigating climate change.	Ask students to research and describe the short-term and long-term carbon emissions created by building, installing, and using different types of energy infrastructure.
	 G		
Water Quality			
Resources	 M	Extracting marine resources like fossil fuels can introduce pollutants into the water. Oil spills can damage both local and distant marine environments, contaminating the water, clogging the gills of marine organisms, and coating the feathers of seabirds. Switching to renewable resources and lessening reliance on fossil fuels would in turn reduce the number of fracking operations and reduce the risk of oil spills.	Ask students to identify the different ways in which fossil fuel pollution can impact marine ecosystems and organisms.
Pollution			
Reducing Water Pollution			
Third Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Evolution			
What Causes Extinction?	 M	Changes to ecosystem conditions can push organisms out of their range of tolerance. While organisms can adapt to these changes over the course of multiple generations, quick changes to ecosystem conditions do not give organisms time to adapt. This can cause the extinction of a species. While some changes to ecosystem conditions are natural, quick changes are often caused by humans. The installation of floating solar panels, offshore wind farms, or oil rigs and wells can all be considered quick ecosystem changes.	Ask students to describe how ecosystem changes, including the installation of energy infrastructure, can change an ecosystem and potentially result in the extinction of organisms.

Topic	Associated Prompts	Justification	Potential Connectors
Biodiversity			
Role of Humans in the Loss of Species		Human-led habitat destruction, including replacing benthic environments with offshore windfarms, can impact many marine species. Specialist species are often at a higher risk of extinction than generalist species when their environment quickly changes.	Ask students to describe how the installation of energy infrastructure can impact specialist and generalist species.
Sustaining Wildlife Species and Services		While offshore wind farms can replace benthic habitats, the base of each wind turbine, called a pylon, can also function as an artificial reef. This can change what kind of ecosystem services are provided by the environment, potentially altering provisioning services by changing fish distribution, regulating services by changing the distribution of organisms that filter the water, cultural services by changing the “aesthetics” of the area and impacting tourism, and supporting services by changing the distribution of organisms that photosynthesize and form soil.	Ask students to brainstorm how installing offshore windfarms can alter ecosystem services.
Resources			
Renewable		Renewable sources replenish over time and effectively cannot run out. This means that geothermal, solar, wind, and tidal energies are effectively limitless. However, all of these renewable energies are not evenly distributed, making some renewable energy sources more viable than others depending on location.	Ask students to explain why some renewable energy sources might be a viable alternative to fossil fuels in one location and not viable in another.
			
			
			
Fourth Quarter			
Topic	Associated Prompts	Justification	Potential Connectors
Resources			
Non-Renewable		Non-renewable resources are finite and can run out. While technically, non-renewable resources can replenish over time through natural processes, the rate at which they replenish is extremely slow. Most of these resources are also only replenished through known processes on Earth. For long-distance space travel, non-renewable sources, such as fossil fuels, are not a viable source of energy.	Ask students to describe why non-renewable resources are not suitable for long-distance space travel.



AP Environmental Science

Associated Prompts: Marine science, health, geology, astronomy

Unit 1: The Living World: Ecosystems

Topic	Associated Prompts	Justification	Potential Connectors
1.3 Aquatic Biomes	 M	Marine biomes, especially coral reefs, are sensitive to change. When offshore energy infrastructure is being planned and implemented, engineers must pay close attention to how the infrastructure may negatively impact these ecosystems.	Ask students to describe how offshore energy infrastructure may impact sensitive ecosystems like coral reefs.
1.4 The Carbon Cycle	 M	Fossil fuels are created when the carbon trapped in the lithosphere is subject to extreme heat and pressure for millions of years. Fracking is used to access these fossil fuels and offshore fracking can negatively impact marine environments by causing oil spills among other issues.	Ask students to create a diagram of the carbon cycle that includes the formation of fossil fuels, offshore fracking operations, and the burning of fossil fuels.

Unit 2: The Living World: Biodiversity

Topic	Associated Prompts	Justification	Potential Connectors
2.7 Ecological Succession	 M	Energy infrastructure that disturbs benthic environments can permanently alter habitats and, depending on the amount of damage caused, can trigger secondary ecological succession. For secondary succession in marine environments, pioneer species may include barnacles, oysters, corals, and other animals that can settle on hard substrates, like the bases of wind turbines, called pylons.	Ask students to identify what species may act as a pioneer species during secondary succession in a shallow, marine environment that was disturbed by the installation of an offshore windfarm.

Unit 4: Earth Systems and Resources

Topic	Associated Prompts	Justification	Potential Connectors
4.1 Plate Tectonics	 G	An understanding of plate tectonics is needed to identify locations that may have high geothermal potential. The areas for high geothermal potential are typically found along plate boundaries but can also be found at hotspots. These hotspots have magma plumes that are hotter than the surrounding magma and may also have thinner crust. This also makes hotspots a suitable location for geothermal energy production as the heat created by the radioactive decay in the Earth's core is more easily accessible in these locations than in the surrounding areas.	Show students a map of geothermal energy production around the world alongside a map showing plate boundaries. Ask students to identify and explain any trends they observe.

Unit 6: Energy Resources and Consumption

Topic	Associated Prompts	Justification	Potential Connectors
6.1 Renewable and Nonrenewable Resources	 M	Sustainability is defined as the ability to meet current and future needs for resources, including energy, without depleting the reserves of those resources. Marine environments can be used to produce both renewable energy, including wind, tidal, and solar energy, and nonrenewable energy in the form of fossil fuels.	Ask students to define "sustainability" and describe how the term relates to their STEM Challenge prompt.
	 A	Sustainability is defined as the ability to meet current and future needs for resources, including energy, without depleting the reserves of those resources. In space, room on spacecraft is limited, and much of this room is used to carry fuel. Fuel is not a sustainable source for long-distance space travel as it is finite and can run out.	Ask students to explain why nonrenewable resources, like fuel, are not suitable for long-distance space travel.
	 G	Sustainability is defined as the ability to meet current and future needs for resources, including energy, without depleting the reserves of those resources. Geothermal energy is sustainable as it is constantly being generated by radioactive decay in the Earth's core.	Ask students to describe how geothermal energy is generated and explain why this makes geothermal energy a sustainable resource.

Topic	Associated Prompts	Justification	Potential Connectors
6.3 Fuel Types and Uses		The ocean contains both natural gas and crude oil reserves which can be accessed through offshore fracking. Offshore fracking can result in environmental degradation and oil spills.	Ask students to debate whether the efficiency of fossil fuels and the convenience of having fossil fuel infrastructure already in place outweighs the environmental risks of their extraction and use.
6.4 Distribution of Natural Energy Resources		The availability of fossil fuels is determined by geologic history. Natural gas and crude oil reserves are often located in oceans because organic matter accumulates on the seafloor over time. This process buried ancient organic matter, where it was subject to heat and pressure and created fossil fuels over millions of years.	Ask students to explain how fossil fuels formed on land and in the ocean.
6.5 Fossil Fuels		Methods like hydraulic fracturing, also known as fracking, can release VOCs and cause oil spills. Many VOCs are water soluble and can impact the water quality of the surrounding area. Oils spills resulting from offshore fracking can coat organisms in oil and poison the food web, harming fish, seabirds, marine mammals, invertebrates, and other organisms.	Ask students to describe how oil spills can impact marine life. As students describe the impacts, encourage students to be specific and to differentiate between different types of organisms.
6.8 Solar Energy		Solar energy in marine environments is widely available as there is no plant life or buildings that could block sunlight from reaching solar infrastructure. However, solar infrastructure in marine environments would block sunlight from marine ecosystems and may impact the growth of algae and aquatic plants, altering the amount of available food and shelter for organisms.	Tell students that scientists and engineers are in the process of developing floating solar infrastructure for marine environments. Ask students to describe the advantages and disadvantages of this type of infrastructure.
		While solar energy can be an effective back-up energy generation system for hospitals, the amount of energy generated is weather-dependent. To be an effective back-up power system, solar panels must be paired with a battery system to store energy in case of power outages.	Ask students to describe the advantages and disadvantages of different backup energy systems for hospitals.
		Photovoltaic cells convert electromagnetic radiation directly into electrical energy. In the vacuum of space, this allows spacecraft to generate power without needing to carry heavy fuels. However, photovoltaic cells can only generate energy using a narrow range of wavelengths. Stars release a wide range of radiation that is not utilized by modern solar systems.	Ask students to explain why solar energy is not evenly distributed throughout the universe and how this may influence what type of energy is used for long-distance space travel.
6.9 Hydroelectric Power		Solar sails do not use solar energy for electricity, but instead use the linear momentum of photons to travel through space. These photons collide with solar sails, transferring their momentum to the solar sail and the attached spacecraft.	Tell students that solar sails use the photons in light to move and ask students to explain how the law of conservation of linear momentum helps move solar sails through space.
		Tidal energy is a form of hydroelectric power generation that utilizes the rising and falling of tides to generate electricity. Tidal energy systems work by holding back water with a barrage and releasing tidal water through an opening with a turbine. Tidal energy is more efficient in areas with large tidal changes.	After students learn about hydroelectric power for freshwater environments, ask students to use their knowledge of tides to design hydroelectric infrastructure for marine environments.
6.10 Geothermal Energy		Geothermal energy is most easily accessed in regions near tectonic boundaries and hotspots but can also be accessed in other areas of the world. To access geothermal in these areas, engineers use deep-drilling techniques. These deep-drilling techniques are new and still in development.	Ask students to debate whether the long-term benefits and low-cost of geothermal energy justify the high initial costs and the environmental risks associated with its implementation.

Topic	Associated Prompts	Justification	Potential Connectors
6.12 Wind Energy		Depending on their location, offshore wind turbines produce between 5-15 MW of energy. This is 2-5 times more energy than onshore wind turbines thanks to the increased size and higher capacity of offshore wind turbines and the more consistent windspeeds offshore.	Ask students to predict how onshore and offshore wind farms may differ. After students have made their predictions, share the information in the “Justification” section.
6.13 Energy Conservation		Improving energy efficiency through green building design can reduce the energy demand of hospitals, reducing the amount of energy needed during power outages and extending the amount of time hospitals can be powered.	Ask students to propose three green design features for a hospital that would improve its energy efficiency.
Unit 8: Aquatic and Terrestrial Pollution			
Topic	Associated Prompts	Justification	Potential Connectors
8.1 Sources of Pollution		While major oil spills resulting from fracking operations are rare, fracking frequently results in small spills of oil, hydraulic fluid, and other chemicals. These point source pollutants can bioaccumulate and biomagnify in the food chain, harming wildlife.	Ask students to identify several sources of pollution that may originate from marine energy infrastructure.
8.2 Human Impacts on Ecosystems		Construction of energy infrastructure can destroy benthic habitats and introduce pollutants into ecosystems. These pollutants can come from construction or from the use of energy infrastructure. For example, the construction of tidal and wind farm infrastructure can introduce pollutants into the water, but once constructed, they will not regularly introduce pollutants into the environment. On the other hand, fracking regularly releases pollutants into the environment even after construction.	Ask students to describe how marine energy infrastructure may impact marine environments.
Unit 9: Global Change			
Topic	Associated Prompts	Justification	Potential Connectors
9.10 Human Impacts on Biodiversity		In HIPPCO acronym, the letters H and P represent “habitat destruction” and “pollution” respectively. These factors are the main anthropogenic threats to biodiversity caused by the installation of offshore energy infrastructure.	Ask students to identify which letters in HIPPCO represent the impact offshore energy infrastructure may have on biodiversity. Ask students to provide an example for each letter.

			
AP Biology			
Associated Prompts: Marine science, health			
Unit 6: Gene expression and regulation			
Topic	Associated Prompts	Justification	Potential Connectors
6.8 Biotechnology		Lab-based biotechnology is energy-dependent. This means that in the case of a power-outage, non-essential and life-supporting biotechnologies are not typically used in order to reserve backup power supplies. While not all biotechnology requires constant power, many biotechnology products require refrigeration to prevent spoilage. These refrigeration systems must remain up and running during power outages to avoid wasting resources. Many of these biotechnology products are biopharmaceuticals and include vaccines, cancer treatments, and more.	Tell students that biopharmaceuticals are a form of biotechnology. Ask students why biopharmaceuticals would require a constant power supply even during power outages.
Unit 8: Ecology			
Topic	Associated Prompts	Justification	Potential Connectors
8.7 Disruptions in Ecosystems		Fracking for fossil fuels can disrupt benthic environments and carries the risk of oil spills. Oil spills can disrupt both local and distant marine environments, contaminating the water, clogging the gills of marine organisms, and coating the feathers of seabirds.	Ask students to describe how fracking, tidal energy, and offshore windfarms may disrupt marine environments.
		Tidal energy can disrupt benthic environments and the movement of organisms in tidal zones. This includes organisms that may nest on beaches, like sea turtles, and organisms that use shallower waters as hunting grounds. Offshore wind farms can disrupt benthic environments, create noise pollution, and harm seabirds.	

Pacing Guides

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.

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 April 3, 2027. During the fourth quarter, students will focus on developing their presentation.

1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Focus: Getting Started 4 Blocks	Focus: Solution Development 6 Blocks	Focus: Model and Display Construction 5 Blocks	Focus: Presentation Development 3 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 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 April 3, 2027. 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 Quarter	2nd Quarter	3rd Quarter	4th Quarter
Focus: Getting Started and Solution Development 5 Blocks	Focus: Solution Development 5 Blocks	Focus: Model and Display Construction 3 Blocks	Focus: Presentation Development 3 Blocks
Activity 1 1 Block (Required) 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 April 3, 2027. During the fourth quarter, students will focus on developing their presentation. This pacing guide omits Activity 5: <i>Mix-it-up</i> .					
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter		
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 (<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	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 April 3, 2027. 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: <i>Mix-it-up</i> .					
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter		
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 (<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	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 April 3, 2027. 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 Quarter	3rd or 4th Quarter	
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 April 3, 2027. 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 Quarter	3rd or 4th Quarter	
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, outreach programs, and virtual Meet the Museum Scientist opportunities. Each page directly corresponds to one quarter of the M-DCPS 2026-2027 school year, excluding December 21 – January 1.

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

OCTOBER

NOVEMBER

DECEMBER

JANUARY

MON	TUE	WED	THU	FRI
19	20	21	22	23
26	27	28	29	30
NOV. 2	3 	4	5	6
9	10	11	12	13
16	17	18	19	20
23 	24 	25 	26	27 
30	DEC. 1	2	3	4
7	8	9	10	11
14	15	16	17	18 
JAN. 4, 2027	5	6	7	8
11	12	13	14	15 
 Legal holiday		 M-DCPS Teacher planning day, professional learning day or recess day.		

JANUARY

FEBRUARY

MARCH

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

MARCH

APRIL

MAY

MON	TUE	WED	THU	FRI
29 	30	31	APR. 1	2
5	6	7	8	9
12	13	14	15	16
19	20	21	22	23
26	27	28	29	30
SATURDAY, MAY 1, 2027  EXPO AT FROST SCIENCE				
 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.

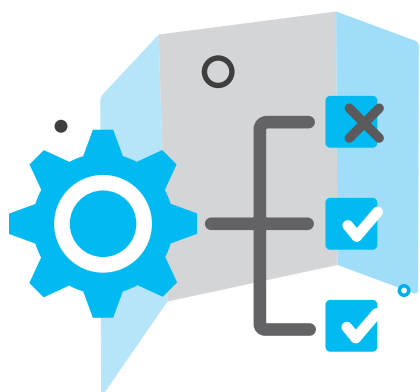
Additional information regarding project submissions will be provided to teachers closer to the STEM Challenge Expo.

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 rushed or thrown together.	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 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



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 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)

Selected Prompt Background Information

Tell us about information related to your prompt and problem/issue.

Page Size: 8.5X11 inches

Additional Information

Page Size: 8.5X8.5 inches

Problem/Issue

Identify your problem/issue. Why did you choose this problem/issue?

Page Size: 8.5X11 inches

Solution

Design

What is your solution? How does it address the problem/issue? What does it look like?

Page Size: 11X5 inches

Innovation

How is your solution new and innovative?

Page Size: 11X5 inches

Impact

Will your solution partially or fully fix the problem/issue? How effective is your solution?

Page Size: 11X6 inches

Design Considerations

Materials

What materials are you using in your solution? How and why are you using these materials?

Page Size: 7x11 inches

Cost

How much does your solution cost to implement and maintain?

Page Size: 7x11 inches

Additional Considerations

What else did you have to consider when designing your solution?

Page Size: 7x11 inches

Solution Implementation

Stakeholders

Who are your stakeholders? How are they invested in helping solve the problem/issue?

Page Size: 8.5X8.5 inches

Implementation Procedure

How can your solution be implemented? What is the implementation timeline?

Page Size: 8.5X11 inches

Sources

List all of your sources in APA format.

Page Size: 8.5X11 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 address energy use or energy infrastructure?

The theme of the 2026-2027 STEM Challenge is “Sustainable Energy Generation and Use.” If your solution does not address energy, 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, geology, 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?

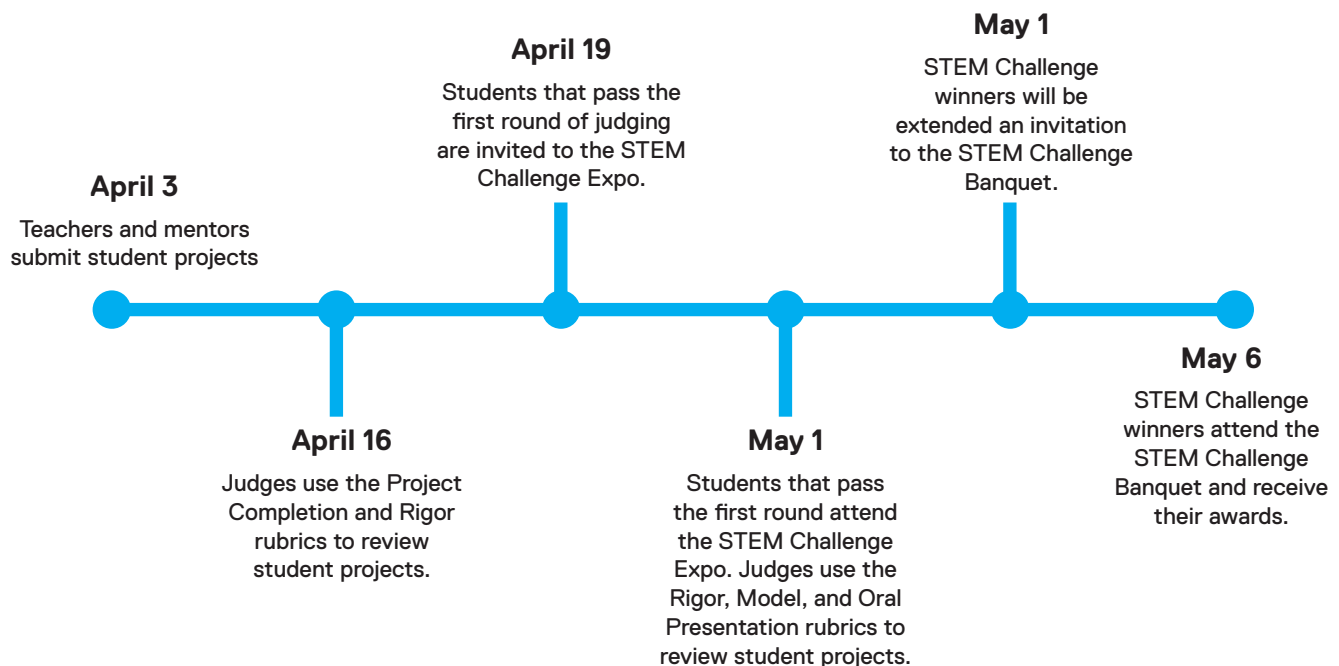
Make sure you address any major real-world constraints. These may include:

- 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.	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 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.	
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:				/50



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:

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Additional Resources

Sustainable Energy Data



Data Bank, Sustainable Energy for All

<https://databank.worldbank.org/source/sustainable-energy-for-all/preview/on>

The Data Bank can be used to see the sustainable energy consumption of different countries around the world. This data can be filtered by year.



Geospatial Energy Mapper

<https://gem.anl.gov/>

The Geospatial Energy Mapper (GEM) website can be used to generate maps of the United States that show sustainable energy potential and current energy infrastructure locations.



International Energy Agency

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

The International Energy Agency (IEA) website contains global data on different energy generation methods. This data is displayed across the site in different reports and graphs.



Our World in Data, Renewable Energy

<https://ourworldindata.org/renewable-energy>

Our World in Data has visualizations for different datasets related to sustainable energy consumption. The visualizations can be viewed as tables, maps, line graphs, bar graphs, and area graphs and the data can be adjusted to view sustainable energy consumption over time.



United States Energy Information Administration, Renewable & Alternative Fuels

<https://www.eia.gov/renewable/>

The United States Energy Information Administration (EIA) website contains data for different energy production methods across the United States. These datasets are often broken down by state. Many data sets are viewable only as tables. The Hourly Electric Grid Monitor shows the energy draw of each power company across the US in real time.

Model Resources

While some modeling software can be expensive or otherwise difficult to access, there are many high-quality free alternatives. As a reminder, creating a digital 3D model is not required for the STEM Challenge as models may include any physical or digital project component that represents the project solution.



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

<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

<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.



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.

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