engineering DREAMS

CREATE YOUR BEST WORLD

DIGITAL LESSON BUNDLE

We Are Problem-Solvers!

OBJECTIVES

Students will:

- **Perform** research to deconstruct and better understand problems and challenges.
- **Design** a creative and empathetic solution to a problem or challenge.
- **Develop** a realistic plan to influence change or inspire action in their community connected to a problem or challenge.

GRADE RANGE

6–8

DURATION

Two class sessions of 45–60 minutes each

OVERVIEW

With this set of resources, students will learn the problem-solving process by exploring three global solutions to problems. After learning the vital connection between problem solving and the engineering design process, students will deconstruct each to determine their viability on larger and smaller scales than currently exist. They will identify and briefly research a local problem or challenge that needs a solution. Then, they will analyze whether an existing solution could solve the local problem and provide suggestions or innovative ideas to design a solution that leads to local change. Students will end by writing a plan for evaluating the success and effectiveness of their designed solution. By using the engineering design process to solve problems and challenges, students are fundamentally engineering!

BACKGROUND

The American Society of Mechanical Engineers (ASME) and Discovery Education are engaging K–12 students in some of the biggest challenges of today and inspiring them to use the principles of engineering and problem-solving to improve their future and humankind. Join us as we challenge students to channel their passion and unique interests into an in-demand career in engineering with standards-aligned resources designed for all learners and communities.

ASME helps the global engineering community develop solutions to real-world challenges. Founded in 1880, it is a non-profit professional organization that enables collaboration, knowledge sharing, and skill development across all engineering disciplines, while promoting the vital role of the engineer in society. ASME codes and standards, publications, conferences, continuing education, and professional development programs provide a foundation for advancing technical knowledge and a safer world.

Throughout the three-part Video Topic Series, *Problem-Solvers for Good*, students explore first-hand the innovation and iteration that comes with the engineering design process. Each episode in the series highlights an innovative and important project that acts as a solution to a global problem. Using the United Nations Sustainability Goals as a foundation, the series is tied together with themes of innovation and improvement, and it leads students through the continuous cycle of problem-solving as they pursue questions such as: What challenge are we trying to solve? How can we design a solution? How do we know this is the right solution for the people being affected?

MATERIALS

ALL SESSIONS

- Computer with projector, one for educator

SESSION 1

- Sticky notes, one per student
- **Big Problem-Solvers Guided Notes** student handout, one per student

SESSION 2

- A device with internet access, one per student or group
- **Be a Problem-Solver!** student handout, one per student

EDUCATOR PREPARATION

- For more information about each of the videos, see the Topic Series Educator Guide and the accompanying activities.
- Determine before the second session whether you want students working in groups or independently. Secure enough devices with internet access.

  Note: *Emphasis should be placed throughout on the value of diverse teams in solving problems; if students must work independently, make sure to discuss this in even greater detail.*
- You may choose to provide students with a curated list of community-based problems or challenges to work with during Session 2.

USING THIS GUIDE

The goal of this guide is to give educators a complete set of resources for facilitating lessons on problem-solving using the engineering design process in the classroom and beyond. It provides slide-by-slide instructions to ensure educators are prepared to explain, discuss, and facilitate the hands-on content in the presentation. The presentation is designed to cover two class sessions, but it can be flexible depending on the students' needs and the time available. However, sessions should be presented in order.

The accompanying presentation was created with PowerPoint so that it can be used in a variety of classrooms. If you are using a laptop with a projector, simply progress through the PowerPoint by clicking to advance. All the interactive aspects of the presentation are set to occur on click. This includes images, text boxes, and links that will appear in your Web browser. If you are using an interactive whiteboard, tap each slide with your finger or stylus to activate the interactive aspects of the presentation. Notes for each slide provide information on how to proceed.

PROCEDURE

SESSION 1 (Slides 1–11)

Overview: Students will learn about the problem-solving process and its similarities to the engineering design process before watching each of the three topic series videos. They will use a guided note sheet to determine elements of each solution that might make them more aligned for larger or smaller scale problem-solving.

Slide 1

- As you distribute a sticky note to each student, direct students' attention to the question at the top of the slide: "What is problem-solving?"
- Click to display the "snowball toss" screen. Tell them that when you say "go," you will start the 30-second timer. They will have 30 seconds to write their answers to the question on their sticky notes, crumple them up, and throw them towards you in the front of the room.
- Click to start the timer.
- When the timer sounds, collect the "snowballs" and tell students that you are going to try to find a response that does not include the words "solve" or "problems." Read any you find.
- Click to reveal the definition of problem-solving and read it aloud.

Slide 2

- Guide students through the steps of the engineering design process and emphasize its usefulness in solving problems and challenges of all kinds. If students have worked through any of the Topic Series activities, this might be a review and you can move quickly through the next four slides. If not, make sure students understand each step before progressing to the next slide.

Slide 3

- The first step of the problem-solving process is to define the problem. Help the students make the connection that this directly relates to the "Ask" and "Research" steps in the engineering design process. Read or ask volunteers to read what is involved in defining a problem.
- Make sure students understand that to define an actual problem, they may need to figure out what the *root* problem is. It may be helpful to use the metaphor of treating symptoms (fever, cough, etc.) rather than figuring out and treating the disease that is causing them.
- Also, part of defining the problem is acknowledging and defining the constraints. Constraints are limitations on the solution or design, such as available materials, funds, or time.
- Emphasize that students should include all stakeholders to make sure that everyone's unique needs are being met.

Slide 4

- The second step of the problem-solving process is to ideate, or *imagine*, solutions. First, define the word "ideate," if students are unfamiliar with the term: *form ideas.*
- Read or ask new volunteers to read what is involved in ideating a solution.
- Make sure students understand that they should reserve judgment or try not to evaluate any of the ideas that come up during brainstorming. All ideas should be listed or considered, as they can form a springboard to the *idea* that solves a problem!
- Emphasize that while strong partnerships and forming good teams is important throughout the engineering design process, having diverse members who think about things in creative ways can be especially beneficial in this step!
- And remind them that they should always consider their constraints throughout every stop of the process!

Slide 5

- The third step of the problem-solving process is to design (and possibly build) a solution to the problem. Emphasize to students how this process mimics the detailed steps of the engineering design process.
- Explain to students that as a team, they must think through their brainstorming list and select the solution most relevant to their problem, most likely to be effective, and most likely to address the needs of all stakeholders. It is also important to consider which they would be most able to implement successfully.
- Read or ask new volunteers to read what is involved in designing a solution. Discuss how different solutions require different steps (i.e., a machine might require a blueprint or model, but a letter-writing campaign might require a detailed set of instructions.)

Slide 6

- The final step in the problem-solving process is to evaluate the solution that was implemented. In the engineering design process, this overlaps with the Test phase and includes the Improve phase.
- Read or ask new volunteers to read the steps in evaluating a design.
- Remind students that failing is part of moving forward, and not every design or solution will always be successful. Define for students the phrase "iterative process." (It is the process of building, refining, and improving on designs.) Emphasize that the engineering design process is often represented as a circle because, during this stage, many engineers start again in order to improve their initial design.

Slide 7

- Explain to students that they will be watching three short videos about real people who solved big problems. Emphasize that each problem was very serious within its community, but could also have had a large impact globally.
- Distribute one **Big Problem-Solvers Guided Notes** handout to each student. Quickly review the handout and instruct students to take notes as they watch each video. If time allows, provide some time after each video for students to add to their notes.

Slide 8

- Explain to students that empathy—the ability to understand and share the feelings of others—is an important aspect to solving problems and challenges. Ask them to imagine for a moment what life would feel like without immediate access to clean water. Would they feel safe? How would their daily life be impacted? Where do they think they would get water from if not from their sinks?
- Explain to students that of the 7.9 billion people on our planet, 2.2 billion people still lack access to safe drinking water.[1] In the first video, students will learn about Caminos de Agua—an organization that aims to improve human health and community well-being through adequate and affordable access to clean water.
- Remind students to take notes as they watch the video.
- Click to begin the video.
- If time allows, provide some time after the video for students to add to their notes.

Slide 9

- Ask students if they have ever taken time to think about what fuels their cooking appliances? Can they imagine how their daily lives would change if they had to go outside and cut wood every day in order to eat? What about the impact their cooking has on the environment?
- Explain to students that in places around the world like the Indian Himalayas, the devastating effects of things like deforestation and climate change affect even simple aspects of human life,

1 ps://sdgs.un.org/goals/goal6

like cooking and staying warm. Products like the Himalayan Rocket Stove offer a way to cook food and produce heat that requires 50% less wood as fuel, and reduces the amount of work while also creating a significant reduction in air pollution.

- Remind students to take notes as they watch the video.
- Click to begin the video.
- If time allows, give students a few minutes to add to their notes.

Slide 10

- Explain to students that in many countries around the world, farming is the largest source of pollution, because it often produces excess food waste, and toxins used in traditional agriculture can harm water, air, soil, and ecosystems. Solutions like close-looped and soilless (hydroponic) farming aim to solve the problem.
- New forms of farming like hydroponics can also have dramatic effects on the health and well-being of those living in cities with little access to fresh produce and nutritious food choices, known as "food deserts."
- Remind students to take notes as they watch the video.
- Click to begin the video.
- If time allows, provide some time after the video for students to add to their notes.

Slide 11

- As time allows, let students share some of their key takeaways from the videos and their notes.
- Tell students that in the next session, they will take on the role of problem-solvers!

SESSION 2 (Slides 12–17)

Overview: Students will research and investigate potential solutions that already exist for solving a community-based problem or challenge. They will analyze the chosen solutions and select one that could have an impact on their local community. Students will use the problem-solving process and engineering design process they learned about in the first session.

Slide 12

- Begin the session by reinforcing what students learned about the problem-solving process in the previous session. Make sure to emphasize how the connection to the engineering design process can help solve most problems and challenges.
- Briefly summarize each problem and its corresponding solution from the three videos.

- Explain to students that in today's session, they will be the problem-solvers as they work through the process to find a solution for a problem facing their local community.
- Distribute one **Be a Problem-Solver!** handout to each student and enough devices with internet access for each student or group, depending on your preference.

Slide 13

- Guide students' attention to the DEFINE section of their handouts. The first step in the problem-solving process is for them to define a problem or challenge that they see in their local community. It can be big or small, affecting families or businesses, be at school or home, etc.
- Using the engineering design process, they should identify the stakeholders and their needs, identify any constraints, and research the problem and suggested solutions thoroughly.
- When it is time for students to research, you may choose to give them acceptable search engines or search engine terms or allow them to research on their own. Their goal is to find information about the problem and any solutions that might have been suggested or attempted.
- Provide students with approximately 10 minutes to conduct brief research on their topic.

Slide 14

- After students research their community-based problem, they need to ideate potential solutions. Encourage them to use previously attempted solutions as springboards for their brainstorming, if relevant.
- Remind students of the importance of building diverse problem-solving teams with creative and unique ways of thinking. All team members and ideas should be valued and recorded.
- Tell them you are going to give them three minutes to list as many ideas as they can that might solve the problem. Remind them to record *all* ideas on their handouts without any evaluation or judgment.
- Click to start the three-minute timer.

Slide 15

- Tell students that you are now going to give them three minutes to go through the ideas in their brainstorming bubble and quickly judge and evaluate each one until they decide on a solution with which to move forward. Remind them to consider what has been successful or not in the past, and what is most likely to be achievable and successful in the future. They should also consider what will address the concerns of all the stakeholders while remaining within the parameters of any constraints.
- Click to start the three-minute timer.
- When the timer sounds, remind students that each solution requires a different design process or prototype. Will theirs require a blueprint, a model, detailed instructions, etc.?

- Direct students' attention to the DESIGN section of their handouts. They should record their chosen solution and details of their design process, including any drawings or notes needed, as well as how they plan to implement or test this solution once it is fully designed (and built, if necessary).

Slide 16

- Remind students that once they implement their designed solution, they will have to test and evaluate its effectiveness. Therefore, it is wise for them to think ahead and create a plan.
- Direct students' attention to the EVALUATE page of their handouts. Give them time to think through the questions on the slide and create a plan to test and evaluate their design.
- Remind students of the importance of the iterative process and finding ways to make their designs even better. Are they willing to improve and redesign their designs in order to solve the problem?

Slide 17

- Congratulate students on working through the problem-solving process and the engineering design process to design a solution to a problem or challenge in their local community!
- Remind them that they have learned the tools to apply to any new problems they may encounter in the future, just like engineers!

EXTENSIONS FOR EDUCATORS

- Facilitate the Topic Series Activities that dive deeper into each of the solutions covered in the three Topic Series Videos.
- Students can fully plan, create, and test their community solutions based on their designs and prototypes. Alternatively, the class can choose one solution from the group to work together on completing as a group service-learning project.

CONTENT AREA STANDARDS

STEM

Next Generation Science Standards (NGSS)—Science and Engineering Practices (SEPs)

- Asking questions and defining problems
- Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions

ELA

Common Core State Standards (CCSS)

- RI.6.7. Draw on information from multiple print or digital sources.
- RI.6.7. Integrate information presented in different media or formats as well as in words to develop a coherent understanding of a topic.
- W.6-8.4. Produce clear and coherent writing, organization, and style appropriate to a task.
- W.6-8.7. Conduct short research projects.
- SL.6-8.1. Engage effectively in a range of collaborative discussions.
- SL.6-8.2. Summarize information presented in diverse media.

BIG PROBLEM-SOLVERS GUIDED NOTES

Directions: As you watch each video, use the charts below to help you take notes on the problems and solutions presented.

Caminos de Agua

Define the problem:
Describe the solution:
Do you think the solution is effective? Explain:
Was the solution designed to be community-based or global? Could it be both? Explain any changes that would need to be made or constraints you see:
Are there any other solutions to this problem that might be effective? List any other ideas you have or solutions you know of:

Himalayan Rock Stove

Define the problem:
Describe the solution:
Do you think the solution is effective? Explain:
Was the solution designed to be community-based or global? Could it be both? Explain any changes that would need to be made or constraints you see:
Are there any other solutions to this problem that might be effective? List any other ideas you have or solutions you know of:

Hydroponic Farming

Define the problem:
Describe the solution:
Do you think the solution is effective? Explain:
Was the solution designed to be community-based or global? Could it be both? Explain any changes that would need to be made or constraints you see:
Are there any other solutions to this problem that might be effective? List any other ideas you have or solutions you know of:

Directions: Work through the problem-solving process and use the engineering design process to find a solution to a problem or challenge in your community!

DEFINE

What is a problem or challenge you see in your community?

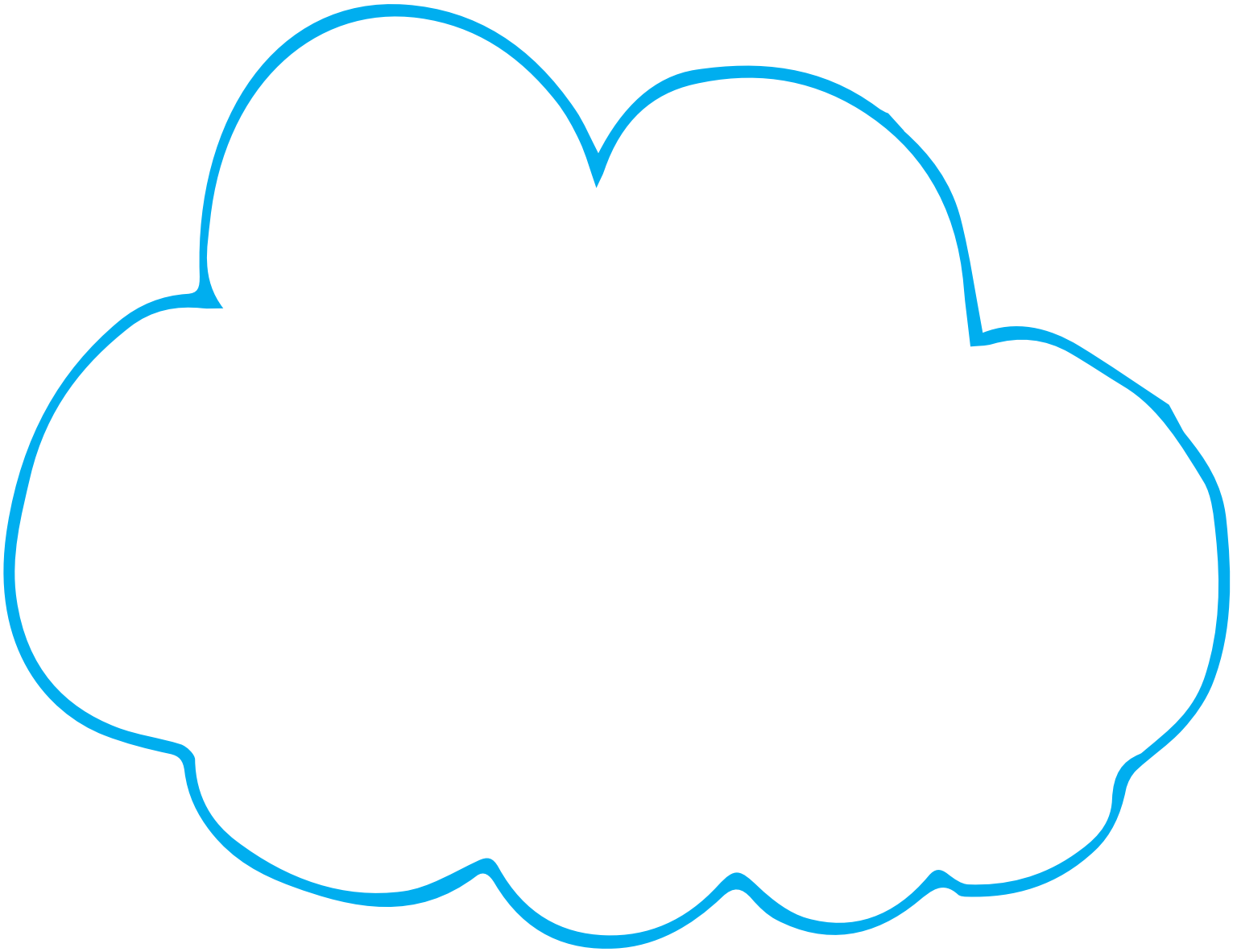
Are there any constraints you must adhere to?

Research this problem. Try to find facts and data about it and take notes here:

Have any solutions been suggested or attempted in the past? How successful were they? Can they act as a springboard for your potential solution?

IDEATE

Brainstorm potential solutions to your problem below. Remember to include all ideas without judgment or evaluation!



DEFINE

What is your chosen solution?

Record your design or prototype process below:

How do you plan to implement or test your solution in your community once it is fully designed/built?

EVALUATE

It is important to have a plan for evaluating your design once it is implemented. How will you test and evaluate if your design is effective?

How will you know if you have successfully solved the problem?

How will you seek out constructive feedback?

What will you do with the feedback that you receive?