

Challenge: Robots!

Engineer Guide



Using Game-Play to Explore Robotics During Your Classroom Visit

Before your visit, read through the *Challenge: Robots!* Educator Guide found at NatGeoEd.org/robots-challenge-educator-guide/. It contains detailed information about the game and game play as well activities that the classroom teacher can use before, during, and after your visit. Be sure to share this guide with the classroom teacher well before your visit.

Learning Objectives

The purpose of the Engineers in the Classroom (EITC) game *Challenge: Robots!* is to provide students with a firsthand look into the engineering process, a series of steps engineers follow to solve a problem. Using robots—programmable machines designed to sense, analyze data, and respond as programmed—students will gain a unique perspective into ways that engineering solutions change to fit the requirements of different problems.

Background Information

The Engineers in the Classroom (EITC) Program

As a classroom visitor, you have the opportunity to inspire the next generation of engineers! Your goal is to encourage young people to consider careers in science, mathematics, engineering, and technology—STEM careers. *Challenge: Robots!* is a unique tool you can use to meet that goal, providing you with a self-directed game to share with students that serves as the focal point for much of the information that you will want to cover. Pairing the game with stories about your own experiences as an engineer, this activity will be both exciting and informative for you and the students you meet.



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The Field of Robotics

Robotics is unique and arguably the most interdisciplinary of engineering endeavors. The design and building of robotic devices combines the talents of a wide array of engineering specialties—including mechanical, electrical, kinematic, and software engineering. Depending on the particular problem being addressed, experts in agricultural, military, medical, and manufacturing industries take part in the design and deployment of the robotics. Using robots as the topic for this game allows you to discuss all of these STEM careers and more.

Game Overview

The *Challenge: Robots!* game invites students to take on the role of an engineer at RoboWorks, a robotics factory. Students undergo orientation and training exercises in the form of fun, self-directed challenges that introduce important concepts about the engineering process as well as the main parts of a robot, how those parts change with the problem the robot is intended to solve, and basic robotics programming. After the two-part orientation, three challenges are available, and players in the role of new RoboWorks engineers can explore them in any order. Each challenge focuses on designing a robot to solve a real-world problem—on land, sea, or in the air. These challenges are all based on real robots in use today:

- **Micro-robots** are miniaturized versions with tiny, sophisticated parts. In the Robotic Bees challenge, students make decisions to create a fleet of identical units controlled by a single controller. Students learn how these bees could be used to pollinate a field of crops.
- **Underwater robots** can perform tasks and record data that would be difficult for humans to perform or gather. In the Ocean Cleanup challenge, students build robots that clean up the Great Pacific Garbage Patch, a massive collection of marine debris in the North Pacific Ocean.

- **Land-based robots** can explore spaces and perform tasks that could be dangerous for humans. In the Tunnel Explorer challenge, students need to locate and safely remove treasures buried in an Egyptian pyramid, where tunnels are either collapsed or filled with obstacles.

Technology Requirements and Set Up

Challenge: Robots! is a browser-based game that works on both Macs and PCs and also on tablets. The following technology is recommended:

- ▶ On a PC: Windows 7 or 8 operating system; Chrome 39.0+, Firefox 34+, or Internet Explorer 9+ browser
- ▶ On a Mac: OSX v. 10.6+ operating system; Chrome 39.0+, Firefox 34+, or Safari 7+ browser
- ▶ On Tablets: iOS version 8 and one generation back or Android 4.1+ operating system
- ▶ Multiple computers or tablets with Internet access (one per student preferred); Internet browsers open to the *Challenge: Robots!* game (www.NatGeoEd.org/robots-challenge/)
- ▶ A single computer or tablet with Internet access, attached to a projector, Internet browser open to NatGeoEd.org/robots-challenge/

Ideally, you will be able to have one student per computer, but check with the teacher before you arrive to determine whether the school's Internet bandwidth can handle multiple students playing the game on the Internet at the same time. If the technology doesn't allow this, ask the teacher to suggest the best alternative for involving all students most effectively.

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Your Classroom Visit

Before the Visit

Play the game through at least once before visiting the classroom. Make notes about topics you may want to use to introduce or support the different components of the game. For example, you may want to discuss:

Orientation

- what it's like to be an engineer; details about your own job
- any experience you have had with robots
- why the engineering process is always described as a cycle
- the importance of iteration, and why engineers don't see mistakes as failure

Build a Robot

- robot parts that might be new for students (e.g., sensors, end effectors, processors)

Challenges

- how changing one or two components changes how the entire robot accomplishes its goal
- the importance of trade-offs (e.g., balancing the need for speed with weight or size)



Review the Engineer Guide at ClassroomEngineers.org for more ideas on how to start the session. You may also want to watch the “Strategies for a Successful Classroom Visit” video, which features two seasoned Engineers in the Classroom volunteers talking about what it takes to have a successful classroom visit experience.

Consider bringing in a familiar robot to use as a concrete example. You may have access to a robotic toy or a Roomba vacuum cleaner, or perhaps even a robot from your own work. You can use this robot during your wrap-up discussion.

Communicate with the teacher at least one week before your scheduled classroom visit to discuss the activity. Explain which portions of the *Challenge: Robots!* Educator Guide you will be responsible for during your visit. Suggest having the teacher create Engineering Journals (Educator Guide, page 11) before your arrival. Recommend that the teacher review the After Game Play classroom activities and gather or prepare materials for the ones he or she will use after your visit has ended.

⚙️ During the Visit

Introduction by the Classroom Teacher

Set the Stage

Get students excited about engineering by sharing who you are, what you do, and why what you do makes a difference for yourself and the world. Tell them a story about how you got interested in engineering, your career, or something that happened in your work that was really exciting. Show the intro video “Build the Future,” found at ClassroomEngineers.org, to the class before the game play.

- If you have any career experience in robotics, be sure to tell students what you’ve done and what you know about the field of robotics. Whenever possible, make connections between your experiences and ones they are able to easily relate to.
- To help students understand the variety of items designed by engineers, share the EITC PowerPoint presentation, found at: <http://www.classroomengineers.org/education/media/powerpoint-presentation/>.
- Talk about the importance of using a journal or notebook in science. If the teacher had students create Engineer Journals before your visit, ask to see them. Remind students to keep their journals handy while they play so that they can take notes of things they want to remember or ask about later.

Introduce the Game

Explain that students will play a new game called *Challenge: Robots!*, which is designed to give them a taste of the field of mechanical engineering.

- Use the Game Overview on page 1 of this guide discuss how the game is organized.
- Talk about the in-game rewards, including the Employee ID that students can print and glue into their Engineer Journals and the in-game badges that will show up on the main screen.



⚙️ Activate Prior Knowledge

Conduct a brief “vote” in the class to see what students already know about engineering and robotics. Read each of the following statements and have students line up on opposite sides of the room according to whether they vote true or false. Briefly discuss (or have older students informally debate) each item.

- ▶ The Ferris Wheel is named after the American engineer who created it. (true)
- ▶ Engineers don’t use math. (false)
- ▶ Robots can play complex games, such as chess, better than human beings. (true)
- ▶ Girls don’t go into engineering. (false)
- ▶ The word “robot” comes from the Slavic word robota, meaning “slavery.” (true)
- ▶ Robots will destroy human jobs and cause unemployment. (false)
- ▶ Emily Roebling, who supervised construction of the Brooklyn Bridge, is known as the “first woman field engineer.” (true)
- ▶ Robots are only good for jobs in mass production, like automobile construction. (false)

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Support the Game

Have students begin with the Orientation and continue through Build a Robot while you are in the classroom. Ask them to stop playing once those parts are completed. (They will play the remainder of the game after you leave.)

While they play, move around the room monitoring game play, and stop occasionally to chat with students about what is happening in the game. Use the following prompts to keep the attention on learning:

- What are you doing right now?
- What step of the engineering process are you working on?
- Tell me about the robot that you are exploring. How is it different from other robots? Why does it need to be different?
- If you were the engineer designing a solution for this problem, would you have tried something different? Explain.

Be prepared to answer questions and to help students with unfamiliar terminology.

End the Game Session

- Have students stop playing after they complete the Build a Robot challenge.
- Be sure to explain how to save their progress with a passcode. Have them write the code down in their Engineer Journals.
- The next time they play, students will input this passcode to return to their stopping point.

Wrap Up

Gather students together away from the computer and briefly discuss the game. Use the following discussion prompts or create your own questions to support what happened during your visit:

- *What are the steps of the engineering process?*
- *Why are those steps in that order so important to good design?*
- *What is iteration? What is its value?*

- *Why is it not only okay but a necessary part of the engineering process to fail, make mistakes, and try again?*

If you brought along a robotic toy or object, bring it out and allow students to check it out. First, work together to identify the parts and discuss how they compare to the MessageBot in the game. Then ask:

- *What problem or task was this robot designed for?*
- *What type of sensor does this robot need?*
- *How does this robot move? What does it use for this movement?*
- *If you were to program this robot, what steps would you identify for it to follow?*
- *What type of end effector(s) does this robot use to perform its task?*
- *How would this robot perform differently if any of those parts were changed to a different one?*

This concludes your classroom visit. The next step for students is to learn some background information about the three challenge activities in the game, which can be introduced by you or by the teacher, depending on the time remaining in your visit. This introductory information can be found on pages 14-15 of the *Challenge: Robots! Educator Guide*.

Follow-Up Ideas (optional)

After you leave, the teacher may conduct classroom support activities like those suggested in the Educator Guide. Consider arranging with the teacher to revisit the classroom at a later date—if you are able and the teacher is agreeable—to see the types of robotics the students have created. Alternatively, you might leave your contact information so the teacher can collect student letters, photos, and videos of their projects and share them with you.

Do not exchange contact information directly with students; always go through the teacher.

Challenge: Robots! Connections to National Standards

National Science Education Standards (NSES):

http://www.nap.edu/openbook.php?record_id=4962

Grades 5–8

- | | |
|---|---|
| 8.E-2a. Identify appropriate problems for technological design. | 8.E-2d. Evaluate completed technological designs or products. |
| 8.E-2b. Design a solution or product. | 8.E-2e. Communicate the process of technological design. |
| 8.E-2c. Implement proposed solutions. | |

Next Generation Science Standards (NGSS):

<http://www.nextgenscience.org/next-generation-science-standards>

- | | |
|---|--|
| MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. | MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. |
| MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. | MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. |



During the Visit

1

Set the Stage

- Talk about who you are, what you do, and why what you do makes a difference for yourself and the world.
- Tell a story: how you got interested in engineering, your career or something that happened in your work that was really exciting.
- Share the EITC PowerPoint presentation.
- Talk about the importance of using a journal or notebook in science. Ask to see their Engineering Journals, if they have them.

2

Prior Knowledge

- Use the activity in the sidebar on page 2 to find out what students already know about engineering and robotics.
- Discuss each statement after the vote.
- Share any other misconceptions you've run into during your career.

3

Introduce the Game

- Introduce *Challenge: Robots!* and the parts of game (see page 1): Orientation, Build a Robot, 3 challenges.
- Talk about mechanical engineering as a field.
- Talk about the in-game rewards: Employee ID to print, badges to earn on the main screen.

4

Support Game Play

- Start game, walk around and ask students what they're doing and answer questions.
- Have them stop after the Build a Robot activity. Allow at least 15 minutes for discussion before you must leave.
- Explain how to save progress, write down the passcode in their journals, and input it when they return.