Picture-Perfect

Lessons, K–2

Using Children's Books to Inspire STEM Learning

by Emily Morgan and Karen Ansberry

NSTA press
National Science Teachers Association

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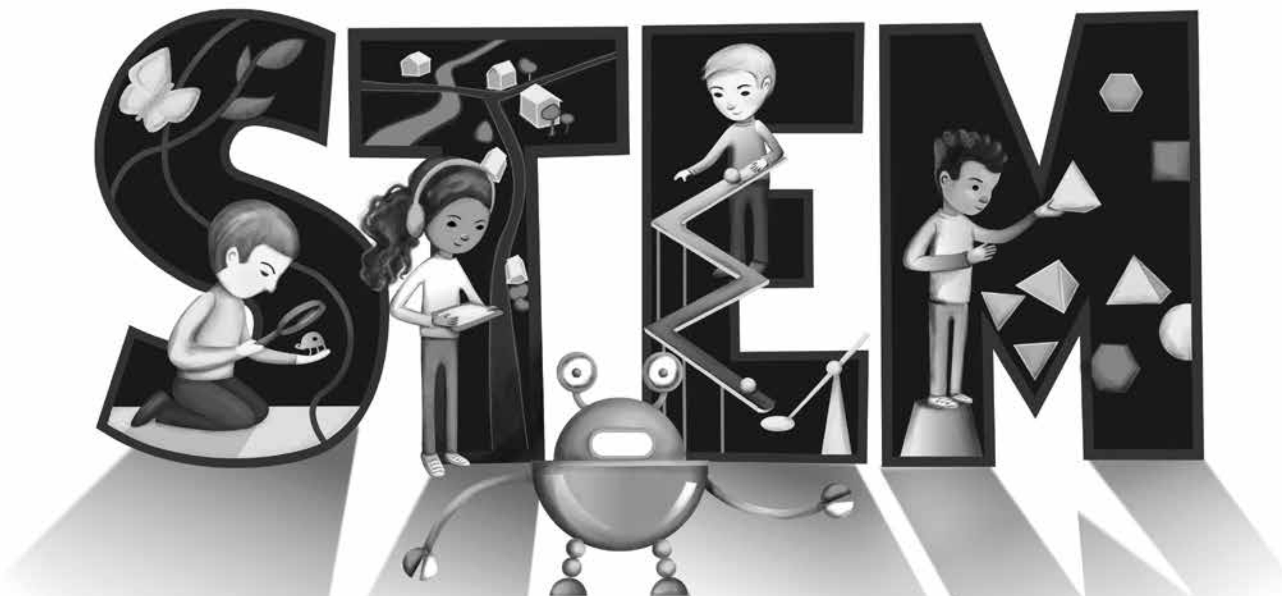

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Arlington, Virginia

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Contents

Preface

First-grade students listen as their teacher reads *The Day the Crayons Came Home,* the clever story of a group of wayward crayons left in various places by a boy named Duncan. The crayons are sending postcards to Duncan, each with a woeful tale and a plea to return to the crayon box. One postcard (p. 10) reads as follows:

Duncan!

It's us … Yellow and Orange. We know we used to argue over which of us was the color of the Sun … but guess what? NEITHER of us wants to be the color of the Sun anymore. Not since we were left outside and the Sun melted us … TOGETHER! You know the real color of the Sun?? HOT. That's what. We're sorry for arguing. You can make GREEN the Sun for all we care, just BRING US HOME!

Your not-so-sunny friends,

Yellow & Orange

The first-grade students giggle at the silly postcards sent by the desperate crayons. After the read-aloud, they recount some of the ways the crayons were changed in the book—broken, melted by the Sun, chewed by a dog, sharpened, melted in the dryer, and so on. This discussion leads them to an exploration of crayon properties (including measurements), an investigation of ways crayons' physical properties can be changed, and a read-aloud and video about how crayons are manufactured. Students discover that there is a surprising amount of engineering and technology behind the design and production of this classroom staple, and they apply the steps of the engineering design process to come up with a way to recycle crayons into new and interesting shapes and colors. This activity addresses the engineering core idea that a situation people want to change or create can be solved through engineering. Finally, students incorporate English Language Arts standards by writing their own postcard from an adventurous crayon who has been through a number of changes. Thus, students demonstrate their understanding of the physical science core idea that heating or cooling a substance may cause changes that can be observed, and sometimes these changes are reversible. Through this engaging lesson found in Chapter 14, students learn about the interdependence of science, technology, engineering, and mathematics in the crayon-manufacturing industry—all within the context of an amusing fictional story.

What Is Picture-Perfect STEM?

The Picture-Perfect Science program was developed to help elementary teachers integrate science and reading in an engaging, kid-friendly way. Since the debut of the first book in the *Picture-Perfect Science Lesson* series in 2005, teachers across the country have been using the lessons to integrate science and literacy. This new series of Picture-Perfect books, *Picture-Perfect STEM Lessons: Using Children's Books to Inspire STEM Learning*, follows the same philosophy and lesson format as the original books but adds an emphasis on the intersection of science, technology, engineering, and mathematics in the real world. *Picture-Perfect STEM Lessons, K–2* contains 15 lessons for students in kindergarten through grade 2, with embedded reading-comprehension strategies to help them learn to read and read to learn while engaged in STEM activities. To help you set up a learning environment consistent with the principles of *A Framework for K–12 Science Education* (*Framework;* NRC 2012), the lessons are written in an easy-to-follow format of constructivist learning—the Biological Sciences Curriculum Study (BSCS) 5E Instructional Model (Bybee 1997, used with permission from BSCS; see Chapter 3 for more information). This learning cycle model allows students to construct their own understanding of scientific concepts as they cycle through the following phases: engage, explore, explain, elaborate, and evaluate. Although *Picture-Perfect STEM Lessons* is primarily a book for teaching STEM concepts, reading-comprehension strategies and the *Common Core State Standards for English Language Arts* (NGAC and CCSSO 2010) are embedded in each lesson. These essential strategies can be modeled while keeping the focus of the lessons on STEM.

Use This Book Within Your Curriculum

We wrote *Picture-Perfect STEM Lessons* to supplement, not replace, your school's existing science or STEM program. Although each lesson stands alone as a carefully planned learning cycle based on clearly defined objectives, the lessons are intended to be integrated into a complete curriculum in which concepts can be more fully developed. The lessons are not designed to be taught sequentially. We want you to use *Picture-Perfect STEM Lessons* where appropriate within your school's current STEM program to support, enrich, and extend it. We also want you to adapt the lessons to fit your school's curriculum, your students' needs, and your own teaching style.

Special Features of This Book

Ready-to-Use Lessons With Assessments

Each lesson contains engagement activities, hands-on explorations, student pages, suggestions for student and teacher explanations, elaboration activities, assessment suggestions, opportunities for STEM education at home, and annotated bibliographies of more books to read on the topic. Assessments include poster sessions, writing assignments, design challenges, demonstrations, presentations, and multiple-choice and extended-response questions.

Background for Teachers

This section provides easy-to-understand background information for teachers to review before facilitating the lesson. Some information in the background section goes beyond the assessment boundary for students, but it is provided to give teachers a deeper understanding of the content presented in the lesson.

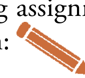
Time Needed

The information in this section helps you pace each lesson. We estimate a primary class period to be about 30–45 min.

Reading-Comprehension Strategies

Reading-comprehension strategies based on the book *Strategies That Work* (Harvey and Goudvis 2007) and specific activities to enhance comprehension are embedded throughout the lessons and clearly marked with an icon. Chapter 2 describes how to model these strategies while reading aloud to students.

Standards-Based Objectives

All lesson objectives are aligned to the *Framework* (NRC 2012) and are clearly identified at the beginning of each lesson. An alignment with the *Next Generation Science Standards* (NGSS Lead States 2013) is included in the appendix (p. 309). The lessons also incorporate the *Common Core State Standards for English Language Arts and Mathematics* (NGAC and CCSSO 2010). In a box titled "Connecting to the Common Core," you will find the Common Core subject the activity addresses as well as the grade level and standard number. You will see that writing assignments are specifically labeled with an icon:  .

STEM at Home

Each lesson also provides an extension activity that is intended to be done with a parent or other adult helper at home. Students write about what they learned about each topic and share their favorite part of the lesson. Then, together with their adult helper, they complete an activity to apply and extend the learning. If students are unable to complete the extension at home, the activities in this section also work well as in-class extensions.

Ideas for Further Exploration

A "For Further Exploration" box is provided at the end of each lesson to help you encourage your students to use the science and engineering practices in a more student-directed format. This box lists questions and challenges related to the lesson that students may select to research, investigate, or innovate. Students may also use the questions as examples to help them generate their own questions. After selecting one of the questions in the box or formulating their own questions, students can make predictions, design investigations to test their predictions, collect evidence, devise explanations, design solutions, examine related resources, and communicate their findings.

References

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National Governors Association Center for Best Practices and Council of Chief State School Officers (NGAC and CCSSO). 2010. *Common core state standards.* Washington, DC: NGAC and CCSSO.

National Research Council (NRC). 2012. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

NGSS Lead States. 2013. *Next Generation Science Standards: For states, by states.* Washington, DC: National Academies Press. *www.nextgenscience.org/next-generation-science-standards.*

Children's Book Cited

Daywalt, D. 2015. *The day the crayons came home.* New York: Philomel Books.

Editor's Note

Picture-Perfect STEM Lessons, K–2 builds on the texts of 29 children's picture books to teach STEM. Some of these books feature objects that have been anthropomorphized, such as crayons that pack their bags and travel the world. Although we recognize that many scientists and educators believe that personification, teleology, animism, and anthropomorphism promote misconceptions among young children, others believe that removing these elements would leave children's literature severely underpopulated. Furthermore, backers of these techniques not only see little harm in their use but also argue that they facilitate learning. Because *Picture-Perfect STEM Lessons, K–2* specifically and carefully supports science and engineering practices, we, as do our authors, feel the question remains open.

Acknowledgments

We would like to dedicate this book to the memory of Dr. Robert Yearout, who gave us the opportunity to present our first teacher workshop at the "Sharing What Works" Conference in Columbus, Ohio, in 2000. Dr. Yearout's leadership of the High Achievement in Math and Science Consortium, which we were both fortunate to be a part of for many years, provided us with opportunities and encouragement to grow as educators and advocates of science and math education. Dr. Yearout's selfless leadership style and utmost respect for the teaching profession continue to inspire us today.

We appreciate the care and attention to detail given to this project by Rachel Ledbetter, Wendy Rubin, and Claire Reinburg at NSTA Press.

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- To Andrea Beaty for giving us a sneak peek of *Ada Twist, Scientist;* promoting STEM education; and encouraging innovation, curiosity, and creativity in kids everywhere

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- Kevin Anderson
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- Ruth McDonald
- Bill Robertson
- Kristina Tank

About the Authors

Emily Morgan is a former elementary science lab teacher for Mason City Schools in Mason, Ohio, and seventh-grade science teacher at Northridge Local Schools in Dayton, Ohio. She served as a science consultant for the Hamilton County Educational Service Center and science leader for the High AIMS Consortium. She has a bachelor of science in elementary education from Wright State University and a master of science in education from the University of Dayton. She is also the author of the *Next Time You See* picture book series from NSTA Press. Emily lives in West Chester, Ohio, with her husband, son, and an assortment of animals.

Karen Ansberry is a former elementary science curriculum leader and fifth- and sixth-grade teacher at Mason City Schools in Mason, Ohio. She has a bachelor of science in biology from Xavier University and a master of arts in teaching from Miami University. Karen lives in historic Lebanon, Ohio, with her husband, two sons, two daughters, and two dogs.

Emily and Karen enjoy facilitating teacher workshops at elementary schools, universities, and professional conferences across the country. This is Emily and Karen's fourth book in the *Picture-Perfect Science Lessons* series. For more information on this series and teacher workshops, visit *www.pictureperfectscience.com.*

Safety Practices for Science Activities

With hands-on, process- and inquiry-based science activities, the teaching and learning of science today can be both effective and exciting. The challenge to securing this success needs to be met by addressing potential safety issues relative to engineering controls (ventilation, eye wash station, etc.), administrative procedures and safety operating procedures, and use of appropriate personal protective equipment (indirectly vented chemicals splash goggles meeting ANSI Z87.1 standard, chemical resistant aprons and gloves, etc.). Teachers can make it safer for students and themselves by adopting, implementing, and enforcing legal safety standards and better professional safety practices in the science classroom and laboratory. Throughout this book, safety notes are provided for science activities and need to be adopted and enforced in efforts to provide for a safer learning and teaching experience. Teachers should also review and follow local policies and protocols used in their school district and/or school (e.g., employer OSHA Hazard Communication Safety Plan and Board of Education safety policies).

Additional applicable standard operating procedures can be found in the National Science Teacher Association's "Safety in the Science Classroom, Laboratory, or Field Sites" (*www.nsta.org/docs/SafetyInTheScienceClassroomLabAndField.pdf*). Students should be required to review the document or one similar to it for elementary-level students under the direction of the teacher. It is important to also include safety information about working at home for the "STEM at Home" activities. Both the student and the parent or guardian should then sign the document acknowledging procedures that must be followed for a safer working and learning experience in the classroom, laboratory, or field. The Council of State Science Supervisors also has a safety resource for elementary science activities titled "Science and Safety: It's Elementary!" Teachers can consult this document at *www.csss-science.org/downloads/scisaf_cal.pdf*.

Please note that the safety precautions of each activity are based, in part, on use of the recommended materials and instructions, legal safety standards, and better professional practices. Selection of alternative materials or procedures for these activities may jeopardize the level of safety and therefore is at the user's own risk.

Robots Everywhere

Description

After sharing what they know about different types of robots, students model how robots are programmed to perform tasks. They learn that every robot is designed for a specific job, and that job determines what a robot looks like. They also make a labeled drawing of a robot that could complete a particular task in their own home or at school, and they compare it with another technology designed to solve the same problem.

Suggested Grade Levels: K–2

LESSON OBJECTIVES Connecting to the *Framework*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concept
Developing and Using Models Constructing Explanations and Designing Solutions	**ETS1.B:** Developing Possible Solutions **ETS2.B:** Influence of Engineering, Technology, and Science on Society and the Natural World	Structure and Function

Featured Picture Books

TITLE: ***Beep! Beep! Go to Sleep!***
AUTHOR: **Todd Tarpley**
ILLUSTRATOR: **John Rocco**
PUBLISHER: **Little, Brown Books for Young Readers**
YEAR: **2015**
GENRE: **Story**
SUMMARY: *This fun, rhyming story will have kids giggling as a little boy tries everything to get his household robots to power down.*

TITLE: ***National Geographic Kids: Robots***
AUTHOR: **Melissa Stewart**
PUBLISHER: **National Geographic Children's Books**
YEAR: **2014**
GENRE: **Non-Narrative Information**
SUMMARY: *Young readers will learn about the most fascinating robots of today and tomorrow in this colorful, photo-packed book.*

Time Needed

This lesson will take several class periods. Suggested scheduling is as follows:

Day 1: **Engage** with *Beep! Beep! Go to Sleep!* Read-Aloud, **Explore** with Robot Arms, and **Explain** with Robot Arms Discussion and Chocolate Factory Video

Day 2: **Explain** with *National Geographic Kids: Robots* Read-Aloud and Robot Jobs Card Sort

Day 3: **Elaborate** with Robots of the Future and **Evaluate** with My Robot

Materials

For Robot Arms (per pair)

- 9 × 12 in. two-pocket folder with a mouse-hole-shaped opening (large enough for a student's arm to reach through) cut in the bottom center
- 1 small bowl
- Plastic sandwich bag with about 10 pieces of spiral-shaped pasta and about 10 pieces of tube-shaped or bowtie pasta
- 1 precut Robot Arm Program Card

Optional: For My Robot Advertisement (per student)

- White poster board or large construction paper
- Markers

SAFETY

- Check with your school nurse about wheat allergies, and substitute wheat-free pasta if necessary.
- Remind students not to eat any food used in the lab or activity.

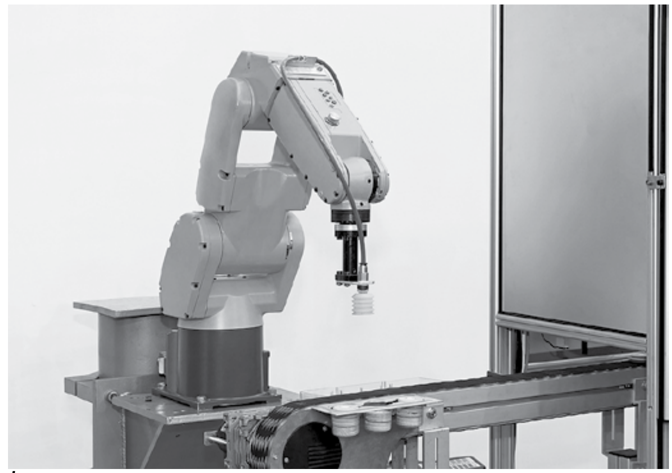
Student Pages

- Robot Jobs Card Sort
- Robot Job Descriptions
- My Robot and My Robot Advertisement
- STEM at Home

Background for Teachers

What do you think of when you hear the word *robot*? Most likely, you have a mental image of a walking, talking, blinking, and thinking humanoid machine. But most robots don't really look like people at all. Robots come in every shape and size you can think of and perform more jobs than you can imagine. If it seems as if robots are everywhere today, that's because they are! In this lesson, students learn about the influence of engineering, technology, and science on society by studying how people have come to depend on robots to do many jobs they could not (or would not) do.

So what exactly is a robot? Oddly enough, there is no widely accepted, standard definition of a robot. Even Joseph Engelberger, often referred to as the "father" of the modern robotics industry, was said to have remarked, "I can't define a robot, but I know one when I see one." In *National Geographic Kids: Robots,* author Melissa Stewart proposes this definition: "A robot, or bot, is a *machine* that has movable parts and can make decisions. People design it to do a job by itself." Although some robots lack computers and perform only simple, motor-driven tasks, the book explains that most robots have three main types of parts: a computer, sensors, and actuators. A robot's *computer* contains programs to help it make decisions. It makes these decisions based on data collected by its *sensors*. Some common robot sensors are video cameras to "see"; microphones to "hear"; pressure and temperature sensors to "feel"; ultrasound, infrared, and laser sensors to measure distance, navigate, and avoid obstacles; and even sensors that detect magnetic fields and certain types of chemicals.


INDUSTRIAL ROBOT ARM

To be called a robot, a machine must move. *Actuators,* also known as drives, are devices that receive messages from the computer and control the robot's movements. Most actuators are powered by pneumatics (air pressure), hydraulics (fluid pressure), or motors (electric current), but they all convert one kind of energy into motion energy. Actuators help the robot make sounds, flash lights, pick things up, move, and so on. Sometimes the whole robot moves, like the rovers that are rolling around the surface of Mars collecting rock samples and other data. Sometimes the robot is stationary with moving parts, like the robotic arms commonly used in industry for many different kinds of jobs. Welding or spray-painting robots don't have to move from place to place, but when a robot's job does require movement, robotics engineers (or *roboticists*) usually design it to have tracks, wheels, or legs (and some robots can even swim or fly). Robots need energy to move. They might be plugged in, battery powered, or even solar powered, depending on what they are designed to do.

In this lesson, students learn that a robot can only do things that engineers and roboticists *program* it to do. They learn that a robot's programming must be very detailed; each and every step must be spelled out for a robot to do its job properly. They model how a "pick-and-place" industrial robot arm needs a very precise and logical *program* to follow in order to complete a task, such as picking things up and sorting them. To model this, each student "programs" his or her partner's "robot arm" to pick up and sort pasta shapes into separate piles.

Students also learn that most robots are designed to do jobs that are too repetitive or dangerous for humans to do. Robots can explore places that humans can't go, such as Mars, the deepest trenches of the sea, or the craters of active volcanoes. But some of the handiest robots have less glamorous jobs: they are the domestic, or household, robots. There are robots to mow your lawn, clean your gutters, scoop out your cat's litterbox, entertain you, and even wake you up! Caregiving robots are being designed to help people with physical challenges move from a chair to a bed, fetch household items, or take a bath.

In this lesson, students look around their homes and classrooms and brainstorm problems that robots could solve. They design a robot and then compare its strengths and weaknesses with those of the technology (or the person!) currently solving the problem. Students share their designs through labeled drawings. Finally, they create an advertisement to "sell" their robot, explaining how it is a better solution than the technology (or person) currently solving the problem. The concept of structure and function is woven throughout the lesson as students explore how a robot's job determines what it looks like.

In the explore phase, students will get a sense of how robots are programmed by being exposed to simple IF-THEN-ELSE statements. Programming is a great way to teach problem-solving, creativity, and communication skills, and even very young children can be taught simple coding. To find out more about teaching young students to code, visit Reading Rockets (see "Websites" section) to view the article "IF kids code, THEN … what?" There are several suggested websites and apps listed at the end of the article, including Code, a nonprofit organization working to ensure that every student in every school has the opportunity to learn computer science. Its completely free curriculum for ages 4 and up consists of multiple courses, each of which has about 20 lessons that may be implemented as one unit or over the course of a school year. We hope that by learning about "robots everywhere" you and your students will be inspired to learn more about the wonderful world of coding!

engage

Beep! Beep! Go to Sleep! Read-Aloud

> Connecting to the Common Core
> **Reading: Literature**
> Key Ideas and Details: K.1, 1.1, 2.1

Engaging with Beep! Beep! Go to Sleep!

Inferring

Show students the cover of *Beep! Beep! Go to Sleep!* and introduce the author, Todd Tarpley, and illustrator, John Rocco. *Ask*

- ? Based on the cover, what do you think this book might be about? (a boy and some robots)
- ? How do you know? (The boy is reading a book called *3 Little Robots,* and there are three robots on the cover.)

Then, read the book aloud.

Questioning

After reading, *ask*

- ? What kinds of jobs do robots do? (Answers will vary.)
- ? What job do you think the robots in the book were designed to do? (entertain the boy or take care of the boy; students may notice that the first two-page spread has pictures on the wall showing that the robots have been with the boy since he was a baby)
- ? Do most robots look like the ones in the book? (Answers will vary.)

explore

Robot Arms

Tell students that most robots look nothing like the cute, funny ones featured in the book *Beep! Beep! Go to Sleep!* In fact, robots that consist of just a moving "arm" are among the most common robots used. Show students the robot arm on pages 22 and 23 of *National Geographic Kids: Robots.* Tell students they are going to do a fun activity to model how one of these robot arms works.

Before beginning the activity, divide students into teams of two. Tell students that one member of each pair is going to be the "robot arm" and the other member is going to be the "programmer." (They will be switching roles after the first trial.)


Robot Arms activity

Explain that all robots need to be *programmed* to do their job. This means that engineers must write a very specific set of instructions called a *computer program* and then upload, or transfer, the program to a robot's computer. The student who is the programmer will be reading these instructions to the student who is modeling the robot arm so that this student knows how to do his or her job. (You may want to read the Robot Program together if your students are not yet reading independently.)

Give a sandwich bag of pasta (spirals and either tubes or bowties) and a precut folder (to act as a screen) to each pair. Give a Robot Arm Program Card to each programmer. Then, read aloud the directions below:

Directions for Robot Arms Activity

1. Stand the folder on the table. The first person to be the robot should place one hand through the hole in the folder and lean over until his or her forehead is touching the folder. The robot should not be able to see his or her own hand (but may use the other hand to keep the folder standing up).
2. The programmer should dump the pasta into a bowl in front of the folder, within reach of the robot arm.
3. The programmer will tell the robot how to do its job by reading a set of instructions called the *Robot Program.*

When all pairs are set up and ready to go, call out, "START!"

Robot Program

1. Pick up a piece of pasta from the bowl.
2. IF the pasta feels like a spiral, THEN place it to the left of the bowl, or ELSE place it to the right of the bowl.
3. IF any pasta is still in the bowl, THEN GO TO step 1, or ELSE END program.

After a few minutes of pasta sorting (or more if necessary), call out, "STOP!" Next, have the programmers remove the folder so their partners can see the results. Then, have students trade roles and repeat the activity.

explain

Robot Arms Discussion and Chocolate Factory Video

Questioning

After everyone has had a chance to be both a programmer and a robot arm, *ask*

- ? What was the job the robot arms had to do? (sort the pasta)
- ? How well did the robot arms do their job? (Answers will vary.)
- ? Is this a job you would want to do? (Students will most likely answer no.)
- ? Why or why not? (It would be boring or too repetitive, and your arm would get tired.)
- ? What parts or structures on the robot arms helped them do their job? (movable elbows, wrists, hands, fingers, etc.)
- ? Did the programmer ever have to give the robot additional instructions? (Answers will vary.)

Explain that real robots can *only* do what they are programmed to do. Every step of a task must be spelled out in the robot's program. If the program is not detailed and exact, the robot won't be able to do its job very well or at all. Discuss the Robot Program used in the model. Point out that many types of computer programs are similar to this one: They are made up of a series of logical statements that include the words IF, THEN, ELSE, GO TO, and END. You may want to give students the opportunity to write another simple program for a robotic arm, such as a program for sorting and placing different-shaped blocks into containers.

Next, explain that robot arms are typically used in factories, doing jobs that people might not want to do because they are so repetitive (meaning they are repeated over and over). There are many different types of robot arms used in industry. One kind is designed to spray paint cars. Another kind welds metal together. One of the most common kinds found in factories and warehouses is called a *pick-and-place robot* because it is designed to pick things up and place them somewhere else, usually into some sort of package. The robot arm they modeled is a type of pick-and-place robot.

After completing the Robot Arms activity, tell students that they will have an opportunity to see some real pick-and-place robot arms in action. The "M-430iA Robots in Food Industry: Pick&Place of Chocolates" video (see "Websites" section) features two FANUC Robotics robot arms in a chocolate factory "picking and placing" different kinds of chocolate truffles into blister packs. Have students watch the video carefully to observe the robot arms doing their jobs.

After watching, point out that these robots have vision sensors, which are cameras that help them "see" the chocolates. Also, explain that although the robots are automatically doing their jobs, a machine operator nearby is controlling the settings on the robots' computers. Robots can only do jobs they are programmed to do, and often their programs need to be changed or adjusted for them to do their jobs properly.

Connecting to the Common Core
Reading: Informational Text
Key Ideas and Details: K.1, 1.1, 2.1

Questioning

After watching the video, discuss the following:

- Is packaging chocolate a job that a person could do? (yes)
- Would you want to do that job? (Answers will vary.)
- Why do you think the chocolate factory uses robots instead of people to pick and pack chocolates? (The job is boring, it is repetitive, the robots are faster, the robots never get tired, etc.)

Making Connections: Text to Self

Then, help students make connections between the video and the robot arms activity. *Ask*

- How were the chocolate factory robot arms like the robot arms we modeled? (They were picking up food and sorting it, they stayed in one place, and they had to be programmed.)
- How were they different? (The factory robots were picking the food from a moving conveyor belt instead of a bowl, they were putting the chocolates into different kinds of packages instead of piles, they could "see" the objects whereas our robots could only feel the objects, they could work a lot faster, etc.)

Tell students that they are going to learn much more about what robots look like and the many kinds of jobs they do.

explain

National Geographic Kids: Robots Read-Aloud

Turn and Talk

Show students the cover of the book *National Geographic Kids: Robots,* and *ask*

? What's a robot? (Students will likely provide a variety of responses—even engineers don't always agree on the definition of *robot.*)

Making Connections: Text to World

Read and discuss pages 4–7, which describe these characteristics of a robot:

- Has movable parts or structures
- Can make decisions
- Is designed by people to do a job by itself

Remind students of the Robot Arm activity. Ask them to think about the pick-and-place robot arm that was programmed to sort the pasta. *Ask*

? If that had been a real robotic arm, and not a kid's arm, would it meet the characteristics of a robot?

Go through each characteristic, asking students to give a thumbs-up or thumbs-down to show whether they think their pick-and-place robot arms meets each characteristic. Then, ask them to explain why.

? Does it have movable parts or structures? (Yes, the arm moved at the elbow and wrist joints, and the fingers also moved.)

? Can it make decisions? (Yes, when it felt a spiral-shaped piece of pasta, it placed it to the left of the bowl. When the bowl was empty, it stopped.)

? Is it designed by people to do a job by itself? (Yes, it could do the job by itself with the right programming.)

Read pages 10–11 about the parts of a robot, and *ask*

? What part of a robot is like a person's brain? (computer)

? What parts of a robot receive messages from the computer and control the robot's movements? (actuators)

? What parts of a robot collect information about its surroundings? (sensors)

Explain that many robots have vision sensors—cameras that help them "see" and recognize the shapes or even the colors of objects. These sensors help the robot make decisions such as what object to pick up, where to put it, where to paint or weld on a car, and so on. *Ask*

? What kind of sensor did your robot arm have in the pasta sorting activity? (touch)

? What kind of sensors do you think the chocolate factory robots had? (touch, sight, or both)

Making Connections: Text to Text

The little blue robot in *Beep! Beep! Go to Sleep!* said, "My sensor aches!" *Ask*

? What kind of sensor do you think it had? (Answers will vary.)

Robot Jobs Card Sort

Explain that every robot is designed for a specific job, and that job determines what a robot looks like. Tell students that in the book *National Geographic Kids: Robots,* they will learn about the jobs that robots do at work, at home, and in space. Before reading, pass out the Robot Jobs student pages, and have the students cut out the pictures of the robots. Read each robot job description aloud, and then have students place their cards where they think the cards go. Students will have the opportunity to move their cards as you read the book.

Connecting to the Common Core
Reading: Informational Text
Key Ideas and Details: K.1, 1.1, 2.1

Explain that, because this book is nonfiction, you can enter the text at any point. You don't have to read the book from cover to cover if you are looking for specific information. Tell students that parts of this book will help them match their robot cards with the robot jobs. Ask students to signal (by giving a thumbs-up, making "robot arms," or using some other method) when they see or hear one of the robots from the picture cards. Stop each time you read about a robot from the Robot Jobs Card Sort student page, and have students move their cards if necessary.

Chunking

Follow the steps below to "chunk" the book into the following sections: Robots at Work, Robots at Home, and Robots in Space. Note that you will not read the entire book aloud.

1. Robots at Work: Read pages 22–25, featuring factory robots and the volcano-exploring robot.
2. Robots at Home: Read pages 26–29, featuring the robot alarm clock and the fetch bot.
3. Robots in Space: Read pages 38–41, featuring the robonaut and the Mars rovers.

After reading, students may glue the picture cards onto the Robot Job Descriptions student page once they are all in the correct spaces. The answers to the Robot Jobs Card Sort are as follows:

1. F (Factory Robot)
2. E (Dante II)
3. A (Robot Alarm Clock)
4. C (Fetch Bot)
5. B (Robonaut)
6. D (Curiosity Rover)

Questioning

After reading, ask students to fill in the blanks as you make the following statements:

- ? Every robot is designed for a specific _____. (job)
- ? What a robot looks like depends on _________. (the job it was designed for or built to do)

Turn and Talk

Ask

- ? What was your favorite robot in the book, and why? (Answers will vary.)

elaborate

Robots of the Future

Read pages 44–45 about robots of the future. *Ask*

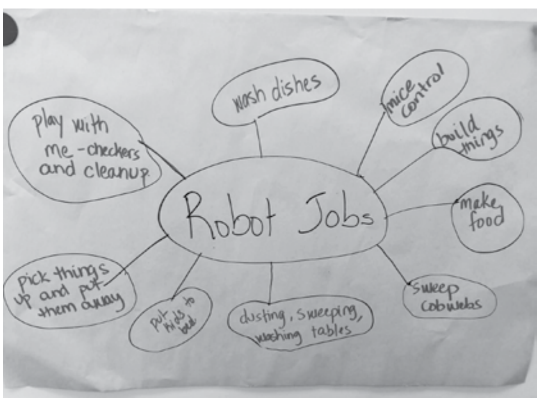
- ? After learning about robots and the jobs they can do, would you want to be a person who designs or builds robots? (Answers will vary.)
- ? Would you want a robot in your home? (Students will likely say yes!)

Tell students they are going to have the opportunity to be roboticists—engineers who design, program, and test robots! They will be designing their very own robot with the purpose of solving a human problem or meeting a human need in their own home or classroom. Tell students that in the not-so-distant future, robots in homes and schools may be commonplace. For inspiration, you can show students the first two-page spread of *Beep! Beep! Go to Sleep!* and have them imagine what it would be like to have a friendly robot in their home or school like the ones pictured.

Word Web

Next, students can brainstorm jobs a robot could help them do. Make a word web with the target words *Robot Jobs* in the middle, and organize student ideas in circles that surround it. Ask guiding questions, such as the following:

- ? What are some jobs that you do around your home or at school?
- ? What tools or machines do you or your parents or teachers use to help get the jobs done?
- ? Are there any jobs that a robot could do around your home or school that you could not?



Robot Jobs Word Web

- ? Are there any jobs that a robot could do around your home or school better than you could do them?
- ? What are some ways that a robot might entertain you or teach you better than another toy or game that you play with?

Then, brainstorm some robot ideas together. Examples might include a robot designed to take out the trash that can carry heavier trash bags than you can carry and can see in the dark to take out the trash at night; a robot designed to play chess that can teach you to play better than your brother or sister and can also put away the chess pieces when you are finished; or a robot that can feed the classroom fish during weekends or vacations and can give the fish exactly the right amount of food every time.

evaluate

My Robot

Connecting to the Common Core
Writing
Text Types and Purposes: K.1, 1.1, 2.1

Writing

Next, have each student select an idea from your brainstorming session, or come up with an idea of his or her own. Give each student a copy of the My Robot student page. Read the first page together.

You may choose to have students use the My Robot Advertisements student page, or have them draw their robot on construction paper or poster board. You can have students present their robots to the class, have a "Robotics Fair," invite other classes to attend a gallery walk, or display the posters in the classroom or hallway.

Our Robot Designs

STEM at Home

Have students complete the "I learned that …" and "My favorite part of the lesson was …" portions of the STEM at Home student page as a reflection on their learning. They may choose to do the following at-home activity with an adult helper and share their results with the class. If students do not have access to the internet at home, you may choose to have them complete this activity at school.

"At home, we can watch a short video together called 'Sandeep Yayathi: Robotics Engineer' about Robonaut 2, or R2, a human-like robot designed to assist astronauts in space."

Search "Sandeep Yayathi: Robotics Engineer" at www.pbslearningmedia.org *to find the video at* http://cet.pbslearningmedia.org/resource/mss13.sci.engin.design.robeng/sandeep-yayathi-robotics-engineer.

"If you were a robotics engineer, what kinds of robots would you want to design and why?"

For Further Exploration

This section is provided to help you encourage your students to use the science and engineering practices in a more student-directed format. This box lists questions and challenges related to the lesson that students may select to research, investigate, or innovate. Students may also use the questions as examples to help them generate their own questions. After selecting one of the questions in the box or formulating their own questions, students can individually or collaboratively make predictions, design investigations or surveys to test their predictions, collect evidence, devise explanations, design solutions, or examine related resources. They can communicate their findings through a science notebook, at a poster session or gallery walk, or by producing a media project.

Research

Have students brainstorm researchable questions:

- ? What is the world's largest walking robot?
- ? How did the Mars rovers get onto the surface of Mars?
- ? What is biomimicry, and what are some examples of it in robot design?

Investigate

Have students brainstorm testable questions to be solved through science or math:

- ? How many pieces of pasta can your partner's "robot arm" sort in 1 min. without looking?
- ? Survey your friends: Would you rather have a robot take care of you if you were sick, or would you prefer a human nurse? Graph the results, then analyze your graph. What can you conclude?
- ? Survey your friends: What household chore would you most want a robot to do? Graph the results, then analyze your graph. What can you conclude?

Innovate

Have students brainstorm problems to be solved through engineering:

- Can you write a code to program your partner's "robotic arm" to sort blocks by their shape or color?
- What kind of robot would you design to help you at school?
- What kind of robot would you design to explore a volcano, the deep ocean, or outer space?

Websites

"IF Kids Code, THEN … What?" (article)
www.readingrockets.org/article/if-kids-code-thenwhat

"M-430iA Robots in Food Industry: Pick&Place of Chocolates" (video)
www.youtube.com/watch?v=ZSbFW_ncldU

More Books to Read

Becker, H. 2014. *Zoobots: Wild robots inspired by real animals.* Toronto: Kids Can Press.
Summary: This book for older readers (grades 3–6) explores the world of robo-animals, or "zoobots." Twelve two-page spreads reveal vivid, Photoshop-rendered illustrations of robot prototypes such as the bacteria-inspired Nanobot, which can move through human blood vessels, and the OLE pill bug, which can fight fires. Each spread shows a smaller illustration of the animal on which the zoobot is based.

Fliess, S. 2013. *Robots, robots, everywhere*. New York: Golden Books.
Summary: This delightful rhyming picture book for very young readers features robots of all kinds, from the ones up in space to the ones we use at home.

Shulman, M. 2014. *TIME for Kids: Explorers—Robots.* New York: TIME for Kids.
Summary: Full of facts and photos, this book in the popular *TIME for Kids* series shows young readers just how useful robots are and why we need them.

Swanson, J. 2016. *National Geographic Kids: Everything robotics—All the photos, facts, and fun to make you race for robots*. Washington, DC: National Geographic Children's Books.
Summary: With stunning visuals and an energetic design, this book for grades 3–7 reveals everything kids want to know about robotics.

Robot Arm Program Cards

ROBOT PROGRAM

1. Pick up a piece of pasta from the bowl.
2. IF the pasta feels like a spiral, THEN place it to the left of the bowl, or ELSE place it to the right of the bowl.
3. IF any pasta is still in the bowl, THEN GO TO step 1, or ELSE END program.

ROBOT PROGRAM

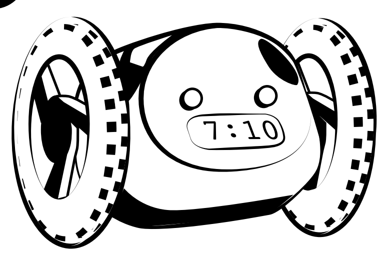
1. Pick up a piece of pasta from the bowl.
2. IF the pasta feels like a spiral, THEN place it to the left of the bowl, or ELSE place it to the right of the bowl.
3. IF any pasta is still in the bowl, THEN GO TO step 1, or ELSE END program.

Robot Jobs Card Sort

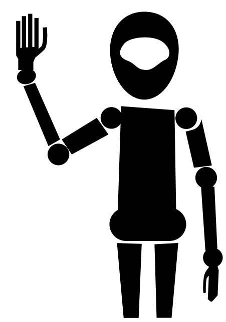
Robots do many different kinds of jobs. They often do jobs that people don't want to do or can't do. What a robot looks like depends on the job it was designed to do.

Directions: Cut out the robot cards below and match each robot to its job description on the next page. Then, listen as your teacher reads the book *National Geographic Kids: Robots*. You will have the chance to move the cards again as your teacher reads the book.

A



B



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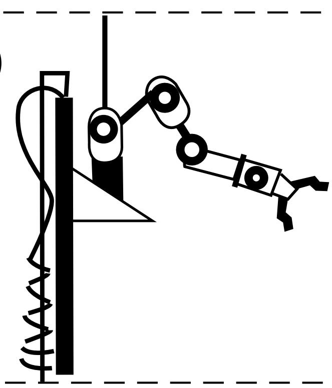
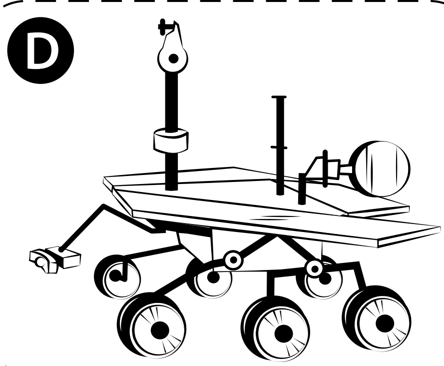
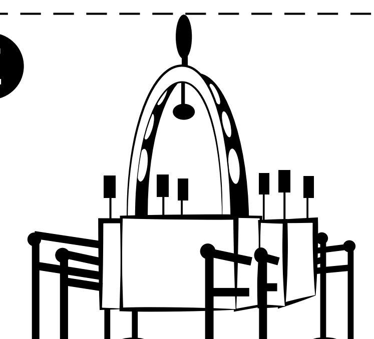


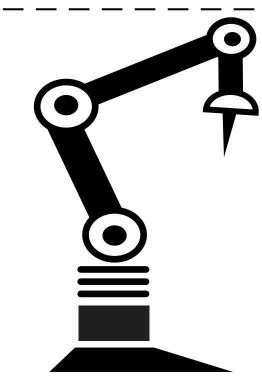
D



E



F



Name: ______________________________

Robot Job Descriptions

Match the robot picture with the right description.

1 This robot arm welds together metal parts in a factory.

2 This eight-legged robot was designed to explore an active volcano.

3 This robot alarm clock is on wheels and rolls around your room.

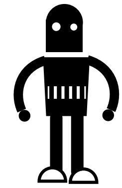
4 This robot can pick up an object you want and bring it to you.

5 This human-like robot works on the International Space Station.

6 This six-wheeled robot was designed to explore the surface of Mars.

Name: ______________________________

My Robot



Challenge: Design a robot to do a job in your home or classroom.

Robot's name: ______________________________

Robot's job: ______________________________

____

____

Think about how your robot can do the job better than a person could do it, or how it can do the job better than another technology. Then, list some reasons that people should buy your robot.

____

____

____

____

____

____

____

Next, draw your robot and create an advertisement to sell it! Include the robot's name and its job, and label the parts of your robot that help it do its job.

My Robot Advertisement

Name: ______________________________

STEM at Home

Dear ______________________,

At school, we have been learning about **robots.** Every robot is designed for a specific job, and that job determines what a robot looks like.

I learned that:

____

____

____

My favorite part of the lesson was: ______________________________

____

At home, we can watch a short video together called "Sandeep Yayathi: Robotics Engineer" about Robonaut 2, or R2, a human-like robot designed to assist astronauts in space.

Search "Sandeep Yayathi: Robotics Engineer" at ***www.pbslearningmedia.org*** to find the video at ***http://cet.pbslearningmedia.org/resource/mss13.sci.engin.design.robeng/sandeep-yayathi-robotics-engineer.***

If you were a robotics engineer, what kinds of robots would you want to design and why?

____

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Index

Page numbers printed in **boldface type** indicate tables, figures, or illustrations.

Picture-Perfect STEM Lessons, K–2

Using Children's Books to Inspire STEM Learning

"Teachers in our district have been fans of *Picture-Perfect Science* for years, and it's made a huge impact on how they fit science into their school day. We are so excited to do more of the same with these *Picture-Perfect STEM* books!"
—**Chris Gibler,** elementary instructional coach, Blue Springs School District in Missouri

"This lively mix of picture books and engaging, standards-based STEM content will be a powerful tool to inspire STEM learning."
—**Andrea Beaty,** author of *Ada Twist, Scientist; Rosie Revere, Engineer;* and *Iggy Peck, Architect*

For teachers who are eager to integrate STEM into their school day, *Picture-Perfect STEM Lessons* is an exciting development. This book's 15 kid-friendly lessons convey how science, technology, engineering, and mathematics intersect in the real world. They embed reading-comprehension strategies that integrate the STEM subjects and English language arts through high-quality picture books. You'll help your K–2 students engage in STEM activities while they learn to read and read to learn.

Picture-Perfect STEM Lessons, K–2 draws on diverse and attention-grabbing books such as *The Handiest Things in the World, The Day the Crayons Came Home,* and *I Wanna Iguana*. The lessons will lead your students to ask questions and define problems; obtain, evaluate, and communicate information; and engage in argument from evidence. Along the way, students invent a handy backpack, design their own process for recycling crayons, and build a model habitat for an imaginary pet. Through these lessons and activities, all young students, including reluctant scientists and struggling readers, will quickly find themselves absorbed in STEM-related discovery.

Along with these new lessons come the easy-to-use features that have made *Picture-Perfect Science* a bestselling series for more than a dozen years:

- Fiction and nonfiction book pairs
- Background reading, materials lists, student pages, and assessments for each lesson
- Connections to science standards and the *Common Core State Standards* for both English language arts and mathematics

Picture-Perfect STEM Lessons is a powerful tool for guiding instruction. You'll love how effective this book is, and your students will love learning about STEM.

Grades K–2

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