**Robotics Open House Lesson Plan**  
Middle School

**Learning Objective**

Students will be able to **differentiate** between a robot and a machine, and **distinguish** between different types of robots that are useful in society.

**Materials**

- Projector and computer to play a video.
- A variety of building materials for students to make a model of the robot they design at the end of the lesson, such as popsicle sticks, cotton balls, foam board, and glue.

**NGSS 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-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

**Additional Resources**

Boeing’s Educational Resources on a robotic arm
- [https://curiositymachine.org/challenges/86/](https://curiositymachine.org/challenges/86/)

Also check these out:
- [http://rasc.usc.edu/robots.html](http://rasc.usc.edu/robots.html)
- [https://www.khanacademy.org/partner-content/mit-k12/mit-k12-physics/v/indoor-flying-robots](https://www.khanacademy.org/partner-content/mit-k12/mit-k12-physics/v/indoor-flying-robots)
- [https://www.youtube.com/watch?v=5Dp2qHz8r2U](https://www.youtube.com/watch?v=5Dp2qHz8r2U) on the engineering design process
Engage: Thinking about Robots

As a class, share prior knowledge of robots and computer programming (also referred to as “coding”).

Working in pairs or small groups, students develop a list of robots (real or fictional) and describe each robot’s function, appearance, and “personality.” Students also list what they know about coding.

Watch these videos about USC Viterbi’s research robots:
https://www.youtube.com/watch?feature=youtu.be&v=URNoNtClH9Q&app=desktop
https://vimeo.com/58507252

Explore: Robot Terms Guided Worksheet

Students complete the included guided worksheet, Robots and Robotics, as they learn about the following vocabulary.

Go over key vocabulary with the class, writing each word and definition on the board:

- **Robot**: A robot is an autonomous system which exists in the physical world, can sense its environment, and can act on it to achieve some goals such as work, exploration, health, observation, or teaching. All four of these components (in bold) must be present in a robot. A robot must have all four bolded qualities to distinguish it from a machine. Robots are useful in situations when it is difficult or time-consuming for humans to do the work, especially when tasks need to be repeated over and over again.

- **System**: A combination of computer code (or programming) plus physical parts (sensors, moving parts).

- **Computer Science**: The study of computation and its applications using computers. A **computer scientist** is a person who can program (or code) a computer.

- **Robotics**: Robotics is the study of robots, which means it is the study of their autonomous and purposeful sensing and acting in the physical world.

- **Autonomous**: Acting on the basis of its own decisions, and, in the case of robots, is not directly controlled by a human.
Explain: Families of Robots

As students follow along with their worksheet, emphasize that robots are classified by their unique ability to sense, respond, and independently achieve specific goals for work, health, observation, and more.

Discuss the difference between a robot and a machine. Is a microwave a robot? Why or why not? Is a washing machine a robot?

Go over four types of robots from the list below (explaining that there are more types, and that all of these types can be mixed/combined):

**Humanoid**: These robots have human-like body parts and movements, such as legs that can walk and arms that can grasp.

**Explorers**: These robots explore places where it can be more difficult or inconvenient for humans to go, such as the ocean or the sky.

**Interactors**: These robots sense human movements or speech patterns and emotions, and respond helpfully, such as in coaching people to exercise after a stroke.

**Learners**: These robots learn as they interact with the environment.

Discuss the difference between a robot and a machine. For instance, a toaster is not a robot because it does not sense the bread or respond independently of humans. Is a microwave a robot? Why or why not? Is a washing machine a robot? Do these machines have sensors? Can they respond independently to their environment? Distinguish between a machine that can mark time (such as when bread is in a toaster for 60 seconds) and a robot that can sense when something (like bread) is completely ready.

Show pictures of each and describe what they do. Also emphasize that researchers work with these robots to program them perform their functions and are constantly making them better.

Find out more about each robot at [http://rasc.usc.edu](http://rasc.usc.edu).
Elaborate: Be a Robotics Researcher

On the provided activity pages (pages 11-13), students will begin by considering the criteria and constraints of robotic problems, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Evaluate: Design Your Own Robot

Next, students will put their understanding of criteria and constraints to use by designing their own robot, naming it, and describe what it **senses** and how it **reacts** so that it can help people.

After completing their design, students will build a model of their robot. Challenge them to evaluate the proper materials needed to build their robot model.

Extend: Take a Robot Personality Quiz

Play the robot quiz!
http://www.playbuzz.com/viterbip/which-robot-are-you

Go to http://rasc.usc.edu, choose a robot or researcher, and write a profile about it/them.
Humanoid Robots

These robots imitate human body parts and movements, such as legs that can walk, cameras for eyes, hands that can grasp. They have a variety of functions, including manufacturing, helping people, working in dangerous environments. Find the sensors on these robots for sight and touch.
Explorer Robots

These robots explore places where it may be difficult or impractical for humans to go, such as the ocean or the sky. They help monitor the environment, search for things, and conduct research. Although humans can travel by airplane, boat, or submarine, in what types of circumstances might these robots do a better job in terms of materials, time, or cost?
**Interactor Robots**

**Interactors:** These robots sense human movements or speech patterns and emotions, and respond helpfully, such as in coaching people to exercise after a stroke.
Learner Robots

These robots learn as they interact with the environment.
USC Viterbi Robotics Researchers

Would you like to research robots, too?

Professor Maja Matarić

Dr. Matarić finds ways for robots to help people in their everyday lives, especially those with special needs.

Professor Gaurav Sukhatme

Dr. Sukhatme creates ways to control robots that go underwater and monitor the ocean environment.

Professor Laurent Itti

Dr. Itti researches how humans and robots see and interact with their environment.

Professor Nora Ayanian

Dr. Ayanian programs robots to work—and fly—together as a team.
Professor Francisco Valero-Cuevas

Dr. Valero-Cuevas researches how the brain controls the human hand so we can build robots that do the same thing.

Professor Gerald Loeb

Dr. Loeb researches robotic prosthetics, such as a robotic hand or arm, that can help people who don’t have one or a fully functioning one.
How Computer Scientists Consider Robot Design Criteria

1. Watch this video: https://www.khanacademy.org/partner-content/mit-k12/mit-k12-physics/v/indoor-flying-robots

2. What is the single most important difference between a robot and a machine? Why?
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

3. It is much easier to design a robot that rolls on wheels than one that can walk like a human. What are some situations where it might be preferable to have a robot that can walk?
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

4. What are some criteria and constraints for designing a humanoid robot that walks?
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

5. Compare and contrast the role of gravity on a humanoid robot that walks and a quadcopter robot that flies.
   ___________________________________________________________________
6. | Draw an example of a **humanoid** robot. | Describe what an **explorer** robot does. |
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<tbody>
<tr>
<td>Explain how <strong>interactor</strong> robots help people.</td>
<td>List the four <strong>characteristics</strong> of robots.</td>
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7. Which robot that you learned about do you find the most interesting? Why?  

__________________________________________________________________  
__________________________________________________________________  
__________________________________________________________________

8. What question(s) do you have about robots?  

__________________________________________________________________
Be a Robotics Researcher! Design and build your own robot.

1. Robots help people, so how will your robot help people? What problem can your robot help solve? ___________________________________________
   ___________________________________________
   ___________________________________________

2. What sensors and responses will you need to design in your robot to achieve this goal? ___________________________________________
   ___________________________________________
   ___________________________________________

3. What is your robot called? ___________________________________________


5. Build a model of your robot based on your sketch. First, write here what materials you will use, paying close attention to the criteria and constraints of your materials:
   ___________________________________________
   ___________________________________________
   ___________________________________________