Robotics in the Classroom

A unit for 7th and 8th grade

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Robotics in the Classroom
Curriculum Unit Overview

Summary

Today more than any other time in history, robots play a significant role in everyday life. For the average person, it is impossible to go through a day without coming into contact, one way or another, with a robotic device. It is the intention of this unit to introduce 7^{th} and 8^{th} grade students to the development of robotics during the 20^{th} and 21^{st} centuries, while illustrating the prevalence of robots in the world today. Students will also use the scientific method to come up with their own designs for a robot that could be useful in their daily lives. Although the subject of robotics is extremely vast, we have selected just a small portion to cover in this unit. Teachers should plan three to four weeks to cover the lessons that follow, excluding the transfer activity.

Big Picture

The first day of the unit, a guest speaker will come in to give a brief introduction and talk about his knowledge of the field of robotics. He will also be able to answer questions that students may have and get them excited about what they will be studying for the next few weeks. It would also be motivational if, prior to the beginning of the unit, teachers made their own robot to show the students. (There are many kits available on the internet and in some local hobby and toy stores.)

Preparation for the Unit

Work in cooperation with science, math, and language arts teachers to:

1. Secure guest speakers. As you are looking into doing this, consider resources such as parents of students, military personnel, and local hobbyists. There are many clubs and organizations set up around robotics-just check around. (See list of guest speakers and informational resources in the appendix.)

2. Find an engaging video that discusses the progression of robotics thorough the 20^{th} and 21^{st} centuries, and introduces major concepts and terminology. A suggested video is Robot Revolution (27 min., grades 1-7) available at http://www.libraryvideo.com for $14.95.

3. Make some sort of exhibit robot available for the opening activity. (See the appendix for details on how to locate a good kit.)

4. As the unit is a collaborative effort among language arts, math, and science teachers, planning ahead of time is necessary. Teachers need to be aware of the ways the parts they will teach tie into the big picture.

5. Make photocopies of the handouts and activity pages found in this unit.

Overview

The following is a summary of the unit including brief summaries of each Authentic Learning Task (ALT). This table provides an overview of the tasks in the unit sections and shows how the activities in the different teaching areas relate to each other.

Robotics in the Classroom
Curriculum Unit Summary

History and Uses of Robots	Components of Robots	Design of Robots
ALT 1 – Robot Uses (Science) Students will examine, through video and discussion, the multiple uses of robots--past, present, and future.	**ALT 1 – Physics and Robotics (Science)** Students will demonstrate an understanding of the relationship among mass, force, work, power, and energy, and how those terms have an impact on the selection of robotic components.	**ALT 1 – Robot designing using the Scientific Method (Science)** Students will apply knowledge of the process of the scientific method as they design a new type of robot.
ALT 2 – Instruction Sequencing (Math) Using logic and sequence, students will write instructions to complete given tasks.	**ALT 2 –Robot Programming (Math)** Students will be introduced to the different kinds of robot sensors. Students will use distance formulas and ratios, instead of a sensor, to be able to tell a robot how far to move.	**ALT 2 – Robot Design Sketch (Math)** Students will make drawings of their robot using concepts of proportion and scale.
ALT 3 – Examining Robotic History Through Writing (LA) Students will infer the impact robots have had on society throughout history and demonstrate their knowledge and opinions through writing.	**ALT 3 – Critical Thinking: What Makes a "Good" Robot? (Language Arts)** Students will use prior knowledge of robotic components to write a detailed description of the robot they want to design.	**ALT 3 – Evaluation: Was your Robot a "Good" Robot? (LA)** Students will evaluate, through writing, the design of their robots. They will compare and contrast their design with that of an already existing robot.

Transfer Activity

Upon conclusion of this unit, students will see how the things they have done connect to the real world. The Lego® Company produces several types of robot kits, one of which is the MindStorms Invention System. The transfer activity uses this particular kit to expand upon the material learned throughout the unit. Students will take their robot designs and modify them based on the equipment available to them in the kit. They will then build and program their own robot. The students, as they go through this process, will have the goal of building a robot that can accomplish a certain task. Students will also have the option of competing in various official robot competitions.

Section One: History and Uses of Robots

ALT One: Robot Uses (Science)

Summary
After watching a video illustrating the many uses for robots and describing their components, students will participate in a class discussion listing major uses and functions of robots.

Competencies
Upon completion of this lesson, students will be able to:
1. List possible uses of robots, and common components.
2. Identify robots in the student's everyday life.

Time
Approximately two hours

Materials
Student rubric
Video showing the progression of robotics through history, plus introducing major concepts and terminology. A suggested video is Robot Revolution (27 min., grades 1-7) available at http://www.libraryvideo.com for $14.95.

Instructions
1. Present video to the class, stopping for discussion as necessary. Students are to make a chart listing facts learned from the video. The goal is to find 10 or more facts.
2. Brainstorm about and list, as a class, the different uses and components of robots, as seen in the video.
3. Extend the activity by having the students make a list of robots they see outside the classroom in everyday life. This can either be a take-home activity, or class activity, depending upon the time available.
4. Discuss the students' findings from the above activity.

Evaluation/Assessment of Student's Competency
Student competency will be based on criteria detailed in the rubric on the following page.

Closure
Discuss how the robots seen in the video differ in mode of locomotion, size, task capability, and speed. Encourage students to move towards the recognition that there is a relationship among the things that have been mentioned. This relationship will be further explored the next time you meet.

History and Uses of Robots, ALT One: Handout One

Robot Uses Rubric

	Beginning 0	**Developing 1**	**Accomplished 2**	**Exemplary 3**	**Score**
List possible uses of robots, and common components.	Student does not list any uses or components	Student lists four or five uses and components	Student lists between six and eight uses and components	Student lists between nine and twelve uses and components	
Identify robots in the student's everyday life	Student does not list any examples of robots	Student lists four or five examples of robots	Student lists between six and eight examples of robots	Student lists between nine and twelve examples of robots	
Extract facts from the video	Student finds no facts from video	Student just finds 3-5 facts, and/or chart is not neat	Student finds 6-9 facts, and chart is neat	Student finds ten or more facts, and chart is exceptional	

Written by Toye and Williams. Last updated 06/29/01.

Section One: History and Uses of Robots

ALT Two: Instruction Sequencing (Math)

Summary
Using logic and sequence, students will write instructions to complete given tasks. This lesson is designed to not only develop the students' logic, sequence, and problem solving skills, but it will be used to introduce to concept of robotic programming.

Competencies
Upon completion of this lesson, students will be able to:
1. Write instructions for a partner to follow to complete given tasks.
2. Follow written instructions to complete a given task.
3. Reflect on the activity, summarizing what worked well, and what did not.

Time
Approximately three hours

Materials
Paper, pencil, photocopies of ALT Two: Handout One (A and B) and rubric

Instructions
1. On a separate piece of paper, students will write instructions for their partners to follow to complete a given task. Instructions must be very detailed and specific. Partners will be following these directions to the letter, so nothing can be omitted or implied.
    - An example task and directions should be given by the instructor to show the expected product. (An example task and directions is given at the end of the lesson.)
    - A variation of the fourth task would be to physically make a maze in the room for students to navigate.
2. Their partners will then attempt to complete the given task, following the instructions exactly.
3. If students are unsuccessful in completing the task, adjustments to the directions must be made, and the task must be attempted again.
4. Both partners will write instructions for all of their tasks, have them completed successfully by their partners, and complete the reflection questions at the end of the worksheet.

Evaluation/Assessment of Student's Competency
Student's assessment will be based criteria found in the rubric that is on the student handouts.

Closure
A class discussion will follow the activity, and should focus on the reflection questions, and the similarities/differences between the activity and robot programming.

History and Uses of Robots, ALT Two: Handout One (A & B)

Worksheet A, page 1

Instruction Sequencing

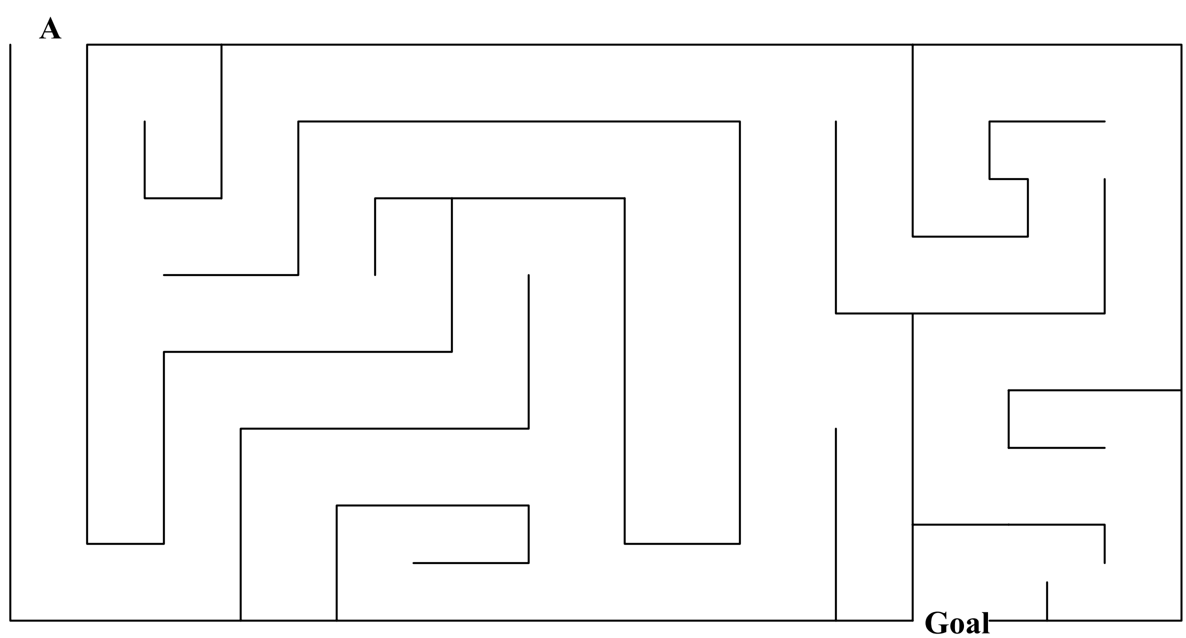
Instructions

1. On a separate piece of paper, write instructions for your partner to follow to complete a given task. Instructions must be very detailed and specific. Your partner will be following these directions to the letter, so nothing can be omitted or implied.
2. Your partner will then attempt to complete the given task, following the instructions exactly.
3. If you are unsuccessful in completing the task, adjustments to the directions must be made, and the task must be attempted again.
4. Both students will write instructions for all of their assigned tasks, have them completed successfully by your partner, and complete the reflection questions at the end of the worksheet.

Tasks

1. Pick a pencil up off the table and place it in your pocket.
2. Take the pencil from your pocket, sharpen it, and return it to the table.
3. Walk up a flight of stairs, turn around, and return down the stairs.
4. Go through the maze from point "A" to the "goal".

Maze



Reflection Questions

1. What was the most difficult part of writing the directions for your partner?
2. What directions confused your partner the most?
3. What directions were the best for helping your partner complete the task?
4. What are some examples of very specific directions that you needed to give your partner to enable them to complete a task?
5. How did you tell your partner when to stop, turn, reverse, etc.?
6. Would you have written your directions differently if you were writing them for a robot to follow?

Writing Instructions Rubric

	Beginning 0	**Developing 1**	**Accomplished 2**	**Exemplary 3**	**Score**
Written Directions	Many steps omitted, and/or are not detailed nearly enough.	Some steps omitted, and/or are not detailed enough.	Includes appropriate steps and details	Steps were very thourough and descriptive.	
Following Directions	Did not follow the written directions, and was uncooperative.	Was cooperative, but did not follow the directions word for word.	Was cooperative and followed directions.	Was cooperative, followed directions, and offered suggestions.	
Reflection Questions	Answers were not well thought out, or grammatically appropriate.	Answers were well thought out, but not grammatically appropriate.	Answers were well thought out.	Answers were extensive, well thought out, and detailed.	

Written by Toye and Williams. Last updated 06/29/01.

History and Uses of Robots, ALT Two: Handout One (A & B)

Worksheet B, page 1

Instruction Sequencing

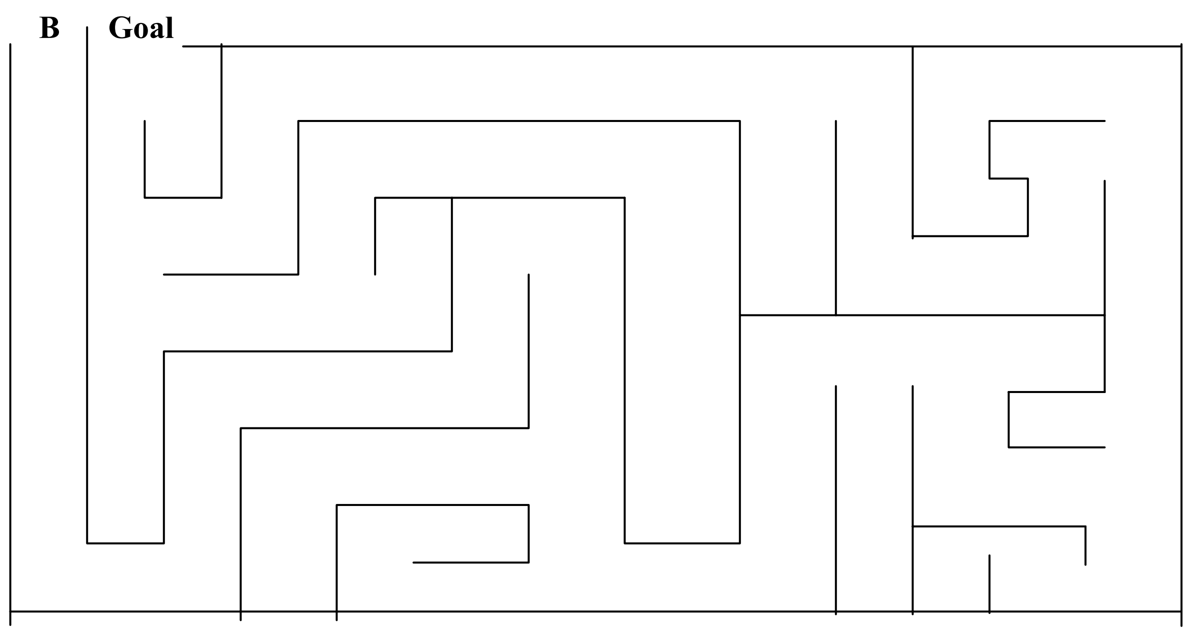
Instructions

1. On a separate piece of paper, write instructions for your partner to follow to complete a given task. Instructions must be very detailed and specific. Your partner will be following these directions to the letter, so nothing can be omitted or implied.
2. Your partner will then attempt to complete the given task, following the instructions exactly.
3. If you are unsuccessful in completing the task, adjustments to the directions must be made, and the task must be attempted again.
4. Both students will write instructions for all of their assigned tasks, have them completed successfully by your partner, and complete the reflection questions at the end of the worksheet.

Tasks

1. Open a book to the table of contents.
2. Close the book and place it on a table on the other side of the room.
3. Put a piece of scrape paper in the trash can/recycling bin.
4. Go through the maze from point "B" to the "goal".

Maze



Worksheet B, page 2

Reflection Questions

1. What was the most difficult part of writing the directions for your partner?
2. What directions confused your partner the most?
3. What directions were the best for helping your partner complete the task?
4. What are some examples of very specific directions that you needed to give your partner to enable them to complete a task?
5. How did you tell your partner when to stop, turn, reverse, etc.?
6. Would you have written your directions differently if you were writing them for a robot to follow?

Writing Instructions Rubric

	Beginning 0	Developing 1	Accomplished 2	Exemplary 3	Score
Written Directions	Many steps omitted, and/or are not detailed nearly enough.	Some steps omitted, and/or are not detailed enough.	Includes appropriate steps and details	Steps were very thorough and descriptive.	
Following Directions	Did not follow the written directions, and was uncooperative.	Was cooperative, but did not follow the directions word for word.	Was cooperative and followed directions.	Was cooperative, followed directions, and offered suggestions.	
Reflection Questions	Answers were not well thought out, or grammatically appropriate.	Answers were well thought out, but not grammatically appropriate.	Answers were well thought out.	Answers were extensive, well thought out, and detailed.	

Written by Toye and Williams. Last updated 06/29/01.

History and Uses of Robots, ALT Two: Handout Two (teacher example task)

Task

Pick up a glass of water and take a drink.

Directions

1. Lift your hand so that it is about two inches above the table.
2. Rotate your hand so that the thumb is pointing up.
3. Open your hand as wide as possible.
4. Line your hand up so that the glass in directly in front of your palm.
5. Slowly move your hand forward, keeping it about two inches above the table, until your palm touches the glass and stop.
6. Close your hand around the glass and stop when there is slight pressure.
7. Keep your hand closed with slight, continued pressure, and raise your hand about three inches.
8. Bend the elbow of the arm that is holding the glass until it is at 90 degrees.
9. Lift the hand holding the glass until the top of the glass is in line with your bottom lip.
10. Bend the elbow of the arm that is holding the glass until the glass touches your bottom lip.
11. Open your mouth about a centimeter.
12. Keeping the glass in contact with your lip, rotate your hand slowly so that the thumb is moving down until water begins to flow into your mouth.
13. Once your mouth is half-full of water, rotate your hand in the opposite direction until the glass is up-right, and close your mouth.

Section One: History and Uses of Robots

ALT Three: Examining Robotic History through Writing (LA)

Summary
Students will demonstrate, through writing, knowledge of the history of robots and infer the impact robots have had on society.

Competencies
Upon completion of this lesson, students will be able to:
1. Recall facts from a passage on robotic history.
2. Research robot history from a list of resources.
3. Explain how the use of robots has changed over the years.
4. Infer how robots have impacted society.
5. Conclude if the impact of robots on our society has been positive or negative.

Time
Approximately five hours, including revision and rewrite

Materials
Written passage discussing the history of robotics (photocopy ALT Three: Handout One, found on the following two pages), internet access, books and magazines about robots.

Instructions
1. Students will take turns reading aloud from the passage about the history of robotics.
2. Discuss main ideas of the passage.
3. Students will use the internet sites (from list in the appendix), books, and magazines to find additional information about the history of, and pros and cons of, robot use.
4. Each student will then make an information web for each of the following:
    - How the uses of robots have changed over the years.
    - How robots have impacted our society.
    - The student's opinion of whether robots have positively or negatively impacted our society.
5. Each student will write a total of three paragraphs, one for each of the above webs.

Evaluation/Assessment of Student's Competency
Each of the three written paragraphs will be assessed using the rubric for this lesson.

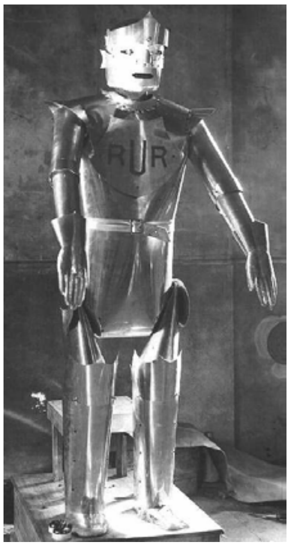
Closure
Discuss reasons why certain types of robots have had greater affects on society than others. What was it about the design or makeup of these robots that made them useful? Why can't robots solve unexpected problems? What is "sequencing"? How are a robot and an android different?

History and Uses of Robots, ALT Three: Handout One

The History of Robotics

1920

The idea of a robot is not new. For many years man has been imagining intelligent mechanized devices that perform human-like tasks. He has built automatic toys and mechanisms and imagined robots in drawings, books, plays and science fiction movies. In fact, the term "robot" was



first used in 1920 in a play called "R.U.R.," or "Rossum's Universal Robots," by the Czech writer Karel Capek (pronouned "chop'ek"). The plot was simple: man makes robot then robot kills man! Many movies that followed continued to show robots as harmful, menacing machines. More recent movies, however, like the 1977 "Star Wars," portray robots such as "C3PO" and "R2D2" as man's helpers. "Number Five" in the movie "Short Circuit" and C3PO actually take on a human appearance. These robots which are made to look human are called "androids." The word robot comes from the Czech word *robota*, meaning "forced labor."

1941

In 1941, science fiction writer Isaac Asimov first used the word "robotics" to describe the technology of robots and predicted the rise of a powerful robot industry. His prediction has come true. Recently there has been explosive growth in the development and use of industrial robots to the extent that terms like "robot revolution," "robot age," and "robot era" are used. "Robotics" is now an accepted word used to describe all technologies associated with robots.

1956

In 1956, George Devo l and Joseph Engelberger formed the world's first robot company. Devil predicted that the industrial robot would "help the factory operator in a way that can be compared to business machines as an aid to the office worker." A few years later, in 1961, the very first industrial robot was "employed" in a General Motors automobile factory in New Jersey. Since 1980, there has been an expansion of industrial robots into non-automotive industries. The main factor responsible for this growth has been the technical improvements in robots due to advancement in microelectronics and computers.

Today

Fully functioning androids are many years away due to the many problems that must be solved. However, real, working, sophisticated robots are in use today and they are revolutionizing the workplace. These robots do not resemble the romantic android concept of robots. They are industrial manipulators and are really computer controlled "arms and hands." Industrial robots are so different from the popular image that it would be easy for the average person not to recognize one.

Pros and Cons of Robots

"What about robots *replacing* humans?" you may ask. The fact is, from a technological point of view, we are very far from having a robot with enough skills, intelligence and autonomy to replace human beings at the majority of tasks and chores. The robots that exist today are industrial models. However, we can hardly refer to them as intelligent. The sole thing they are capable of doing is reproducing sequences of highly complex movements such as holding, displacing, releasing, pinpointing, touching, pulling, and so on, imitating a human.

Take for instance an automobile assembly line, or an electronic printed circuits plant, where repetitive and precise processes take place. Here, the robots perform well ... until something gets out of the programmed sequence or positions. Then comes disaster, since artificial robots, with rare exceptions, are not intelligent, that is, they do not possess the senses of vision, touch or hearing, do not how to "feel" the object or solve an unexpected problem, nor have adaptive capabilities to automatically adjust themselves to the completely new situations.

Industrial robots spot weld automobile bodies on an assembly line.

Robots offer specific benefits to workers, industries and countries. If introduced properly, industrial robots can improve the quality of life by freeing workers from dirty, boring, dangerous and heavy labor. It is true that robots can cause unemployment by replacing human workers but robots also create jobs: robot technicians, salesmen, engineers, programmers and supervisors. The benefits of robots to industry include improved management control and productivity and consistently high quality products. Industrial robots can work tirelessly night and day on an assembly line without a loss in performance. Consequently, they can greatly reduce the costs of manufactured goods. As a result of these industrial benefits, countries that effectively use robots in their industries will have an economic advantage on world market.

Information from Renato M.E. Sabbatini, PhD

History and Uses of Robots, ALT Three: Handout Two

History of Robotics Rubric

	Beginning 0	**Developing 1**	**Accomplished 2**	**Exemplary 3**	**Score**
Organization	-No topic sentence -Several unrelated ideas -No ending -No sense of audience or purpose	-Weak topic sentence -Some unrelated ideas -Weak ending -Weak sense of audience or purpose	-Adequate topic sentence -Most ideas related to topic -Good ending -Some sense of audience and purpose	-States topic clearly -All ideas relate to topic -Contains clear ending -Considers audience and purpose	
Development	-No details to support topic -Lacks clear organization and pattern -Details not in order -No mention of information from internet, book, or magazine research	-Few details to support topic -Has some organization and pattern -Few details are mentioned from internet, book, or magazine research	-Some specific details to support topic -Rarely strays from order and pattern -Some specific details are mentioned from internet, book, or magazine research	-Many specific details to support topic -Follows logical order -Follows a consistent pattern of organization -Many specific details are mentioned from internet, book, or magazine research	
Structure	-No sentence variety -Many awkward sentences -Frequent fragments and run-ons -Lack of consistent point of view	-Limited sentence variety -Some awkward sentences -Some fragments and run-ons -Some shifts in point of view	-Some variety of sentences -Occasional awkward structure -Few fragments and run-ons -Few shifts in point of view	-Uses complete sentences -Uses great variety of sentence structure -Keeps the same point of view	
Mechanics	-Numerous errors	-Some errors in mechanics, grammar, and/or spelling.	-Generally uses mechanics, grammar, and spelling correctly	-Consistently uses mechanics, grammar, and spelling correctly	

Written by Toye and Williams. Last updated 06/29/01.

Section Two: Components of Robots

ALT One: Physics and Robotics (Science)

Summary
Students will demonstrate an understanding of the relationship among the following terms: mass, force, work, power, torque, and energy, and how they relate to robotics.

Competencies
Upon completion of this lesson, students will be able to:
1. Differentiate between mass and weight, work and power.
2. Apply knowledge of vocabulary terms (mass, force, work, power, torque, and energy) to robots.
3. Physically demonstrate an example of a given vocabulary term.
4. Propose a relationship among the above terms.

Time
Approximately three hours

Materials
Photocopies of ALT One: Handouts One through Six, found on the following pages.

Instructions
1. Divide the class into 6 groups. Assign each group a topic (mass, torque, power, energy, work, force) to work with. Give each group a different sheet to read and discuss. Groups should make notes of the main idea and important details, and answer questions. Groups will select a spokesperson to relay their findings to the rest of the class.
2. As the spokespersons discuss their topics, the rest of the groups should make note of the important things mentioned. (Total notes: 6 sections.)
3. Discuss, as a class, the total findings of all groups. Make connections between terms and make a diagram detailing those connections.
4. Students should then discuss with their group members how the vocabulary terms relate to the field of robotics. (Recall video from previous day.) Each student should then write a paragraph discussing this relationship.

Evaluation/Assessment of Student's Competency
Each group's grade will be based on several factors, as detailed in the Physics and Robotics Rubric found on ALT One: Handout Seven.

Closure
Discuss the following activity, in which students will be asked to use the scientific method to design their own robot. They should keep in mind factors affecting the ability of their robots to function well, for example how would mass affect the power?

Components of Robots, ALT One: Handout One

What is Mass?

Generally, **mass is defined as the measure of how much matter an object or body contains** -- the total number of subatomic particles (electrons, protons and neutrons) in the object. If you multiply your mass by the pull of Earth's gravity, you get your weight. So if your body weight is fluctuating, by eating or exercising, it is actually the number of atoms that is changing. The SI unit of mass is the gram (g) or kilogram (kg).

Common Units of Mass

SI:
Gram (g)
1 g = 0.001 kg
Kilogram (kg)
1 kg = 2.2 lbm
1 kg = 0.0685 slug

It is important to understand that mass is independent of your position in space. Your body's mass on the moon is the same as its mass on the earth, because the number of atoms is the same. The earth's gravitational pull, on the other hand, decreases as you move farther away from the earth. Therefore, you can lose weight by changing your elevation, but your mass remains the same. You can also lose weight by living on the moon, but again your mass is the same. Your mass on earth is 50 kilograms. What is your mass on the moon?

Answer: ___________________ **Why??** ____

Mass is important for calculating how fast things accelerate when we apply a force to them. What determines how fast a car can accelerate? You probably know that your car accelerates slower if it has five adults in it. **Why?**

____

Questions to answer with your group: (Be ready to discuss!)

1. How does the mass of a robot affect the amount of power a robot would need?

2. How does the mass of a robot affect the amount of force needed to move it? To move or pick up another object?

3. Think of a very simple demonstration of mass that you can do using just the things you have with you today. You will be asked to show your demonstration to the class during the class discussion.

Information taken from www.howstuffworks.com

Components of Robots, ALT One: Handout Two

What is Force?

One type of **force** that everyone is familiar with is weight. This is the amount of force that the earth exerts on you. There are two interesting things about this force:

- It pulls you down, or, more exactly, towards the center of the earth.
- It is proportional to your mass. If you have more mass, the earth exerts a greater force on you.

Common Units of Force
SI:
newton (N)
1 N = 0.225 lb
English:
Pound (lb)
1 lb = 4.448 N

When you step on the bathroom scale, you exert a force on the scale. The force you apply to the scale compresses a spring, which moves the needle. When you throw a baseball, you apply a force to the ball, which makes it speed up. An airplane engine creates a force, which pushes the plane through the air. A car's tires exert a force on the ground, which pushes the car along.

Force causes **acceleration**. If you apply a force to a toy car (for example, by pushing on it with your hand), it will start to move. This may sound simple, but it is a very important fact. The movement of the car is governed by **Isaac Newton's Second Law**, which forms the foundation for classical mechanics. Newton's Second Law states that the *acceleration (a) of an object is directly proportional to the force (F) applied, and inversely proportional to the object's mass (m)*. That is, the more force you apply to an object, the greater the rate of acceleration; and the more mass the object has, the lower the rate of acceleration. Newton's second law is usually summarized in equation form:

a = F/m, or F = ma

To honor Newton's achievement, the standard unit of force in the SI system was named the **newton**. One newton (N) of force is enough to accelerate one kilogram (kg) of mass at a rate of 1 meter per second squared (m/s^2). In fact, this is really how force and mass are defined. A **kilogram** is the amount of weight at which 1 N of force will accelerate at a rate of 1 m/s^2.

The Earth exerts enough force to accelerate objects that are dropped at a rate of 9.8 m/s^2. If you drop something off a cliff, for each second it falls it will speed up by 9.8 m/s. So, if it falls for five seconds, it will reach a speed of 49 m/s. This is a pretty fast rate of acceleration. **If a car accelerated this fast, it would reach 60 mph in less than three seconds**! That's some force!

Questions to answer with your group: (Be ready to discuss!)

1. How would the amount of force needed to accelerate your robot be affected by its mass?

2. How does Newton's Second Law apply to the field of robotics? (Be specific!)

3. Think of a very simple demonstration of force that you can do using just the things you have with you today. You will be asked to show your demonstration to the class during class discussion.

Information taken from www.howstuffworks.com

Components of Robots, ALT One: Handout Three

What is Torque?

Torque is a force that tends to rotate or turn things. You generate torque any time you apply a force using a wrench. Tightening the lug nuts on your wheels is a good example. When you use a wrench, you apply a force to the handle. This force creates a torque on the lug nut, which turns the lug nut. The SI unit of torque is the Newton-meter. Notice that the torque units contain a distance (meter) and a force (Newton). To calculate the torque, you just multiply the force by the distance from the center. In the case of the lug nuts, if the wrench is 0.3 m long, and you put 50 N of force on it, you are generating 15 Newton-meters of torque (50 N x 0.3 m = 15 Nm). If you use a 0.6 m long wrench, you only need to put 25 Newtons of force on it to generate the same torque (25 N x 0.6 m = 15 Nm). A car engine creates torque, and uses it to spin the crankshaft. This torque is created exactly the same way; a force is applied at a distance.

If you have ever tried to loosen really tight lug nuts on your car, you know a good way to make a lot of torque is to position the wrench so that it is horizontal, and then stand on the end of the wrench. This way you are applying all of your weight at a distance equal to the length of the wrench. If you were to position the wrench with the handle pointing straight up, and then stand on the top of the handle (assuming you could keep your balance), you would have no chance of loosening the lug nut. You might as well stand directly on the lug nut.

> **Common Units of Torque**
> **SI:**
> Newton meter (Nm)
> 1 Nm = 0.737 ft lb

Questions to answer with your group: (Be ready to discuss!)

1. How would the size of the gears change the torque needed to turn them?

2. What gear combination would require the most force (torque) to turn them? Which combination would require the least?

3. How does the gear combination affect the amount of power needed for your robot?

4. Think of a very simple demonstration of torque that you can do using just the things you have with you today. You will be asked to show your demonstration to the class during the class discussion.

Information taken from www.howstuffworks.com

Components of Robots, ALT One: Handout Four

What is Work?

The work we are talking about here is work in the physics sense. Not home work, or chores, or your job or any other type of work. It is good old mechanical work.

Work is simply the application of a force over a distance, with one catch -- the distance only counts if it is in the direction of the force you apply. Work = Force x distance, but the motion has to be in the same direction as they force. Lifting a weight from the ground and putting it on a shelf is a good example of work. The force is equal to the weight of the object, and the distance is equal to the height of the shelf. If the weight were in another room, and you had to pick it up and walk across the room before you put it on the shelf, you didn't do any more work than if the weight were sitting on the ground directly beneath the shelf. It may have felt like you did more work, but while you were walking with the weight you moved horizontally, while the force from the weight was vertical.

Your car also does work. When it is moving it has to apply a force to counter the forces of friction and aerodynamic drag. If it drives up a hill, it does the same kind of work that you do when lifting a weight. When it drives back down the hill, however, it gets back the work it did. The hill helps the car move down.

Work is energy that has been used. When you do work, you use energy. But sometimes the energy you use can be recovered. When the car drives up the hill, the work it does to get to the top helps it get back down. Work and energy are closely related. The units of work are the same as the units of energy, which we will discuss later.

Questions to answer with your group: (Be ready to discuss!)

1. How does work relate to energy?

2. What kind of tasks could a robot do that require it to do work?

3. Where does a robot get the energy to do work?

4. How does work relate to power?

5. Think of a very simple demonstration of work that you can do using just the things you have with you today. You will be asked to show your demonstration to the class during the class discussion.

Information taken from www.howstuffworks.com

Components of Robots, ALT One: Handout Five

What is Power?

Power is a measure of how fast work can be done. Using a lever, you may be able to generate 200 N-m of torque. But could you spin that lever around 3,000 times per minute? That is exactly what your car engine does!

Common Units of Power
SI:
Watts (W)
1000 W = 1 kW
Kilowatt (kW)
1 kW = 1.341 hp
English
Horsepower (hp)
1 hp = 0.746 kW

The SI unit for power is the **watt**. A watt breaks down into other units that we have already talked about. One watt is equal to one Newton-meter per second (N-m/s). You can multiply the amount of torque in Newton-meters by the rotational speed in order to find the power in watts. Another way to look at power is as a unit of speed (m/s) combined with a unit of force (N). If you were pushing on something with a force of 1 N, and it moved at a speed of 1 m/s, your power output would be 1 watt.

An interesting way to figure out how much power you can output is to see how fast you can run up a flight of stairs.

1. Measure the height of a set of stairs that takes you up about three stories.
2. Time yourself while you run up the stairs as quickly as possible.
3. Divide the height of the stairs by the time it took you to ascend them. This will give you your speed.

For instance, if it took you 15 seconds to run up 10 meters, then your speed was 0.66 m/s (only your speed in the vertical direction is important). Now you need to figure out how much force you exerted over those 10 meters, and since the only thing you hauled up the stairs was yourself, this force is equal to your weight. To get the amount of power you output, multiply your weight by your speed. Do a sample problem now: solve for the power if the speed you were able to travel up the stairs was 0.50m/s, and your weight (force) is 125 pounds.

Answer: ____ (show work!)

power (W) = (height of stairs (m) / Time to climb (s)) * weight (N)

Questions to answer with your group: (Be ready to discuss!)

1. How does power relate to the torque of your robot?

2. How does power relate to force?

3. How does power relate to the mass of your robot?

4. How could you find the power output of your robot?

5. Think of a very simple demonstration of power that you can do using just the things you have with you today. You will be asked to show your demonstration to the class during the class discussion.

Information taken from www.howstuffworks.com

Components of Robots, ALT One: Handout Six

What is Energy?

Energy is the final chapter in our terminology saga. We'll need everything we've learned up to this point to explain energy.

If power is like the strength of a weightlifter, energy is like his endurance. **Energy is a measure of how long we can sustain the output of power, or how much work we can do**; power is the rate at which we do the work. One common unit of energy is the kilowatt-hour (kW-hr). A kW is a unit of power. If we are using one kW of power, a kW-hr of energy will last one hour. If we use 10 kW of power, we will use up the kW-hr in just six minutes.

> **Common Units of Energy**
>
> **SI:**
> Newton meter (Nm)
> 1 Nm = 1 J
> 1 J = 0.239 cal
> 1 cal = 4.184 J
> 1 Wh = 3,600 J
> 1 kWh = 1000 Wh
> 1 kWh = 3,600,000 J

There are two kinds of energy: **potential** and **kinetic**.

Potential Energy

Potential energy is waiting to be converted into power. Gasoline in a fuel tank, food in your stomach, a compressed spring, and a weight hanging from a tree are all examples of potential energy. The human body is a type of energy conversion device. It converts food into power, which can be used to do work. A car engine converts gasoline into power, which can also be used to do work. A pendulum clock is a device that uses the energy stored in hanging weights to do work.

When you lift an object higher, it gains potential energy. The higher you lift it, and the heavier it is, the more energy it gains. For example, if you lift a bowling ball one inch, and drop it on the roof of your car, it won't do much damage (please, don't try this). But if you lift the ball 100 feet and drop it on your car, it will put a huge dent in the roof. The same ball dropped from a higher height has much more energy. So, by increasing the height of an object, you increase its potential energy.

The formula to calculate the potential energy (PE) you gain when you increase your height is: **PE = Force * Distance**

Kinetic Energy

Kinetic energy is energy of motion. Objects that are moving, such as a rollercoaster, have kinetic energy (KE). If a car crashes into a wall at 5 mph, it shouldn't do much damage to the car. But if it hits the wall at 40 mph, the car will most likely be totaled.

Kinetic energy is similar to potential energy. The more the object weighs, and the faster it is moving, the more kinetic energy it has. The formula for KE is: **KE = 1/2 m** $\mathbf{v^2}$, where **m** is the mass and **v** is the velocity.

One of the interesting things about kinetic energy is that it increases with the velocity squared. This means that if a car is going twice as fast, it has four times the energy. You may have noticed that your car accelerates much faster from 0 mph to 20 mph than it does from 40 mph to 60 mph.

Questions to answer with your group: (Be ready to discuss!)

1. How does energy relate to the tasks you want your robot to do?

2. When does your robot need the most power?

3. Where is the potential energy of your robot? Where is the kinetic energy?

4. Think of a very simple demonstration of energy that you can do using just the things you have with you today. You will be asked to show your demonstration to the class during the class discussion.

Information taken from www.howstuffworks.com

Components of Robots, ALT One: Handout Seven

Physics and Robotics Rubric

	Beginning 0	**Developing 1**	**Accomplished 2**	**Exemplary 3**	**Score**
Working as a part of a group	Student does not attempt to be a part of the group, and/or hinders progress	Student does attempt to be a part of the group, but is not an active member	Student is an active part of the group, and fulfills given role	Student is an active part of the group, fulfills given role, and provides leadership	
Note taking	Student does not take any notes	Student does not take notes for each speaker, and/or notes are sloppy and incoherent	Student takes detailed notes for each speaker, but notes lack some coherence	Student takes very detailed notes for each speaker, and the notes are neat and coherent	
Diagram	Student does not make a diagram	Student attempts to make a diagram, but connections among terms are missing and/or diagram is not neat	Student makes a neat diagram with few connections among terms missing	Student makes a high quality diagram with no connections among terms missing	
Paragraph	Student does not write a paragraph	Student attempts to write a paragraph, but lacks coherence	Student writes a paragraph that attempts to find relationships between vocabulary terms and robotics	Student writes a coherent paragraph that shows clear relationships between vocabulary terms and robotics	

Section Two: Components of Robots

ALT Two: Robot Programming (Math)

Summary

Students will be shown the need for robots to have some kind of sensor(s) to help them perform most tasks. Students will be introduced to the different kinds of robot sensors that are generally used. Students will also learn to use distance formulas and ratios, instead of a sensor, to be able to tell a robot how far to move.

Competencies

Upon completion of this lesson, students will be able to:

1. Identify different robot sensors, and what they do.
2. Manipulate distance formulas to find rate, time, and distance of a moving object.
3. Use distance formulas and rates to find the time it takes a robot to move a certain distance.

Time

Approximately six hours

Materials

- Teacher example of a Lego® MindStorms robot
- An obstacle course for the MindStorms robot
- A stop watch or watch with a second hand
- A measuring tape
- Student activity worksheet
- Rubric

Instructions

1. Set up the obstacle course for the MindStorms robot, and tell the class what the robot needs to do on the course. (An example of a possible obstacle course is on handout one of this ALT.)
2. Have the class give you directions on what they want the robot to do.
3. The teacher will then manually move the robot through the maze following the students' directions exactly.
4. Ask the class, "How will the robot know when to perform the command?"
5. Explain to the students that the robot must have some kind of sensor to know when to perform each command. Discuss what a sensor is and if humans have sensors, too. What does a sensor do? (Senses changes in its environment.)

6. Describe to the students the different kinds of sensors and what they do:
   - Touch
   - Light/Color
   - Temperature
   - Sound
7. Have each student write directions for the obstacle again, this time, incorporating sensors. The students must include 3 out of the four sensors described in class, and how they would be used to control the robot.
8. Explain to the class that another way to direct the robot, would be to tell it to go a certain distance before it performs a command, (ex: go three feet, then turn 45 degrees to the right.). Also explain that we would further need to know how long it would take the robot to go a certain distance.
9. Show the class the formula: Rate * Time = Distance. Explain how to solve the formula for a missing value when the other two are known.
10. Using the teacher's example MindStorms robot, record how long it takes the robot to go a certain distance. Put the values into the formula to find the robot's rate. Use that rate to find how long it would take that robot a different distance. (You could also write the rate as a ratio, write an equivalent fraction, and cross multiply.)
11. Have the students complete the problem solving worksheet using the distance formula.

Evaluation/Assessment of Student's Competency

Student's assessment for the obstacle directions, (step 6) will be based criteria found in the rubric that is on student handout three. Student assessment for the problem solving worksheet is explained, by a breakdown of the points possible for each problem, on the handout.

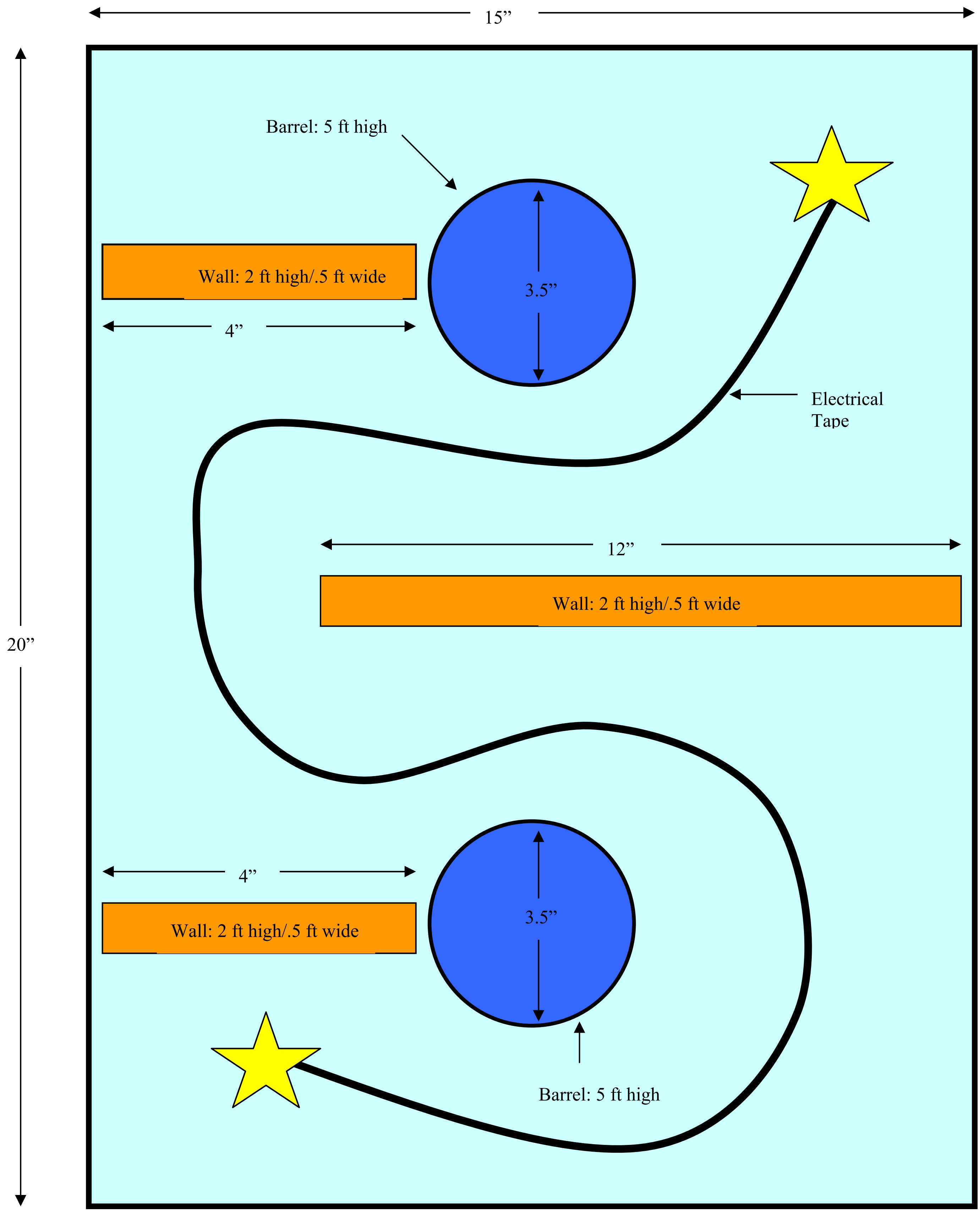
Closure

Discuss with students how the power of a robot relates to the rate it travels. Talk about whether changing the gear combination but keeping the same power will then alter the rate it travels. How does this work?

Components of Robots, ALT Two: Handout Two

Example Obstacle Course

This is just an example course and can be modified to your class' specific needs.



Components of Robots, ALT Two: Handout Two

Distance/Rate Problem Solving

Rate * Time = Distance

R * T = D

For each example, use the distance formula above to solve for the missing value. (One pt. for substituting in the correct numbers, and one pt. for solving correctly.)

1. R = 5 km/hr
   T = 12 hr
   D = ? km

2. R = ? ft/sec.
   T = 18 sec.
   D = 90 ft

3. R = 27 m/min.
   T = ? min.
   D = 432 m

2. R = ? mi/hr
   T = 3 hr
   D = 200 mi

1. R = 650 mi/hr
   T = 3 hr
   D = ? mi

3. R = 98 in/sec.
   T = ? sec.
   D = 9800 in.

Use the distance formula to help you solve each problem. For each problem, make sure to write out the distance formula and show all the steps needed to solve the problem.

7. A robot needs to stop one foot in front of a wall that is 5 feet away. How many seconds must the robot be going forward before it must stop, if it is moving at a rate of .2 ft/sec.?

8. How far can a robot travel if it is moving at a rate of 4ft/min. and is running for 10 minutes?

9. Our robot needs to be programmed to complete an obstacle course in less than 8 minutes. What is the minimum speed the robot can travel if the course is a total of 56 feet long?

10. Our robot needs to go forward ten feet, stop, turn 180 degrees, and return from its starting place. If it's rate is 2 ft/sec., and it takes one second to stop and 3 seconds to turn around, how long will the task take?

Components of Robots, ALT Two: Handout Two (Answer Key)

Distance/Rate Problem Solving

Rate * Time = Distance

R * T = D

For each example, use the distance formula above to solve for the missing value. (One point for substituting in the correct numbers, and one point for solving correctly.)

1. R * T = D
   5 * 12 = D
   60 = D
   Distance is 60 km.

2. R * T = D
   R * 18 = 90
   R = 90/18
   R = 5
   Rate is 5 ft/sec.

3. R * T = D
   27 * T = 432
   T = 432/27
   T = 16
   Time is 16 min.

4. R * T = D
   R * 3 = 200
   R = 200/3
   R = 6.67
   Rate is 6.67 mi/hr.

5. R * T = D
   650 * 3 = D
   1950 = D
   Distance is 1950 mi.

6. R * T = D
   98 * T = 9800
   T = 9800/98
   T = 100
   Time is 100 sec.

Use the distance formula to help you solve each problem. For each problem, make sure to write out the distance formula and show all the steps needed to solve the problem. Be sure to answer your questions in complete sentences. (One point for substituting in the correct numbers, one point for solving the equation correctly, and one point for the correct final answer.)

7. R * T = D
   .2 * T = 4
   T = 4/.2
   T = 20
   The robot would need to travel for 20 seconds before stopping.

8. R * T = D
   4 * 10 = D
   40 = D
   The robot could travel 40 feet.

9. R * T = D
   R * 8 = 56
   R = 56/8
   R = 7
   The robot must travel 7 ft/min.

10. R * T = D
    2 * 10 = D
    20 = D
    20 + 3 + 1 = 24
    The task will take 24 seconds.

Components of Robots, ALT Two: Handout Three

Obstacle Instructions Rubric

	Beginning 4	Developing 6	Accomplished 8	Exemplary 10	Score
Written Directions	-Many steps were omitted -Did not include any sensors	-Some steps omitted -Only included one or two kinds of sensors	-Included the necessary steps -Included three different kinds of sensors	-Included the necessary steps -Directions were very clear and descriptive -Included four different types of sensors	

Written by Toye and Williams. Last updated 06/29/01.

Section Two: Components of Robots

ALT Three: Critical Thinking: What Makes a "Good" Robot? (LA)

Summary
Students will use knowledge of robotic components, as discussed in Section One, ALT 1, to write a detailed description of the robot they want to design.

Competencies
Upon completion of this lesson, students will be able to:
1. Explain clearly what components are found in "good," robots- ones that do the programmed job well.
2. Begin a design for a robot using known components, whose goal is to accomplish a certain task, to be specified by the student.

Time
Approximately three hours, including revision and rewrite

Materials
Student- made brainstorming web, to be used for prewriting

Instructions
1. Discuss as a class the characteristics that make a robot have a good or bad design. (See Teacher Information Sheet for details.)
2. Students should make a prewriting web, visually showing their ideas. The teacher must approve students' webs before they continue.
3. Students should then move on to the writing portion. One paragraph should be made for each of the following:
    - Discuss various components and give examples of what can be accomplished with those components. What classifies a robot as a "good" one?
    - Tell what task you want your robot to be able to do, and what components need to be included in order to meet that goal. Briefly describe some of the features you want your robot to have (how large, what shape, what manner of locomotion). Describe the amount of power, torque, and energy your robot will need.

Evaluation/Assessment of Student's Competency
Both paragraphs will be assessed using the rubric with this lesson.

Closure
Discuss the importance of making a plan before beginning something. Connect this idea to the design of their robot, and stress the significance of evaluating the final result as well.

Components of Robots, ALT Three: Handout One

What Makes a "Good" Robot" Rubric

	Beginning 0	Developing 1	Accomplished 2	Exemplary 3	Score
Organization	-No topic sentence -Several unrelated ideas -No ending -No sense of audience or purpose	-Weak topic sentence -Some unrelated ideas -Weak ending -Weak sense of audience or purpose	-Adequate topic sentence -Most ideas related to topic -Good ending -Some sense of audience and purpose	-States topic clearly -All ideas relate to topic -Contains clear ending -Considers audience and purpose	
Development	-No details to support topic -Lacks clear organization and pattern -Details not in order	-Few details to support topic -Has some organization and pattern	-Some specific details to support topic -Rarely strays from order and pattern	-Many specific details to support topic -Follows logical order -Follows a consistent pattern of organization	
Structure	-No sentence variety -Many awkward sentences -Frequent fragments and run-ons -Lack of consistent point of view	-Limited sentence variety -Some awkward sentences -Some fragments and run-ons -Some shifts in point of view	-Some variety of sentences -Occasional awkward structure -Few fragments and run-ons -Few shifts in point of view	-Uses complete sentences -Uses great variety of sentence structure -Keeps the same point of view	
Mechanics	-Numerous errors	-Some errors in mechanics, grammar, and/or spelling.	-Generally uses mechanics, grammar, and spelling correctly	-Consistently uses mechanics, grammar, and spelling correctly	

Written by Toye and Williams. Last updated 06/29/01.

Components of Robots, ALT Three: Teacher Information Sheet

‘Good’ Versus ‘Bad’ Robot Design
Ideas for ‘good’ design

+ Interchangeable attachments • faster response time + User-friendly • controls • gives feedback • orientation (inside/outside) + Artificial Intelligence (AI) • one command does many functions + Modular • can add parts as you go, so it doesn’t get outdated + Reliable + Task-appropriate + Efficient • power • time • programming	+ Locomotion • terrain appropriate + Type of interface • robot-robot • human-robot • machine-robot + External appearance • does it have “look good” for the user? + Gear usage/ratio + Waterproof, if needed + Way to sense that object to be picked up is in range + Size is appropriate + Power is in areas that need it

Section Three: Design of Robots

ALT One: Robot designing using the Scientific Method (Science)

Summary
Students will apply knowledge of the process of the scientific method as they design a new type of robot, using writing done in language arts class as the basis for their design.

Competencies
Upon completion of this lesson, students will be able to:
1. Understand the five steps in the Scientific Method, as it relates to designing and testing models of robots.
2. Make conclusions and alterations to their model, based on data.

Time
Approximately three hours

Materials
Photocopies of ALT 1: Handouts One and Two, found on the following pages.

Instructions
1. Introduce the Scientific Method, using a simple example.
2. Give students copies of the handout on the following page (Scientific Method).
3. Divide class into groups of six, if possible, and these will be the robot building 'teams.' Each team will be responsible for coming up with a design for a working robot.
4. Student teams will use the first three steps of the Scientific Method to make notes of what task they want their robot to do, components their robot needs to have, and how they want it to look. They will then take the notes and put them into paragraph form.

Evaluation/Assessment of Student's Competency
Assessment will be based on groups' adherence to the steps of the Scientific Method. (See rubric found on ALT One: Handout Two.)

Closure
Talk about using the last two steps of the Scientific Method during the transfer activity. These last two steps will be used when students actually build and program a robot. Discuss with students the importance of strictly adhering to the steps of the Scientific Method throughout the transfer activity, as it is a tool that will make this experimentation process easier.

Design of Robots, ALT One: Handout One

The Scientific Method

Step 1: State the problem	You cannot solve a problem until you know exactly what it is. My problem is: I need to build a robot to accomplish my task. What does the robot need to be able to do?
Step 2: Research the problem	What will it take to solve my problem? What do I know, and need to know, about my problem? To solve my problem, I need to know how to build and program a robot. -Examine the possibilities -Eliminate poor choices -Consider likely choices
Step 3: Form a hypothesis	A hypothesis is a possible solution to my problem. Remember: the simplest solution is often the best solution! Based on my research, I will build and program a robot that can (State goals…what task will be done?)
Step 4: Test the hypothesis	Perform an experiment to see if your hypothesis is a valid one. Program your robot and try it!
Step 5: Draw conclusions from the data	Data are the results of an experiment. In its simplest form, there are only two possibilities: (1) If your hypothesis was correct, you now have a successful robot. PROBLEM SOLVED! (2) If your hypothesis was incorrect, the experiment failed. DON'T GIVE UP! DO MORE RESEARCH! -What was wrong with your original hypothesis? -Was the robot built to do the job? -Was your experiment flawed? -Form another hypothesis based on more research. -Test your new hypothesis.

Continue this process until the problem is solved!

Design of Robots, ALT One: Handout Two

Robot Design/Scientific Method Rubric

	Beginning 0	**Developing 1**	**Accomplished 2**	**Exemplary 3**	**Score**
Designing the Experiment	Fails to develop any type of plan	Design allows comparison of variables to standard	Design allows comparison of variables, but lacks sufficient number of tests to obtain meaningful data	Design allows comparison of variables and indicates sufficient number of tests to obtain meaningful data	
Collecting and Reporting Data	Fails to collect any data	Describes observations in rambling discourse	Makes a meaningful table, but fails to record the observations or records them inaccurately	Makes a meaningful table and records the data accurately and neatly	
Drawing Conclusions	Fails to reach a conclusion	Draws a conclusion that is not supported by the data	Draws a conclusion that is supported by the data, but fails to show the support for the conclusion	Draws a conclusion that is supported by the data, and gives supporting evidence for the conclusion	

Written by Toye and Williams. Last updated 06/29/01.

Section Three: Design of Robots

ALT Two: Robot Design Sketch (Math)

Summary
Students will make a drawing of their robot using concepts of proportion and scale.

Competencies
Upon completion of this lesson, students will be able to:
1. Draw a scale design of a robot using the concept of proportions.

Time
Approximately five hours

Materials
Pencil, paper, rulers, protractor, compass, rubric

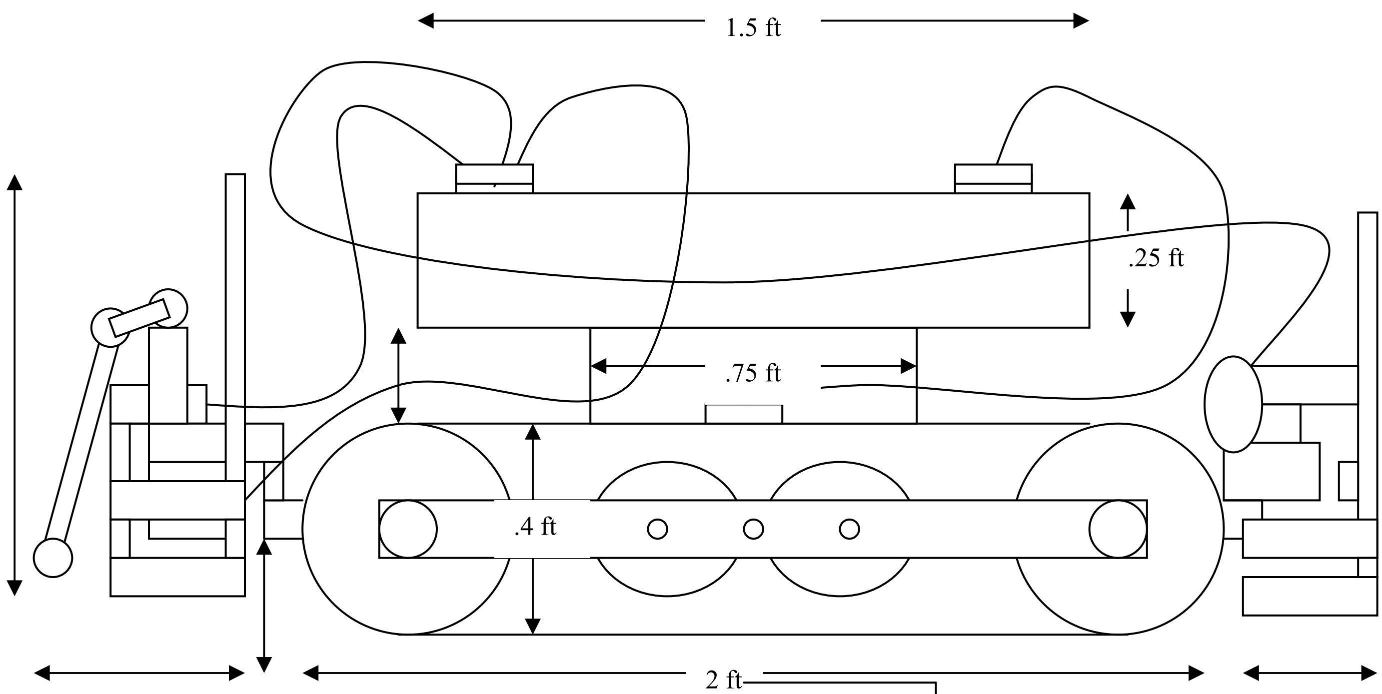
Instructions
1. Have students draw a model of their robot, including the actual (life-size) measurements that are desired. The drawing can include more than one view of the robot, (ex: front, back, and side).
2. Based on the actual measurements, students are to find the scale measurements using proportions.
   - Students will pick a ratio to use to convert the life-size measures to the scale measures. The ratio will then be used to write a proportion to find the scale measures. (There is a teacher example of this initial drawing and measurements on handout two of this lesson.)
3. Lastly, students will make a second drawing, this time drawing it using rulers and the scale measures they found.

Evaluation/Assessment of Student's Competency
Student's assessment will be based criteria found in the rubric that is on the student handouts.

Closure
Share with students the goal of the transfer activity. Let them know that they will need to be able to take their knowledge of robot construction and put it into use as they build and program a real, working, Lego® robot.

Design of Robots, ALT Two: Handout Two

Teacher Example of Initial Robot Drawing



Ratio: 2 in = 1 ft

$$\frac{2\text{ in}}{1\text{ ft}} = \frac{X\text{ in}}{2\text{ ft}}$$

$X = 4$ in

1. A ratio for the desired scale of the drawing is picked.

2. That ratio is then used to write a proportion for the parts of the drawing. By cross multiplying to solve, we see that a part of our real robot that we want to be 2 ft long needs to be drawn 4 in long. This should be done for all of the measurements of the robot.

3. Next, a final drawing should be made: this time using the scale measurements you just found, and a ruler.

* **Note:** in the above drawing, not all needed measures have been included.

Design of Robots, ALT Two: Handout One

Robot Design Sketch Rubric

	Beginning 0	**Developing 1**	**Accomplished 2**	**Exemplary 3**	**Score**
Initial Sketch	-sketch is sloppy -includes only a few of the life-size measures that are needed	-sketch is fairly neat -includes most life-size measurements that are needed	-sketch is neatly drawn -includes at least one view -includes all life-size measures that are needed	-sketch is drawn neatly -includes more than one view -includes all life-size measures	
Scale Measurements	-correctly wrote a proportion comparing one life-size measure with one scale measure -used proportions to find few of the scale measures for of the drawing	-correctly wrote a proportion comparing one life-size measure with one scale measure -used proportions to find scale measures for some of the drawing	-correctly wrote a proportion comparing one life-size measure with one scale measure -used proportions to find scale measures for most of the drawing	-correctly wrote a proportion comparing one life-size measure with one scale measure -used proportions to find scale measures for all of the drawing	
Scale Drawing	-drawing is sloppy -includes few needed measures -parts of the design are not drawn to scale	-drawing is fairly neat -includes most needed measurements -some parts of the design are drawn to scale	-drawing is neat -includes all needed measurements -most parts of the design are drawn to scale	-drawing is very neat -includes all need measures -all parts of the design are drawn to scale	

Section Three: Design of Robots

ALT Three: Was your Robot a "Good" Robot? (Language Arts)

Summary

Students will evaluate, through writing, the design of their robots.

Competencies

Upon completion of this lesson, students will be able to:

1. Draw conclusions about what robotic components are useful in certain situations, and which are not.
2. Evaluate the effectiveness of their design.

Time

Approximately five hours, including rewrite and revision

Materials

1. Scientific method data sheet from science class, showing the steps gone through when designing the robots.
2. Paper and writing utensil

Instructions

1. Ask students to think about the design of their robot. Have students write a paragraph discussing three good points and three not-so-good points of their design.
2. Have students write a paragraph that discusses what parts enabled them to achieve the task they set for the robot, or what parts hindered them from doing so.
3. Students will write a third paragraph discussing what, if anything, would they change about the design to be more efficient.

Evaluation/Assessment of Student's Competency

The three written paragraphs will be assessed using the rubric for this lesson.

Closure

Discuss with students the importance of a good design, and orally recall the robot components and their functions. Let them know that this knowledge will be invaluable to them as they move into the final (transfer) activity.

Design of Robots, ALT Three: Handout One

Was your Robot a "Good" Robot? Rubric

	Beginning 0	**Developing 1**	**Accomplished 2**	**Exemplary 3**	**Score**
Organization	-No topic sentence -Several unrelated ideas -No ending -No sense of audience or purpose	-Weak topic sentence -Some unrelated ideas -Weak ending -Weak sense of audience or purpose	-Adequate topic sentence -Most ideas related to topic -Good ending -Some sense of audience and purpose	-States topic clearly -All ideas relate to topic -Contains clear ending -Considers audience and purpose	
Development	-No details to support topic -Lacks clear organization and pattern -Details not in order	-Few details to support topic -Has some organization and pattern	-Some specific details to support topic -Rarely strays from order and pattern	-Many specific details to support topic -Follows logical order -Follows a consistent pattern of organization	
Structure	-No sentence variety -Many awkward sentences -Frequent fragments and run-ons -Lack of consistent point of view	-Limited sentence variety -Some awkward sentences -Some fragments and run-ons -Some shifts in point of view	-Some variety of sentences -Occasional awkward structure -Few fragments and run-ons -Few shifts in point of view	-Uses complete sentences -Uses great variety of sentence structure -Keeps the same point of view	
Mechanics	-Numerous errors	-Some errors in mechanics, grammar, and/or spelling.	-Generally uses mechanics, grammar, and spelling correctly	-Consistently uses mechanics, grammar, and spelling correctly	

Written by Toye and Williams. Last updated 06/29/01.

Transfer Activity

Upon conclusion of this unit, students should see how the things they have done connect to the real world. To extend this even further, teachers are invited to do the transfer activity that follows. As previously mentioned, the Lego® Company produces several types of robot kits, one of which is the MindStorms Invention System. This transfer activity involves the use of this product to expand upon the material learned throughout the unit.

First, students will actually build and program their own robot. (We recommend that students follow the tutorial that is included in the kit when building their robots.) It is through this exploration that the students will learn how to get their robots to perform certain tasks.

Teachers could then set up a series of challenges for the robots to complete. Teachers could then set up a series of challenges for the robots to complete. It is very important that students are only told information that is <u>critical</u> to the challenge; in other words, tell them as little as possible. Students learn best by experimenting and coming up with their own solutions to challenges, rather than being told flat-out how to accomplish the task at hand. They should be encouraged to experiment and make modifications as needed, and stress that it is NOT a competition- all who meet the challenge have been successful.

Lego® sponsors various competitions during the year, which are open to teams of students. Teams are comprised of one to ten students, and each team needs an adult sponsor. To get more information on these competitions, go to www.mindstorms.lego.com. These competitions foster teamwork, creative thinking, and enhances logic and sequencing.

Appendix One: Robot Resources

Internet resources

These sites contain excellent information, photos, and links to other sites. Some sites also contain short video clips, lesson plans, and ideas for tying robotics into your curriculum. (The last site listed is especially recommended.)

http://prime.jsc.nasa.gov/ROV/library.html
www.howstuffworks.com
www.kipr.org/curriculum/content.html
www.kipr.org/curriculum/curriculum_intro.html
http://tc.engr.wisc.edu/zwickel/Outreach/robotics.html
www.unt.edu/robotics/reference.htm
http://ranier.hq.nasa.gov/telerobotics_page/coolrobots.html
http://www.ai.mit.edu/projects/humanoid-robotics-group/cog/cog.html
http://avdil.gtri.gatech.edu/AUVS/IARCLaunchPoint.html
http://www.pbs.org/safarchive/4_class/45_pguides/pguide_705/4575_idx.html
http://cache.ucr.edu/~currie/roboadam.htm

Speaker/ Informational resources *

Erik Blasch, PhD, physics and robotics, WPAFB
Bruce Clough, Technical Area Leader (Air Vehicles/Flight Control), WPAFB
Jason Crum, Lego® MindStorms and Battlebots, WPAFB
Senior Master Sergeant Paul Hicks, demolition, WPAFB
Lt. Jason Lawson, robot competitions, WPAFB Air Force Research Lab
Connie Jensen, Lego® MindStorms and other information, Educational Outreach Office
Chief Master Sergeant Jeff Seeloff, demolition, WPAFB

*** To arrange for guest speakers, contact the WPAFB Educational Outreach Office at (937) 904-8622 and they will set everything up for you.**

Other resources

There are a number of videos on robotics for sale on the PBS and NOVA websites.

If your district has money available, there are wonderful robotic kits available for purchase. (Lego® MindStorms Invention System is an excellent example, but each kit costs around $200.) These would be great tools for students to use as they design their own robots.

There are mini grants available for the Mindstorms Invention System, which will make obtaining the robot kits more feasible. There are two websites you can visit to get all the information you need. Note that the deadlines for the second listed mini grant are as follows: (1) October 15, (2) February 15, and (3) June 15.

www.aiaa.org/education/index2.cfm?edu=19 ($200 maximum)
www.osgc.org/page/Minigrant.html ($1000 maximum)