Roaming Robotics

If you build it, they will come
Dance, dance robot
Go fetch, Rover
Go, go gadget arm

Students will be using Lego Mindstorm Kits to build and program their own robots! By the end of the week, students will have accomplished several tasks with their robots that mirror challenges faced by astronauts, surgeons, and members of the armed forces. Students will also be maintaining a website so they can share their robot knowledge with the world and have a lasting memento of their week.

Catharine Knapp
SPED 6402 Spring 2012
East Carolina University

CONTENT RESEARCH PAPER

People have had a love affair with robotics dating back almost as far as its origin. People are both fascinated with the idea of science fiction becoming a reality and intrigued by the practicality and promised ease of life associated with robots. While the concept of machinery working autonomously to benefit mankind dates back as far as Aristotle, robotics has recently blossomed into a technology of its own with implications in industry, military, medicine, and exploration.

Robotics has been commonly used in industry since the birth of the assembly line during the Industrial Revolution. Robots can do the menial tasks that people find boring, tiring, and monotonous without fear of being rundown, overworked, or injured. Robots can do the same task over and over again without error or injury, whereas a human worker might start making silly mistakes from being tired and overworked or suffer from work related injuries like carpal tunnel. Robots have made industry more efficient, leaving human workers to do more satisfying jobs. Robots can plug chips into circuit boards, weld car bodies on an assembly line, and paint stealth fighter planes more precisely and at faster speeds than any human worker (Baker, 2002). Not to mention, robotics has made its way into commercial fields to promote luxury and ease of life for consumers. The iRobot Roomba (Fig. 1) vacuums carpets and polishes hardwood floors with the push of a button, cars like the Lexus LS (Fig. 2) can park themselves and sense obstacles in their paths, and there is an array of robotic toys that can interact with children. This is a huge advancement from machines that can only perform one task. Robotic toys do not just make noises and move, they adapt from exchanges with their playmates; Furby (Fig. 3) can learn new words and will “chat” with other Furbies. With robots that respond to various stimuli already at work in numerous middle class homes, it makes the Jetsons's loveable maid Rosie (Fig. 4) closer to a reality than a science fiction cartoon character.

While everyone wants their own personal robot to do their chores for them, it is the military that has yielded the most reward from robotics. The military uses robots to accomplish tasks that are much too dangerous for human soldiers. The Army currently uses robotic ground systems that haul gear, remove obstacles from roads, navigate through rough terrain, and capture and transmit images of areas that are unsafe for human soldiers to occupy (CNN, 2012). Robots can be remotely controlled from a safe distance and have already been used to disable bombs. Self-automated robots can even be programmed to "sniff out" bombs and react accordingly. According to *CNN* (2012), Fido (Fig. 5) is the first robot with an explosives sensor that will help soldiers easily detect roadside bombs and land mines to prevent casualties. These robots will not only keep our soldiers safe, they can lessen the workload for soldiers and make up for any reduction in military workforce due to budget cuts. The Predator (Fig. 6) is the most famous unmanned military vehicle. While it was designed for stealth reconnaissance, it can be outfitted with weaponry like heat sensing missiles that makes war possible without sending troops overseas (Hooper, 2008).

Robotics has also made its way into the field of medicine. Biomedical engineers at Duke University have built a robot surgeon that can potentially operate on patients with little to no human guidance (Akasie, 2008). The robot features two robotic arms, cameras, 3D ultrasound scanners, and a "master-slave" option to provide remote access to surgeons (Fig. 7). While the robot originally was built to make routine surgery safer by providing surgeons with better imagery of muscles and tissue before the first incision, the robot can conceivably operate autonomously when human surgeons are unavailable, such as on the battlefield. It is the hope of biomedical engineers that surgeons will be able to operate a robotic system from remote locations, offering the potential to provide better access to expert medical care in remote areas and the developing world (Akasie, 2008). According to *Science Daily* (2012), robotics is already being commonly used in routine surgeries like prostate and eye surgery. Robotic surgeons have already successfully accomplished heart surgery without breaking the breastbone, making for a much speedier recovery for patients (Travis, 2008). Robotics is also being used to make prosthetics more lifelike. *Time Magazine* declared the bionic hand the best invention of 2008 (Fig. 8). The hand features motors in each finger which allows for improved range of motion, whereas traditional artificial hands are only capable of opening and closing (Travis, 2008). Doctors have also found a way to link human nerves to robotic electrodes so people using prosthetics can move the artificial limbs by thought much like they could before injury (Charleton, 2010). Indeed, the use of robotics has opened up a new field of medicine that will hopefully put an end to medical problems caused human error and provide a better way of life for patients.

While space may be the final frontier for mankind, robots have already been there and back. Robots were first sent into space to gather information about celestial bodies astronauts cannot reach, such as our neighboring planet Mars. Over time, robotics has proved to be invaluable to the NASA program: robots can perform tasks less expensively than astronauts, operate over long periods of time, and enter into perilous situations without fear or hesitation (Cowen, 2005). The majority of robotic missions into space have been labeled “suicide missions” because the robot is not retrieved after it completes its mission. This can certainly not be done with human astronauts. Robots are a clear choice for space missions because they do not require atmosphere, nutrients, rest, or gravity in order to function. In fact, many upcoming robot space missions cannot be successfully completed in a human lifespan, such as the exploration of Jupiter's moon Titan (Cowen, 2005). Robots have been used in space exploration to gather information in the form of images, fix broken machinery, and collect samples. Robots can also be sent into other risky locales, such as the bottom of the ocean and inside active volcanoes (Science Daily, 2012). The discovery of the sunken Titanic was only possible thanks to remotely guided robots (Baker, 2002). Since robots can venture into territories previously untouched by man, the implications of exploration are endless.

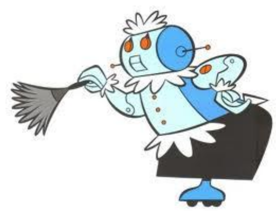
Robots have made their way into our culture by means of toys, movies, books, and television shows, but the field of robotics is opening up doors few people ever thought possible. Robotics has made industry more productive, the military safer, medicine more advanced, and exploration possible. With these advancements in technology in just the last few decades, robots can successfully run autonomously, respond to stimuli, and adapt to situations. As technology continues to develop, there is no telling what robots of the future can accomplish.

(Figure 1)

Roomba uses sensors to find dirt on floors and avoid obstacles. It can be used on carpet and hardwood floors. There is also a version that mops floors.

(Figure 2)
Lexus LS can park itself using cameras, sonar, and a built in computer.

(Figure 3)
Furby is a toy that became popular in the late 1990's. It is the first robot aimed for domestic use. While every Furby begins speaking "Furbish", it can learn new words through interaction.



(Figure 4)
Rosie is the robot maid from the animated Hanna-Barbera cartoon The Jetsons originally airing in 1962 and again from 1985-1987.

(Figure 5)
Fido detects explosives through use of a sensor and has a moveable arm that can disable bombs.

(Figure 6)

Predator is an unmanned reconnaissance plane used by United States military that has recently been modified to use laser guided missiles.

(Figure 7)
Robot surgeons are already being used in conjunction with human surgeons to make routine surgeries more precise and less invasive.

(Figure 8)
The bionic hand offers more movement capabilities to prosthetic users.

References

Akasie, J. (2008). A brave new world of medicine: Robotic surgery near reality. *Special to the Sun*. Retrieved from http://www.nysun.com/health-fitness/brave-new-world-of-medicine-robotic-surgery-nears/76630

Baker, C. (2002). Robots among us: The challenges & promises of robotics. Minneapolis, MN: Lerner publishing group.

Charleton, G. (2010). Bionic arm moved by thought. *Discovery News*. Retrieved from http://news.discovery.com/tech/bionic-arm-moved-by-thought.html

Cowen, R. (2005). Roving on the red planet. *Science News.* 167: 344–346.

Hooper, R. (2008-2012). Learn about robots. [Blog]. Retrieved from http://www.learnaboutrobots.com

Travis, C. (2007-2012). Robotics: The evolution of robotics. [Blog]. Retrieved from http://cat007.blogspot.com/2007/03/evolution-of-robotics.html

Unknown author. (2012). Robot news. *Science daily*. Retrieved from http://www.sciencedaily.com/news/computers_math/robotics

Unknown author. (2012). Robots sniff out bombs. *CNN*. Retrieved from http://www.cnn.com

CONNECTION TO THE THEME

A system is a set or series of objects that work together to perform a specific task or function. All objects of the system work independently, but they must also work together in order to be successful. All objects in the system must have something in common, usually the function or end goal. For example, the solar system is made up of individual planets that each have their own characteristics, but they all rotate around a central sun.

Robotics and systems go together for many reasons. First of all, a robot is a series of parts put together in order to make a complete design capable of performing certain tasks. Each individual piece alone will not make a robot, but together they create a functioning structure. This is similar to the idea of body systems. Each part works together for the whole to function correctly.

Secondly, the programming of a robot uses the idea of systems because each program is made up of a series of if-then commands. The program would not be successful if any part were left out. The programming of a robot is similar to DNA or a roadmap. It is read and interpreted by the robot, and it can only perform tasks where instructions have been written.

Lastly, the robot's structural design and computer programming must work together in order to accomplish a task. A robot would be incomplete without a running program, and a program could certainly not run without a robot. The two pieces have an obvious relationship that is indicative of a system.

TECHNOLOGY INTEGRATION

I intend to introduce some key historical moments in robotics, and this would be much easier to understand if explained by an expert or seen in a video. It is my plan to deliver a video montage of the evolution of robots. I think it would also be more interesting to students to see images and video clips of robots they already recognize as well as to see the progression in robotic technology. In order to see this progression, I will create a virtual timeline of robotics using Photo Story or PowerPoint Gallery.

Also, I think the key facts of robotics would be more valued by students if seen in real world application. The main goal of the unit is to design a robot similar to the land rover used to explore Mars. The best way to relay this information is with video clips and images of Mars and the land rover itself. Any other information will be delivered using a Prezi, since it is capable of hosting videos, images, and active websites within the presentation.

In the first lesson, students will be asked to create a map of their perception of the Mars or oceanic landscape. To aid in this task, I will show students Google Earth to remind them how a topographic map should look. I will also show them the Google Mars Application to show them how the surface of Mars really looks. This can lead into a discussion of remote sensing, which will transition into the next activity of creating step-by-step directions from one point in the room to another. Students might recognize that this process is how GPS works.

In the second lesson, students will be designing their robots using Lego MindStorm. This program will need to be put on laptops or desktop computers (I have the installation disk). Each NXT kit comes with basic instructions, but I will push students to use the Internet to research more innovative designs as the week progresses and students have practice working with their robot. Students will be encouraged to be creative with their designs and adapt the robot to each task, instead of sticking to the basic design.

In the third lesson, students will be programming their robots. I would like students to actively problem solve and make decisions for their programs based on their specific tasks. Students will be shown how to use the tutorials in the NXT program, but I would like most of the programming to come from the students. As this is a trial and error process, students will be logging their attempts into a journal. This journal will show the students' growth as well as provide them with reproducible steps if they need to change something in their programs (which they will) . The journal will be done digitally using Weebly. Each student will have his or her own page on the class's website. The website will also persuade the public why the final design is the best suited for each specific tasks. The website will also host images of their robot, design specifications, and video taken by digital cameras of each robot performing tasks. Students will discuss their robot's strengths and weaknesses in mobility, manipulation, timeliness, adaptation to environments, use of sensors or attachments, and aesthetics. The website will allow students to showcase their creativity in design and problem solving and provide an opportunity for students to share their experience with an audience.

CONTENT OUTLINE

I. Introduction to Robotics
   A. Definition: Use of a robot (machine that completes tasks on command) to perform manual tasks
   B. History of Robots
      1. 350 B.C.- Greek mathematician Archytas invented a mechanical bird propelled by steam that serves as the earliest recorded model airplane
      2. 322 B.C. - Greek philosopher Aristotle wrote "If every tool, when ordered, or even of its own accord, could do the work that befits it... then there would be no need either of apprentices for the master workers or of slaves for the lords."
      3. 1495 - Leonardo DaVinci invented a robotic suit of armor capable of movement to amuse royalty
      4. 1738 - Frenchman Jacques de Vacanson invented an autonomous robotic duck that quacked, flapped its wings, and ate food
      5. 1801 - Joseph Jacquard invented an automated loom
      6. 1847- George Boole represented logic in mathematical form using Boolean Algebra
      7. 1898 - Nikola Tesla built and demonstrated a remote controlled boat
      8. 1921 - Czech writer Karel Capek introduced the word "robot" in his play *Rossum's Universal Robots*
      9. 1926 - first robot movie is released, *Metropolis*
      10. 1950 - *I, Robot* is released by author Isaac Asimov
      11. 1961- Heinrich Ernst developed computer-operated mechanic hand
      12. 1962 - robots were first used on assembly line at General Motors
      13. 1979 - Robotic Institute at Carnegie Mellon is established.
      14. 1992 - Dr. John Adler came up with the concept of the *CyberKnife,* a robot that images the patient with x-rays to look for a tumor and delivering a pre-planned dose of radiation to the tumor when found
      15. 1993 - Dante, an 8-legged walking robot developed at Carnegie Mellon University, descended into Mt. Erebrus, Antarctica**.**
          a. Its mission was to collect data from a harsh environment similar to what we might find on another planet
          b. The mission failed when Dante's tether snapped after a short 20 foot decent
      16. 1994 - Dante II descended successfully into the crater of Alaskan volcano Mt. Spurr

17. 1994 - Marc Thorpe started *Robot Wars* where robots battle each other for sport
18. 1997 - Sojourner landed on Mars
19. 1998 - Furby is released
20. 2000 Lego Mindstorms is released

II. Types of Robots
   A. Remote controlled robot
      1. What is it?
         a. Controlled by a programmer or other user from a <u>distance</u>
         b. Must have a remote control or computer to send robot signals
      2. Benefits
         a. Controller can alter robot’s direction at any time using the remote
         b. Does not require complex programming
      3. Disadvantages
         a. User must be able to see the robot in order for it to work properly
         b. Repetitive tasks will become tedious for controller
      4. Where have I seen it?
         a. Common in remote control toys
         b. Battlebots
   B. Autonomous robot
      1. What is it?
         a. Robot is programmed in advance and the program cannot be changed quickly
         b. There is no remote
      2. Benefits
         a. Robot does not require a user to tell it what to do
         b. Robot can complete tasks while very far away from programmer/user
         c. Programmer/user does not have to continually watch robot
         d. Robot will not stop until it completes its task (or dies trying!)
      3. Disadvantages
         a. Robot can only respond using pre-written program
         b. No changes can be made “on the spot”
      4. Where have I seen it?
         a. Common in assembly lines
         b. Used in iRobot Roomba vacuums
         c. Moving characters at Chuck E. Cheese
   C. Master-slave robot
      1. What is it?
         a. Robot mimics user (master)

        b. Does not have remote control
        c. Does not have specific task
    2. Benefits
        a. Does not require advanced programming
        b. Robot works as quickly as programmer/user
    3. Disadvantages
        a. User must be in sight of robot
        b. Program will not be consistent because robot can only mimic task
        c. Robot cannot respond without user
    4. Where have I seen it?
        a. Wii, Move, Connect, etc.
        b. Toys that repeat or mimics

III. Practical Uses of Robotics
- A. Industry
    1. Robots are more *productive* than human workers because they act faster
    2. Robots can perform *menial tasks* repeatedly without fear of injury
    3. Robots work with *precision & accuracy*
- B. Commercial Use
    1. Self-parking cars
    2. Self-cleaning materials
    3. Interactive household objects
- C. Entertainment
    1. Interactive toys
    2. Drones for movies
    3. Theme park attractions
        a. Disney World
        b. Chuck E. Cheese
- D. Military
    1. Remote controlled robots can go places too dangerous for soldiers
        a. Disable bombs
        b. Investigate enemy territory
        c. Handle hazardous materials
    2. Autonomous robots are used as weapons
        a. Bomb sniffing robots
    3. Self-flying planes
    4. Heat-seeking weapons
- E. Medicine
    1. Surgery
    2. Non-invasive exams
    3. Prosthetics
- F. Exploration
    1. Space

a. Mars land rover
b. Robonaut- humanoid robot
c. Canadarm- arm on space station
d. Sojourner- missile that takes pictures from space

2. Ocean
   a. Discovery of Titanic
   b. Trenches
   c. Observe sea-life

3. Active volcanoes

IV. Programming Robots

A. If-then loops

1. Boolean concept- true or false

2. Robot will follow choice A until something happens, then it will follow choice B

3. Robot will continue in a loop until told to stop

B. Sensors

1. Light
   a. Used to differentiate between colors
   b. Follow a line

2. Sound
   a. Back away from loud noises
   b. Come when called

3. Temperature
   a. Measure temperature of samples
   b. Operate during specific temperatures

4. Ultrasonic
   a. Sense obstacles
   b. Come close to objects without touching

5. Touch
   a. “Feel” its way
   b. Press buttons

C. Distance vs. rotations

1. Distance is measured in feet, inches, etc from start

2. Rotations refers to number of times wheel turns

V. Robot Design

A. Mobility- What obstacles will robot need to navigate around?

B. Manipulation- How do I want to control the robot?

C. Timeliness- How quickly must the task be done?

D. Environments- What extreme environments must be overcome?

E. Attachments- What do I need to build so my robot can complete the task?

F. Aesthetics- How do I want my robot to look?

LESSON #1
If you build it, they will come

I. DEFINE THE CONTENT	
LESSON OBJECTIVE	Students will build a complete robot using NXT kits
POINT TO PONDER	The same destination can be reached through many differing paths.

II. PREPLANNING: BEING WITH THE END IN MIND	
What 3 items are worth knowing? (Think about the content you have selected. What is important for students to KNOW?)	After the lesson, Students will KNOW that robots have evolved throughout history. Students will KNOW that robots should be designed for their specific tasks. Students will KNOW that robots are built using individual pieces that function as a whole.
What 3 items are important for students to be able to DO? (Define what students should be able to DO as a result of your lesson.)	After the lesson, Students should be able to explain the importance of the evolution of robotics to various fields and provide examples of how their robot can benefit society. Students should be able to justify their particular robot design in their blog entries. Students should be able to explain how the design of a robot functions as a system.
What are the enduring understandings that students should take away from the lesson? (Define the BIG Ideas.)	After the lesson, Students will UNDERSTAND that there are many different ways to build something, and they can all be correct. Students will UNDERSTAND that advancements in math and science affect other areas as well. Students will UNDERSTAND that similar results can be achieved using different materials.

III. PLANNING	
ESSENTIAL QUESTION (One overarching lesson question)	How does design affect function?
ASSESSMENT (Performance Task) What will the students DO to demonstrate that they have mastered the content? Be specific and include actual assessment with unit materials.	Students will work in pairs to place events on a timeline of robotics. Using the instructional booklet that comes with the NXT kit, students will build a complete robot out of materials given. Once the robot is built, students will search the NXT website for other design ideas and discuss the pros and cons of each design. Students will decide on a final design for their robot make any necessary adjustments. Students will take pictures of their robot and post them on a website (Weebly) explaining why they choose the specific design.
CONTENT Outline the content you will teach in this lesson.	I. Introduction to Robotics A. Definition: Use of a robot (machine that completes tasks on command) to perform manual tasks B. History of Robots 1. 350 B.C.- Greek mathematician Archytas invented a mechanical bird propelled by steam that serves as the earliest recorded model airplane 2. 322 B.C. - Greek philosopher Aristotle wrote "If every tool, when ordered, or even of its own accord, could do the work that befits it... then there would be no need either of apprentices for the master workers or of slaves for the lords." 3. 1495 - Leonardo DaVinci invented a robotic suit of armor capable of movement to amuse royalty 4. 1738 - Frenchman Jacques de Vacanson invented an autonomous robotic duck that quacked, flapped its wings, and ate food 5. 1801 - Joseph Jacquard invented an automated loom 6. 1847- George Boole represented logic in mathematical form using Boolean Algebra

7. 1898 - Nikola Tesla built and demonstrated a remote controlled boat
8. 1921 - Czech writer Karel Capek introduced the word “robot” in his play *Rossum’s Universal Robots*
9. 1926 - first robot movie is released, *Metropolis*
10. 1950 - *I, Robot* is released by author Isaac Asimov
11. 1961- Heinrich Ernst developed computer-operated mechanic hand
12. 1962 - robots were first used on assembly line at General Motors
13. 1979 - Robotic Institute at Carnegie Mellon is established.
14. 1992 - Dr. John Adler came up with the concept of the *CyberKnife,* a robot that images the patient with x-rays to look for a tumor and delivering a pre-planned dose of radiation to the tumor when found
15. 1993 - Dante, an 8-legged walking robot developed at Carnegie Mellon University, descended into Mt. Erebrus, Antarctica**.**
    a. Its mission was to collect data from a harsh environment similar to what we might find on another planet
    b. The mission failed when Dante's tether snapped after a short 20 foot decent
16. 1994 - Dante II descended successfully into the crater of Alaskan volcano Mt. Spurr
17. 1994 - Marc Thorpe started *Robot Wars* where robots battle each other for sport
18. 1997 - Sojourner landed on Mars
19. 1998 - Furby is released
20. 2000 Lego Mindstorms is released

II. Robot Design

A. Mobility- What obstacles will robot need to navigate around?

B. Manipulation- How do I want to control the

	robot? C. Aesthetics- How do I want my robot to look?
HOOK Describe how you will grab students' attention at the beginning of the lesson. Be CREATIVE.	There will be images of various robots (including famous ones) around the room. Students will work in pairs to classify and sort them.
INSTRUCTION Explain Step-by-step what you will do in this lesson. Include ALL support and teaching materials with your unit.	Students will work in pairs to sort the images. Students will be asked how they classified and grouped the items. Teacher will then lead a discussion about the definition of robot using student input from sorting activity. What is a robot? What are the different types of robots? How are different robots used? How have robots changed over time? Etc. Students will be given a timeline and various important events. They will work in pairs to put the events on the timeline. Students will watch a teacher-made presentation using Animoto about the history of robotics, and students will correct their timelines. Students will then answer how robots have changed over time. Do the ones we use today look similar to earlier models? Is the primary function of robots still the same? Etc. Teacher will then explain that students will be building robots. Teacher will pass out NXT kits to each pair of students and explain that step-by-step directions to build a basic robot and pieces are already in the kit. Once every pair has completed their robot, teacher will direct them to the NXT website to browse other designs. Students may choose to alter their robot design. http://www.active-robots.com/nxt-building-instructions

LESSON #2
Dance, dance Robot

I. DEFINE THE CONTENT	
LESSON OBJECTIVE	Students will program their robot to move forwards and backwards, stop, and turn.
POINT TO PONDER	Robotics works as a system.

II. PREPLANNING: BEING WITH THE END IN MIND	
What 3 items are worth knowing? (Think about the content you have selected. What is important for students to KNOW?)	After the lesson, Students will KNOW that their robot is classified as autonomous. Students will KNOW that robots can only do what they are programmed to do. Students will KNOW that programming works in Boolean sequences.
What 3 items are important for students to be able to DO? (Define what students should be able to DO as a result of your lesson.)	After the lesson, Students should be able to program their robot to move forwards and stop. Students should be able to program their robot to move backwards and stop. Students should be able to program their robot to turn clockwise, counterclockwise, and pivot.
What are the enduring understandings that students should take away from the lesson? (Define the BIG Ideas.)	After the lesson, Students will UNDERSTAND that robots can be classified by the way they are programmed. Students will UNDERSTAND that programming is like writing step-by-step instructions. Students will UNDERSTAND that robots cannot “think” for themselves.

III. PLANNING	
ESSENTIAL QUESTION (One overarching lesson question)	How does a robot with no "senses" gather information?
ASSESSMENT (Performance Task) What will the students DO to demonstrate that they have mastered the content? Be specific and include actual assessment with unit materials.	Student robots will move forward in a straight line and stop after it moves 17 inches. Student robots will move backwards and stop where it started. Student robots will move forwards 17 inches, turn, and come back to start. Students will keep a journal stating every adjustment they make to their program and add a blog to the website reflecting the process they used to complete each task. Students will answer questions the following questions in their blog: **1. How did you solve the problem(s) you were presented with?** **2. What adjustments did you need to make?** **3. What advice would you give someone who had to solve a similar problem?** **4. What have you learned today?**

CONTENT Outline the content you will teach in this lesson.	I. Types of Robots
	  A. Remote controlled robot
	    1. What is it?
	      a. Controlled by a programmer or other user from a <u>distance</u>
	      b. Must have a remote control or computer to send robot signals
	    2. Benefits
	      a. Controller can alter robot's direction at any time using the remote
	      b. Does not require complex programming
	    3. Disadvantages
	      a. User must be able to see the robot in order for it to work properly
	      b. Repetitive tasks will become tedious for controller
	    4. Where have I seen it?
	      a. Common in remote control toys

	b. Battlebots B. Autonomous robot 1. What is it? a. Robot is programmed in advance and the program cannot be changed quickly b. There is no remote 2. Benefits a. Robot does not require a user to tell it what to do b. Robot can complete tasks while very far away from programmer/user c. Programmer/user does not have to continually watch robot d. Robot will not stop until it completes its task (or dies trying!) 3. Disadvantages a. Robot can only respond using pre-written program b. No changes can be made “on the spot” 4. Where have I seen it? a. Common in assembly lines b. Used in iRobot Roomba vacuums c. Moving characters at Chuck E. Cheese C. Master-slave robot 1. What is it? a. Robot mimics user (master) b. Does not have remote control c. Does not have specific task 2. Benefits a. Does not require advanced programming b. Robot works as quickly as programmer/user 3. Disadvantages a. User must be in sight of robot b. Program will not be consistent because robot can only mimic task c. Robot cannot respond without user 4. Where have I seen it? a. Wii, Move, Connect, etc. b. Toys that repeat or mimics II. Programming Robots

	A. If-then loops 1. Boolean concept 2. Robot will follow choice A until something happens, then it will follow choice B 3. Robot will continue in a loop until told to stop B. Distance vs. rotations 1. Distance is measured in feet, inches, etc from start 2. Rotations refers to number of times wheel turns III. Robot Design A. Mobility- What obstacles will robot need to navigate around? B. Manipulation- How do I want to control the robot? C. Timeliness- How quickly must the task be done?
HOOK Describe how you will grab students' attention at the beginning of the lesson. Be CREATIVE.	Teacher will ask students how they think their robots will be programmed. Teacher will show a YouTube video of a robot mimicking its "master." http://www.youtube.com/watch?v=zKQHtH9MCWQ http://www.youtube.com/watch?v=945Z2xtdEBE Teacher will explain that the video clip is of a master-slave robot. Their robot can be programmed to act as though it is responding to human interaction, but it is *autonomous.* It must be given a set of directions to follow.
INSTRUCTION Explain Step-by-step what you will do in this lesson. Include ALL support and teaching materials with your unit.	Teacher will explain the different types of robots (autonomous, remote controlled, and master-slave) and ask students where they have seen them before. As a class, we will look at the groups students made of robots the day before. We will then classify them as autonomous, remote controlled, or master-slave. Students will be given two pieces of paper and will fold a paper airplane with one and write the how-to directions on the other. Students will then give their airplanes to the teacher and switch directions with their partner. Each partner will try to recreate the airplane using only the directions.

	Teacher will explain that their robot is autonomous and must be given directions in the form of a program in order to function. It works similarly to the airplane activity and will do exactly what it's told, regardless of what the programmer might have meant. Teacher will show NXT tutorials on moving forward and turning on projector. It explains how to use the NXT program. Students will focus on the movement block. Students will then program their robot to move forwards *exactly* 17 inches and stop. Students will need to do some problem solving to figure out how to make the robot move exactly 17 inches. Students will be equipped with a meter stick and basic knowledge of the movement block in the NXT program- the rest is up to them! This will be a trial and error process and will take up the majority of class time. When finished, students will program their robot to move back to start. After that, students will combine the two programs to move forward, turn, and return to start. Students will write how they programmed each task in their journals. Students will assess themselves on each task using a check sheet. Students will update their blogs using the same questions: **1. How did you solve the problem(s) you were presented with?** **2. What adjustments did you need to make?** **3. What advice would you give someone who had to solve a similar problem?** **4. What have you learned today?**

LESSON #3
Go fetch, Rover

I. DEFINE THE CONTENT	
LESSON OBJECTIVE	Students will program their robot using light, sound, touch, and ultrasonic sensors.
POINT TO PONDER	It is always best to gather as much information as possible.

II. PREPLANNING: BEING WITH THE END IN MIND	
What 3 items are worth knowing? (Think about the content you have selected. What is important for students to KNOW?)	After the lesson, Students will KNOW that sensors are used to gather information from surroundings. Students will KNOW that robots have been developed to respond to stimuli. Students will KNOW that robots have provided many advances in several fields.
What 3 items are important for students to be able to DO? (Define what students should be able to DO as a result of your lesson.)	After the lesson, Students should be able to explain how robots have advanced exploration. Students should be able to use touch, sound, light, and ultrasonic sensors. Students should be able to choose appropriate sensors for defined tasks.
What are the enduring understandings that students should take away from the lesson? (Define the BIG Ideas.)	After the lesson, Students will UNDERSTAND that sensors provide information necessary for the robot’s system to function properly. Students will UNDERSTAND that the land rover has been crucial to understanding Mars. Students will UNDERSTAND that programming is a trial and error process.

III. PLANNING	
ESSENTIAL QUESTION (One overarching lesson question)	How does information/input guide reaction?
ASSESSMENT (Performance Task) What will the students DO to demonstrate that they have mastered the content? Be specific and include actual assessment with unit materials.	Students will work in pairs to program their robot to back away from a loud noise using a sound sensor. Students will work in pairs to program their robot to avoid obstacles using an ultrasonic sensor. Students will work in pairs to program their robot to follow a line using a light sensor. Students will work in pairs to program their robot to change directions after touching something. Students will be able to give at least one scenario when each sensor might be useful and include it in their blog.
CONTENT Outline the content you will teach in this lesson.	I. Practical Uses of Robotics A. Industry 1. Robots are more *productive* than human workers because they act faster 2. Robots can perform *menial tasks* repeatedly without fear of injury *3.* Robots work with *precision & accuracy* B. Commercial Use 1. Self-parking cars 2. Self-cleaning materials 3. Interactive household objects C. Entertainment 1. Interactive toys 2. Drones for movies 3. Theme park attractions a. Disney World b. Chuck E. Cheese D. Military 1. Remote controlled robots can go places too dangerous for soldiers a. Disable bombs b. Investigate enemy territory c. Handle hazardous materials

	2. Autonomous robots are used as weapons a. Bomb sniffing robots 3. Self-flying planes 4. Heat-seeking weapons E. Medicine 1. Surgery 2. Non-invasive exams 3. Prosthetics F. Exploration 1. Space a. Mars land rover b. Robonaut- humanoid robot c. Canadarm- arm on space station d. Sojourner- missile that takes pictures from space 2. Ocean a. Discovery of Titanic b. Trenches c. Observe sea-life 3. Active volcanoes II. Programming Robots A. If-then loops 1. Boolean concept 2. Robot will follow choice A until something happens, then it will follow choice B 3. Robot will continue in a loop until told to stop B. Sensors 1. Light a. Used to differentiate between colors b. Follow a line 2. Sound a. Back away from loud noises b. Come when called 3. Temperature a. Measure temperature of samples b. Operate during specific temperatures

	4. Ultrasonic a. Sense obstacles b. Come close to objects without touching 5. Touch a. "Feel" its way b. Press buttons C. Distance vs. rotations 1. Distance is measured in feet, inches, etc from start 2. Rotations refers to number of times wheel turns III. Robot Design A. Mobility- What obstacles will robot need to navigate around? B. Manipulation- How do I want to control the robot? C. Timeliness- How quickly must the task be done? D. Environments- What extreme environments must be overcome? E. Attachments- What do I need to build so my robot can complete the task? F. Aesthetics- How do I want my robot to look?
HOOK Describe how you will grab students' attention at the beginning of the lesson. Be CREATIVE.	What's the best part of August? Going back to school? No! It's the date of the next Mars landing! Students will watch a video clip of the newest land rover missions to Mars. http://www.youtube.com/watch?v=vFK38ZixrjY Teacher will then explain that students will be using their robots much like NASA using its land rover.
INSTRUCTION Explain Step-by-step what you will do in	After showing Mars video clip, teacher will ask students what information the robot needs in order to navigate the terrain. Teacher will remind students of the airplane task and ask how it would be different if students were blindfolded.

this lesson. Include ALL support and teaching materials with your unit.	Teacher will show students GoogleMars and ask what senses are necessary to navigate. Students will identify landforms, specifically mountains and craters. If students are having trouble, teacher will introduce them to GoogleEarth, where landforms are easier to identify. Teacher will explain that sensors are how the robot senses, and the robot can be programmed to respond to stimuli. Teacher will show tutorial on each sensor and allow students to practice. Teacher will explain that sensors use *Boolean loops (if-then sequencing)* in their programming. The robot will move if it senses stimuli, and then it will respond however it is programmed. For instance, a robot using a light sensor will search for light by moving forward; when it senses the light, it will stop. Students will choose two sensors that they think will be necessary to navigate through rough terrain.

LESSON #4
Go, go gadget arm

I. DEFINE THE CONTENT	
LESSON OBJECTIVE	Students will build an attachment to their robot capable of retrieving an object.
POINT TO PONDER	Some of the best ideas were first mistakes.

II. PREPLANNING: BEING WITH THE END IN MIND	
What 3 items are worth knowing? (Think about the content you have selected. What is important for students to KNOW?)	After the lesson, Students will KNOW that design affects functions. Students will KNOW that sensors are used to gather information, and certain sensors are better fit for certain scenarios. Students will KNOW that programming is a trial and error process, but it can be expedited with a good strategy.
What 3 items are important for students to be able to DO? (Define what students should be able to DO as a result of your lesson.)	After the lesson, Students should be able to build a workable attachment that retrieves an object. Students should be able to program their robot to reach the object. Students should be able to explain the methods they used to accomplish the task and how it can be applied to the Mars mission.
What are the enduring understandings that students should take away from the lesson? (Define the BIG Ideas.)	After the lesson, Students will UNDERSTAND that attachments can be customized to their function. Students will UNDERSTAND that there are several different ways to solve a problem or accomplish a task. Students will UNDERSTAND that problem solving is an on-going process.

III. PLANNING	
ESSENTIAL QUESTION (One overarching lesson question)	How can the best design be judged?
ASSESSMENT (Performance Task) What will the students DO to demonstrate that they have mastered the content? Be specific and include actual assessment with unit materials.	Students will work in pairs to program their robot to run an obstacle course and retrieve an object. Students will continue to modify their programs until they successfully retrieve the object while avoiding all obstacles. Students will continue to write their process in their journals. After successfully completing the obstacle course, students will write a blog entry about how what they did in class can relate to what NASA is currently doing on Mars.
CONTENT Outline the content you will teach in this lesson.	I. Programming Robots A. If-then loops 1. Boolean concept 2. Robot will follow choice A until something happens, then it will follow choice B 3. Robot will continue in a loop until told to stop B. Sensors 1. Light a. Used to differentiate between colors b. Follow a line 2. Sound a. Back away from loud noises b. Come when called 3. Temperature a. Measure temperature of samples b. Operate during specific temperatures 4. Ultrasonic a. Sense obstacles b. Come close to objects without

	touching 5. Touch a. "Feel" its way b. Press buttons C. Distance vs. rotations 1. Distance is measured in feet, inches, etc. from start 2. Rotations refers to number of times wheel turns II. Robot Design A. Mobility- What obstacles will robot need to navigate around? B. Manipulation- How do I want to control the robot? C. Timeliness- How quickly must the task be done? D. Environments- What extreme environments must be overcome? E. Attachments- What do I need to build so my robot can complete the task? F. Aesthetics- How do I want my robot to look?
HOOK Describe how you will grab students' attention at the beginning of the lesson. Be CREATIVE.	Students will use Google Earth to chat with a "Martian".
INSTRUCTION Explain Step-by-step what you will do in this lesson. Include ALL support and teaching materials with your unit.	Teacher will show students the obstacle course and explain the objective. Students will race to see who can retrieve the object first! Teacher will monitor programming and offer suggestions. Students will be given the entire class time to program their robot to successfully make it through the obstacle course.

APPENDIX OF SUPPORT MATERIALS

Websites:

Google Earth (http://www.google.com/earth/index.html)
Google Mars (http://www.google.com/mars/)
Weebly (http://www.weebly.com/)
Building instructions (http://www.active-robots.com/nxt-building-instructions)
http://ricquin.net/lego/instructions/

Software:

Lego Mindstorms (installation disk)

Videos:

YouTube (http://www.youtube.com)
http://www.youtube.com/watch?v=zKQHtH9MCWQ
http://www.youtube.com/watch?v=945Z2xtdEBE
Teacher-made video on Animoto (http://animoto.com/)

Materials:

Complete NXT Kits
Digital camera
Rulers
Paper/notebooks
Laptop or desktop computers
Teacher-made obstacle course

Robot Timeline. Teacher will cut strips and place them in a paper bag for students to sort in their best guess of chronological order.

A mechanical bird propelled by steam was invented that serves as the earliest recorded model airplane.
Leonardo DaVinci invented a robotic suit of armor capable of movement to amuse royalty.
The first remote-controlled boat is invented.
A computer-operated mechanic hand was invented.
CyberKnife, a robot that takes patient x-rays to look for a tumor and delivers a pre-planned dose of radiation to the tumor when found, is born!
Dante the robot descended into Mt. Erebrus, Antarctica to explore the harsh conditions.
Robot Wars was invented for spectators to watch robots battle each other.
The first Mars Landrover landed.
Furby, the talking toy capable of learning new words, is released.
Lexus creates a car that can parallel park itself!

Robot Movement Checklist

Moving Forward (need 4 out of 6)

- ☐ My robot moved forward.
- ☐ My robot stopped on its own.
- ☐ My robot moved in a straight line.
- ☐ My robot moved between 12 and 22 inches before stopping.
- ☐ My robot moved exactly 17 inches before stopping.
- ☐ The program I made runs consistently 5 times.

Moving Back to Start (need 4 out of 6)

- ☐ My robot moved forward.
- ☐ My robot moved backwards.
- ☐ My robot stopped on its own.
- ☐ My robot moved in a straight line.
- ☐ My robot made it back to START.
- ☐ The program I made runs consistently 5 times.

Turning (need 2 out of 3)

- ☐ My robot can turn clockwise.
- ☐ My robot can turn counterclockwise.
- ☐ My robot can pivot around a point.

Programming (need 2 out of 3)

- ☐ My robot can complete all 3 tasks.
- ☐ My robot can complete all 3 tasks consistently (5 times in a row).
- ☐ My robot can complete all 3 tasks without stopping in between.

Explain what system you used to get your robot to complete each task.

____

____

____

____

____