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Building Bots

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Goals and Objectives:

Writing:

The student will:

- Use a variety of transitional words, phrases, and clauses to manage the sequence of events.
- Use concrete words and phrases and sensory details to convey experiences and events precisely.
- Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- Conduct short research projects that use several sources to build knowledge through investigation of different aspects of topic.

Reading:

The student will:

- Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g. however, although, nevertheless, similarly, moreover, in addition).
- Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
- Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussion.

- Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
- Determine the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts.

Math:

The student will:

- Write and interpret numerical expressions.
- Analyze patterns and relationships.
- Understand the place value system.
- Perform operations with multi-digit whole numbers and with decimals to hundredths.
- Classify two-dimensional figures into categories based on their attributes.

Science:

The student will:

- Assess how technology is essential to science for such purposes as access to outer space and other remote locations, sample collection, measurement, data collection and storage, computation, and communication of information.
- Define a problem, support a scientific investigation, such as identify variables, collect, organize and interpret data, make predictions, and support conclusion.

Program Overview:

In today's society technology is essential; therefore it is imperative that we incorporate it in our everyday lessons. Lego Education Mindstorms provides our students with this opportunity. Through this amazing program more students are exposed and encouraged to participate in S.T.E.M. activities. Through the research and designing of robots our classroom is converted into a hands-on learning inquiry laboratory. Our students have learned to work together identifying problems and finding possible solutions.

Our program is an afterschool program consisting of students in third, fourth, and fifth grades. Four to five students are assigned to each group – multiple grade levels. Using the Lego Education Mindstorms EV3 pack, and the Classroom Activities for the Busy Teacher: EV3; students will work in cooperative groups to build and program robots.

The students complete a series of lessons; then each group is assigned a different task and they work within their group to complete the task. I monitor their progress, overlook their work, and encourage them to succeed. As they finish the project, each group shares their project, their learning experience and how they would improve upon this project. Students design and build a challenge course and compete with each other.

Lesson Plans:

Introduction: (Day 1 & 2)

First time I meet with the group I ask the following questions

1. "What do you know about robotics?" The students use a KWL to answer the question.
2. "Why do you want to be a part of the Robotics Club?"
3. "What do you want to learn and do in this club?

We discuss the answers and I divide them into groups. I make it clear that groups are flexible and if I feel the need to change anyone, I will. Within the group they choose a group captain, material person (makes sure all materials are available to begin and that everything is put away at the end), plans person (reads the building charts and keeps binder in order); data person (records all activities and results to share). (These jobs rotate)

Lesson 1: What is a Robot?

Objective: Discover what a robot is, and what functions it performs. Students are introduced to robotics, their use in today's society and the difference between fictional and functional robots.

The students will develop research skills, report writing, design and multimedia and oral presentation.

Project: Students research on robots and prepare a report or a PowerPoint presentation.

Activities:

1. Photocopy student handout – *What is a Robot?* and distribute. Give students an opportunity to begin research. Bring the group back together and begin to form a class opinion on robots.
2. Ask the following questions:
    - What is a robot?
    - Where did the term robot come from?
    - Name some types of robots.
    - Why do we have robots? / What function do they perform in society?
    - What are the main components of a robot?

Definition: *Robot – a machine used to perform jobs automatically, which is controlled by a computer.*

Even though there is no universally accepted definition of a robot, the following points cover the vast majority of robots.

- A robot is artificial, it has been manufactured.
- It is controlled by a computer of some description. From a full size computer to a small embedded micro-controller.
- It can sense the surrounding environment.
- It can perform actions and movements.

Assessment: The students are to present their findings on robots. (You may need 2-3 weeks for research and presentations depending on size of group).

KWL Chart Robotics

Directions: 1. Complete the "K" and "W" portion of your chart. 2. Update the "L" column as you progress. 3. Make changes in the "K" column. 4. Find answers to the "W" column.

K What do you **KNOW** about robotics?	W What do you **WANT** to know about robotics?	L What have you **LEARNED** about robotics?

What is a Robot?

When you hear the word 'robot' some famous movie robots spring to mind. Robots in real life however are not yet up to the standard of their movie counterparts.

Robots are becoming more prevalent in today's society. They are used in high level applications such as space exploration right through to commercial vacuuming robots found in everyday households. You are required to do a research assignment on robotics in general and focus on one robot in particular. Robots come in many different shapes and sizes and are often tailored to meet a particular need or action.

Assessment:

Create a report or PowerPoint presentation on robotics. The following questions must be addressed in your work.

- What is a robot?
- Where did the term robot come from?
- Name some types of robots.
- Why do we have robots? / What function do they perform in society?
- What are the main components of a robot?
- Why do we have robots?

Pick one robot and elaborate on it. You must have your robot choice approved by your teacher before you begin your research.

You will need to include the following information in your report:

Sensors – What information does it take in? (e.g. Sound, distance, etc)

Software – What does it do? (e.g. Vacuum floors, explore space)

Mechanical – What materials is it made out of? How does it move? (e.g. motors, arms and metal frames)

Name ______________________________ Due Date ______________

Robot Chosen _______________________________

Presentation Type ____________________________

Approved ______

Teacher Resource

Why do we have Robots?

There are many reasons that robots are used in society, each one filling a particular need. This question may also be posed as:

"What advantages are achieved by having robots in certain situations?"

Robots are generally built to serve for what is commonly known as the 3 D's; Dull, Dirty and Dangerous.

In an industrial setting, the use of robots allows repetitive tasks to be performed accurately time after time. Robots can generally perform simple tasks far quicker than humans can. This leads to increased productivity and better quality control of goods. Some types of robots, particularly those that need to pick up and put down fragile items, are so accurate that they can stop within a human hairs width of the objects they need to manipulate. Medical robots are reaping the benefits of such accuracy, allowing doctors to perform surgery on patients who are in another city or on the other side of the world.

Exploratory robots and military robots are designed to keep people away from harmful situations. Robot operators can drive a robot into an unsafe area, and use the sensors and cameras on board to gather information. This is particularly useful for search and rescue missions in disaster areas, where the environment may be unsafe for humans to go looking for survivors.

Entertainment robots are another category and provide a lot of fun and interest for people. They can be typically found on TV, highlighting the fun things that robots can do. The range of sophistication goes from the very complex humanoids such as ASIMO and NAO, to the toys like RoboSapien and the LEGO® MINDSTORMS system. Household robots such as the vacuuming Roomba was one of the first robots to be marketed as a domestic robot with later versions that have been developed to mop floors and clean out gutters. The dream of a robotic butler to pick up our clothes and do our chores is not far away.

Name different types of robots?

There are a variety of different categories for robots, including but not limited to:

- Entertainment (ASIMO, NAO, AiBO, animatronics, RoboSapien, LEGO®)
- Domestic (Roomba, automatic lawn mowers)
- Movies (C3PO, R2D2, Terminator, Johnny 5)
- Industrial (welding, Pick and Place, factory automation)
- Medical (remote surgery, minimally invasive surgery)
- Exploratory (Mars rovers, deep sea ROV's, unassisted aerial vehicles)
- Military (PackBot, bomb disposal, search and rescue)

What are the main components of a robot?

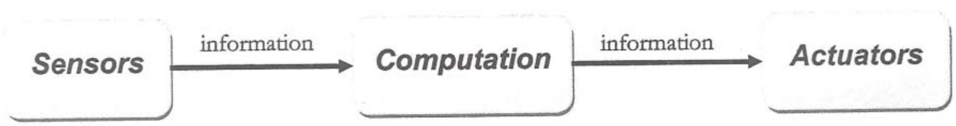
Robots can be broken down into three distinct components; Sensors, Computation and Actuators.

Sensors are used to 'feel' the surrounding environment. The robot uses these sensors to take in information about where it is and what it is doing. Different sensors can be used to sense different conditions including light and dark, temperature, bump sensors, ultrasonic, infrared… the list goes on and on. Think about what senses a human has, and how a robot replicates them. Sensors are classed as inputs, that is, they take information and input it into the robot's brain.

The Computation component consists of an onboard computer that the robot uses to process the information coming from its sensors. This can be as small as a few integrated circuits right through to a full personal computer. The level of complexity of the required tasks will dictate the amount of computational ability needed by the robot.

The last distinct component of a robot are its Actuators. Actuators are a fancy way of saying 'parts that do things'. These may be motors in the wheels, or engines that make the arms go back and forth. It could also be hydraulic pistons or pneumatic cylinders. Actuators are a form of outputs, along with lights and speakers. The robot Computation tells these outputs to do different tasks.

Generally speaking, the sensors provide the information to the computers, which in turn tell the motors what to do.



Path of information flow in a robot

Where did the term 'Robot' come from?

While the idea of artificial beings have been around for many years, the term 'robot' was first coined by Czech writer Karel Čapek in his play R.U.R. (Rossum's Universal Robots) in 1920. The word is derived from the Czech 'robota', which translates as 'forced work', 'slave' or 'servitude'. Čapek credits his brother Josef as the true inventor of the word.

Robots have enjoyed the majority of their exposure through movies and science fiction writings, such Star Wars and the Asimov series of 'Robot' books.

Robots in their presently accepted state were first developed in the 1950's, with George Devol's Unimate robot, capable of lifting hot pieces of metal from a die casting machine and stacking them. The first Unimate was sold to a General Motors assembly plant in New Jersey.

Lesson 2: Flowcharting

Overview: An introduction to flowcharting.

Project: Students are introduced to the concept of flowcharting. This process will allow them to coordinate their thoughts and will make programing less difficult as they progress. A larger project is systematically broken down into a series of more manageable tasks that are more readily completed. This especially important as computers and robots are extremely literal, they will do exactly as they are told, no more and no less.

This section can be done using a whiteboard or SmartBoard. (Note: if SmartBoard or Promethean Board is available you may go to Lego Education and show the students the actual program flow charts and how to adjust the commands.) The concept of a flowchart should be explained with emphasis on both the correct order of tasks and providing sufficient detail. With both these concepts understood, generating a program for a robot becomes considerably easier.

When planning the program for a robot, it is very beneficial to go through a flow charting process. Flow charting allows us to take the ideas we have for a robot, and start to assemble them in a logical fashion.

Example: Let's look at a typical student morning. We will look at how we approach our morning as a series of different individual tasks. Firstly, we need to get the order in which we do each step correct. If we try and do things in the wrong order, the whole day may not work. In addition, the amount of detail for each task is important. Each task should be sufficiently small enough, so as it can be done as a single step. If we keep these tasks short and simple and concise, it is easier plan out the bigger tasks. Occasionally, some steps need to be revisited and broken sown further into smaller steps.

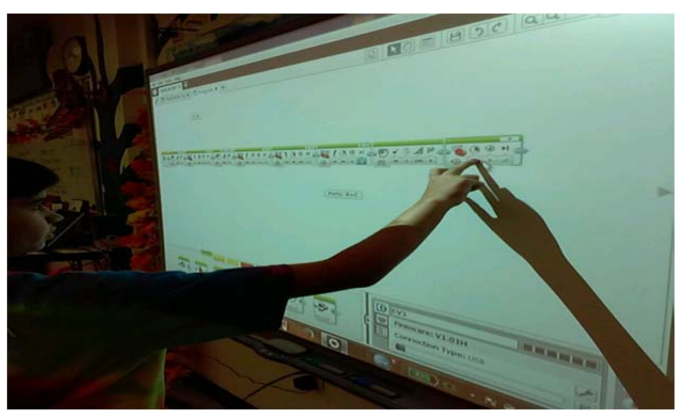
Flow chart sample:

1. Go to School
2. Get Out of Bed
3. Have Breakfast
4. Wake up

Obviously this flow chart is wrong we need to place each step in the right order as they occur. The same must be done when creating a flow chart for the robot. **The order in which we do each task is very important. If we get the order around the wrong way, the tasks will not make sense.**

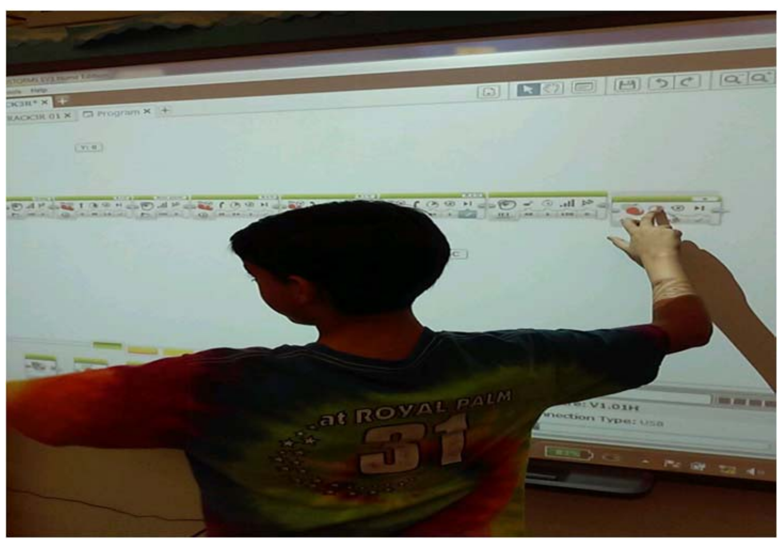
Correct Flow chart sample:

1. Wake Up
2. Get Out of Bed
3. Have Breakfast
4. Go to School



When the students start to program their robots, they will need to sketch out a flowchart of how he would like the robot to behave. If we can break sown the whole program into little tasks it will be easier to program our robot. Ideally, each individual task will relate directly to a single block in EV3 programming environment. (See picture below) Once we have this sequence of tasks, we can start putting them into a language that the robot will understand. We will be using the EV3 programming language to make our robot perform each of the tasks that we have defined.

It is important to remember that the first draft of the program may not work; changes will have to be made along the way. That is why it is vital to have a plan (flowchart) before we start programming the robots. Students should complete the attached flowchart worksheet, remember details are most important. The robot will do only what it is programmed to do; no more or less.

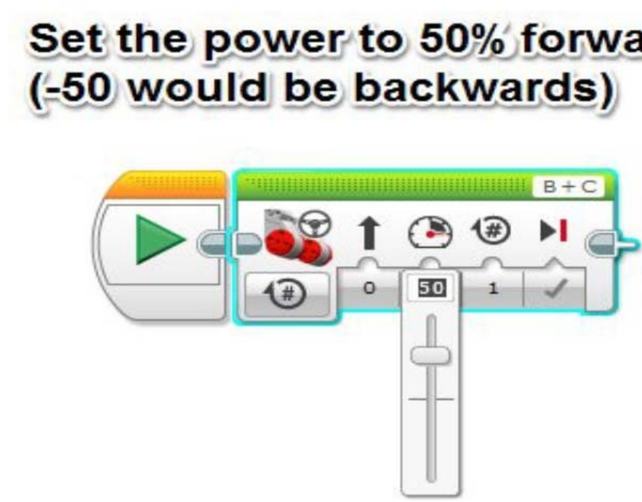


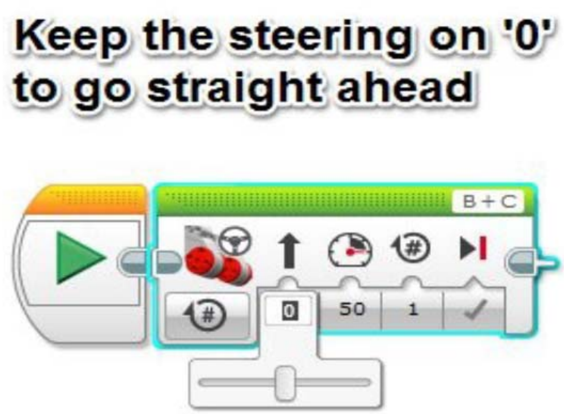
Flowcharting Activity

All robots need to have programs to make them run. The easiest way to start a program is to first have a plan. This plan consists of a flowchart of small steps that make up the entire program. Each step is simple enough that the robot can perform it without too much effort.

Task: Create flowchart, plan out your daily morning routine, from when you wake up until you get to school.

Program Samples:





Reflections:

The lessons included are the basic lessons I used in my classroom to get started. Once these lessons were completed, using the Lego Mindstorm Software we began to build, program and use our robots. This has been one of the best learning experiences my students and I have had. Why teach robotics? I was asked. My answer is always simple, we are now living in the 21st Century where technology is at the heart of all we do and are; what a better way to prepare our students then to expose them to robotics at a young age. Since then, I have had various students move on to middle school and continue with robotics. I continue to sponsor a third, fourth and fifth grade robotics club; and have many eager participants.

Resources:

- Classroom Activities for the Busy Teacher: EV3
  By: Damien Kee

- http://www.damienkee.com
- http://www.legoeducation.us.com
- http://www.mindstorms.lego.com
- http://www.cs2n.org

The Following is a list of free online courses that are tailored directly to the LEGO EV3 system. This list was compiled by the amazing 'Robotics in Education' community mailing list.

- Dale Yocum - http://www.stemcentric.com/ev3-tutorial/
- Carnegie Mellon - http://www.education.rec.ri.cmu.edu/content/lego/ev3/curriculum/
- Dr Graeme - http://www.drgraeme.org/EV3/EV3.html
- Stem Robotics - http://stemrobotics.cs.pdx.edu/node/2643
- Nigel Ward - https://sites.google.com/site/gask3t/lego-ev3/ev3eeb3
- Udemy - https://www.udemy.com/fun-with-beginner-lego-mindstorms-ev3-robotics
- Rowan U / Google CS4HS - http://www.rowan.edu/cs4hs
- RobotC - http://www.robotc.net/blog/2014/09/09/fall-training-2014/#more-3623

Materials:

EV3 Core Set

Cost $349.95

EV3 Core Set with Software Pack

Cost $443.95

EV3 Software

Single License

$99.95

EV3 Expansion Set

Cost $99.95

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Project funds are to be spent within the current school year or an extension may be requested. An expense report with receipts is required by May 2, 2016.

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