Webster UNIVERSITY SCHOOL OF EDUCATION

POINTS OF INFLUENCE

Course Syllabus

EDTC 5630-01	Advanced Topics in Classroom Technologies **Robotics in the Classroom**	Sum. 2008 – Tues / Thurs July 8, 10, 15, 17 9-4
Webster Hall, room 221	Mary G. Beckmann Office Phone: 314-968-7490 (leave message) beckmann@webster.edu ponotoc2@yahoo.com	2 credit hours

1. **COURSE DESCRIPTION:**
   In this class students will build a TechCard chassis-based robot using principles of basic electronics. Students will create a robot that is aesthetically pleasing and one that solves a real-world problem and does something. Students will examine how incorporating robotics technology into pre-existing lesson plans will create investigative play through the design of meaningful projects, encourage group participation, enhance social skills, increase comprehension, retention, and thinking and learning skills. Students will examine and discuss how robot building involves probability, planning and predicting, designing, hypothesizing, measuring, and applying mathematical and scientific principles. Students will access the Internet to search for and examine robotic sites that include NASA robotic information, robotic games and activities for age appropriate classroom use, and to print items such as a paper ruler that will be used to convert to and from metric and imperial systems of measurement.

   Discussions will include how robotics relate to education, how to incorporate robotics into existing lesson plans to enrich and expand on already existing lessons at any grade level in multiple disciplines. Kits, pre-built robots, and mechanical aspects of beginning robotics, will be discussed. Students will become adept at purchasing products from various sources.

2. **LEARNING OUTCOMES:**
   At the end of this class students will:
   - examine and explain to an age appropriate classroom, the three elements of a robot (ISTE 1, 2, 3, 4, 5, 6)
   - analyze the history of robots and discuss the Russian/American scientist and author, Isaac Asimov (ISTE 1, 2, 3, 4, 5, 6)
   - explain the value of robots in everyday life, in Hollywood, and in space (ISTE 1, 2, 3, 4, 5, 6)
   - compare and contrast artificial intelligence robots, vehicular robots, micro robots, nanobots, and humanoids, and spider bots (ISTE 1, 2, 3, 4, 5, 6)
   - explain and demonstrate the use of gears, wheels, chassis, motors, sensors, batteries, switches
   - examine various uses of Legos in classrooms (ISTE 1, 2, 3, 4, 5, 6)
   - create a lesson plan incorporating technology robotics in a classroom within a discipline (ISTE 1, 2, 3, 4, 5, 6)
   - design and create a working chassis-based robot (ISTE 1, 2, 3, 4, 5, 6)
   - design a method for analyzing and evaluating a finished product (ISTE 1, 2, 3, 4, 5, 6)
   - examine how to successfully group students to build a chassis-based robot (ISTE 1, 2, 3, 4, 5, 6)
   - discuss and examine various outlets for purchasing robotic supplies (ISTE 1, 2, 3, 4, 5, 6)

3. **SCHEDULE OF REQUIRED READINGS, CLASS PREPARATIONS AND ASSIGNMENTS, LECTURES, DISCUSSIONS, STUDENT PRESENTATIONS, OUT-OF-CLASS ASSIGNMENTS AND EXAMS.**

Module 1	**July 6**	**Intro to class, to robotics, to kit, to tools and supplies, various energy forms** (electric, wind/air, programmable using string, wind/air combos using propellers, solar, and pneumatic), **bounce bot assembly** for intermediate aged students, **demo of and then search for age appropriate worksheets** for classroom students to use during down-times (glue drying, etc.), **why robotics in the classroom**, discussion of **history of robots**, **what they are, how robotics work with curriculum content**, short **video of robotics in classrooms**
		Wind/ air, no electric motor robot - assembly of balloon chassis based robot for younger students, demo of and then search for age appropriate worksheets for classroom students to use during down-times (glue drying, etc.)
Module 3	**July 13**	**Discussion on programmable electric motor robot** - assembly of simple string programmable motor chassis robot for older students, demo of and then search for age appropriate worksheets for classroom students to use during down-times (glue drying, etc.) **Midterm and final project:** this will be a combination of several activities and it will culminate in an oral presentation on the last night of class. Midterm and final projects include: • create a short lesson plan for students that involve building a robot • build the robot from your kit or one you found on the Internet, or use a robot that you've already built • if you are going to use a robot that you already built then create two downtime activity sheets, if you are going to create a new robot then create one activity sheet • create a check list or rubric to assess your students robot that they will build
Module 4	**July 20**	**Discussion on wind / air combo robot** – assembly of propeller / electric motor driven chassis based robot for intermediate aged students, demo of and then search for age appropriate worksheets for classroom students to use during down-times (glue drying, etc.)
Module 5		**Discussion on solar power projects and kits** – experiment with various kits and solar power, demo of and then search for age appropriate worksheets for classroom students to use during down-times (glue drying, etc.) **Pneumatic power** – assembly of pneumatic dump truck, demo of and then search for age appropriate worksheets for classroom students to use during down-times (glue drying, etc.) –
Module 6	**July 27**	**Assessing in robotics and final project presentation** **Final project -** create any robot from the kit and a method to assess and present orally

4. RESOURCES:

Required Text(s): Required **Ultimate Robot Kit**, **ISBN**: 0789479451, **Publisher:** DK Publishing, Inc. Approximate $25.99. There is a small text and it is included in the kit. If this kit is not available at the Webster Campus Book Store, please purchase it through another sources such as Borders, Amazon.com, or Barnes and Nobel.

Various Internet readings as assigned throughout the course.

5. **EVALUATION / GRADING SCALE:**

93-100 = A
90-92 = A-
86-89 = B+
83-85 = B
80-82 = B-
76-79 = C+

Weekly Readings and Discussion (6 classes x 2 = 12 points possible)	12
Class attendance (2 points for every full class in attendance = 6 x 2 = 12 points possible)	12
6 weekly assignments / projects / activities (6 classes x 6 = 36 points possible)	36
Midterm	20
Final project	20

All academic and professional behavior of students in this course is subject to review for the purposes of student evaluation.

I plan to keep the final project. So if you desire a copy of it, please make one for yourself before turning it into me.

6. **ACADEMIC HONESTY POLICY:**

Students at Webster University are expected to practice academic honesty.

In its broadest sense, plagiarism is using someone else's work or ideas, presented or claimed as your own. Any time you refer to another person's work, whether as a direct quotation or paraphrased, you must use a citation. Students should not copy more than two paragraphs from any source as a major component of papers or projects. All citations must be properly documented and references must be provided using APA guidelines (http://library.webster.edu/citation.html).

7. **ACCESSIBILITY/ACCOMODATIONS POLICY:**

If you have a disability, please notify your instructor as soon as possible to discuss your accommodation needs.

8. **ATTENDANCE:**

Attendance at all classes is required. If a student anticipates missing a class, the instructor must be notified prior to the class. Students will be required to complete the work assigned and to make up any missed work by the next class. **Please note that we only meet 8 days, hence each meeting is crucial. The instructor reserves the right to lower the final grade by a letter grade for absences.**

Students who do not complete the requirements of the course must contact the instructor prior to the end of the course to complete an Incomplete Course form. Incompletes are not awarded except in emergencies, as defined by the instructor.

NB: An Incomplete may only be awarded to a student who has maintained a passing grade up to the point of the emergency. Incomplete grades will change to a grade of F or NC unless the requirements stipulated on the incomplete form are met by the date listed on the form or one calendar year from the end of the course, whichever comes first.

9. **OTHER**

Expectations: EDTC 5330 is a graduate class. A graduate class includes readings from the textbook as well as library articles. It is expected that the students will write as part of the course requirements. In the final project not only the technical requirements of the assignment must be met, it is expected that there will be considerable writing involved in proposal that is designed. Further writing is expected on the discussion list each week based upon the readings assigned. Finally, the final project proposal must stipulate how it will be used within the school.

10. STANDARDS / GOALS:

International Society for Technology in Education **(ISTE)** - National Educational Technology Standards for Teachers **(NETS)** – http://cnets.iste.org/teachers/t_stands.html

ISTE NET Standards:

1. **Technology operations and concepts.**
   Teachers demonstrate a sound understanding of technology operations and concepts.
2. **Planning and designing learning environments and experiences.**
   Teachers plan and design effective learning environments and experiences supported by technology.
3. **Teaching, learning, and the curriculum.**
   Teachers implement curriculum plans that include methods and strategies for applying technology to maximize student learning.
4. **Assessment and evaluation.**
   Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.
5. **Productivity and professional practice.**
   Teachers use technology to enhance their productivity and professional practice.
6. **Social, ethical, legal, and human issues.**
   Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PK-12 schools and apply those principles in practice.

The School of Education (SOE) Goals:

1. **The knowledgeable learner:**
   Education candidates will demonstrate knowledge of the subject matter, knowledge of the learner, and knowledge of pedagogy based on inquiry and scholarship.
2. **The informed instructor:**
   Education candidates will incorporate multiple assessment and instructional strategies to support effective educational practices based on research and theory.
3. **The reflective collaborator:**
   Education candidates will reflect on the roles educators take as leaders of change through collaboration with colleagues, students, and families in schools and communities.
4. **The responsive educator:**
   Education candidates will demonstrate respect for diversity through responsive teaching and learning that values individual differences.

This syllabus is subject to change at the discretion of the instructor.

EDTC 5630 ROBOTICS IN THE CLASSROOM **July 8, 10, 15, 17 - 9 a.m. to 4 p.m.**

WEEKS 1 & 2

1. **Introductions and handouts**
2. **What we'll be doing overall**
   a. discuss and create bots that do something and relate to the real world for pre-K to adults and special needs individuals
   b. discuss and create projects and activities that include energy, force, and motion
   c. discuss how to group students and how to incorporate robotics into classrooms and merge with curriculum to enhance pre-existing lesson plans or create new lesson plans

3. **The items that we'll attempt to create in this class include items below. With each creation we will tie the item with curriculum and in some cases discuss and create methods to assess**

Rubber bands, gears/pulleys, motors, Solar Power, hydraulics, pneumatics, and balloons can power chassis-based bots

HYDRO (water)
Water powered calculator

PENUMATIC
Tipper truck and robotic arm

KIT
Create the bounce bot
Create another bot from the kit (your choice)

SOLAR (crickets, beads, paper, kits with leads)
When energy from the sun is used to create power, we have solar power – we'll work with solar beads, photo paper, kits with leads, solar motors, toy cricket and solar,

HYDRO
Calculator

GEARS
Gear windmills
Gear battery kits

WIND
Propeller chassis-based
Balloon powered chassis based bots
Merry go round (hand/wind powered)

MORPHING
Morphing is not really energy or a robot, although robots are often used to demonstrate morphing. Morphing is really motion – it is included in our robotics class because of it's popularity and misconception by students that morphing is robotics.

4. **Important info:**
    a. Anything put on the computers will be erased once the computers reboot, so bring flash drives – or email items to yourself
    b. Print what you find throughout this class freely – I'll leave all printouts in the printer tray and you can pick them up when we break or during assembly times when no one is presenting
    c. Sometimes we'll work in groups, sometimes individually
    d. We'll create a variety of projects, the ones from the kit you purchased are yours to keep of course, others will have to remain with the university
    e. We'll discuss the text that came with the kit, how to shop for robot kits, for parts to duplicate those parts in the kit you purchased, how to create/design our own bots, and price items to find cost effective methods of incorporating bots into classrooms
    f. Point values for the final grade – be here and you'll earn points because all projects will be created in class - if you are missing from class then your grade will be lowered
5. **Suggestions:**
    - Use the box top of your kit to carry items back and forth
    - Use the cardboard that comes in your kit to draw templates
    - Keep in mind; there are various ways to power bots – gears, pulleys, wind, hand-powered, motors, solar, hydraulics, pneumatics, balloons, and rubber bands.

TERMS, TERMINOLOGY, QUESTIONS - Pre-teaching ideas

<u>What are robots and robotics?</u>

- Robots can be categorized into:
    i. robots in the real-world (robots in factories, homes, etc.
    ii. robots in science, technology, and space
    iii. robots in science fiction (in Hollywood, reading, i.e.)
- These site explain that robots most recently include many common objects, although true scientists would not declare your VCR as a robot
  http://schoolscience.rice.edu/duker/robots/robotwhatis.html
  http://www.thetech.org/exhibits/online/robotics/activities/page02.html
  http://www.42explore.com/robots.htm
- The word 'robot' is not a new word - it has been around for many years – click on both of these sites – one is geared more toward younger children and is more inclusive
  http://www.robotics.megagiant.com/history.html
  http://www.thetech.org/robotics/timeline/index.html
- Basically, robotics is the science or study of the technology associated with the design, fabrication, theory, and application of robots
- Robotics is considered the art and science of creation and use of robots and robotic devices
- The science and technology of general purpose, programmable machine systems, most of which are anchored to fixed positions
- Within the area of learning and play, robotics refers to a interactive devices-including toys, pets, assistants to the disabled and overtly educational tools used in ways that have profound and beneficial effects on how children develop (from textbook: **Robots for Kids: Exploring New Technologies for Learning**, by Allison Druin and James Hendler, **ISBN:** 1558605975, Morgan Kaufmann; 1 edition (March 29, 2000).

PRE-TEACHING ROBOT TOPICS

What is considered a robot?

- A stand-alone hybrid computer system that performs physical and computational activities.
- A machine or device that operates automatically or by remote control.
- A mechanism that can move automatically
- A typical robot has a movable physical structure, a motor or some form of movement or energy, a sensor system, and a power supply

What is technology?

- Much of today's technology implies that technology is the use of computers – but technology is far more than computers, it includes digital cameras, PDAs, and a variety of electronic or digital products and systems
- Applying a systematic technique - method or approach to solve a problem
- The discipline dealing with the art or science of applying scientific knowledge to practical problems

WHY ROBOTICS IN EDUCATION AND WHY THIS CLASS?

- In the 60's people were amused when Seymour Papert Ph.D., spoke of children learning and enhancing their creativity by using a computer. Papert's beliefs come from his personal experiences as a young child when he would visit his father's auto shop and play with gears. In the 80's as a researcher at MIT, Papert called upon those early learning experiences and he produced the Logo programming language, which led to the first children's toys with built in computation. During that time Papert wrote *Mindstorms: Children, Computers, and Powerful Ideas.*

- In the foreword of his book titled, *The Gears of My Childhood*, **Papert** speaks of his belief that students need cognitive tools to work through the operational level identified by Piaget:

- "What the gears cannot do the computer might. The computer is the Proteus (sea god) of machines. Its essence is its universality, its power to simulate. Because it can take on a thousand forms and can serve a thousand functions, it can appeal to a thousand tastes. This book is the result of my own attempts over the past decade to turn computers into instruments flexible enough so that many children can each create for themselves something like what the gears were for me."

- Today Papert is considered the world's expert in how technology can provide new ways to learn. His beliefs come from his personal experiences, and extensions of his ideas include robotic technology in the education field such as Lego Mindstorms and Robolab.

- An extension of Papert's belief is also evident in 1995 when Dr. Chris Dede, Harvard Graduate School of Education, suggested the use of robots in education during a discussion. Dede states that learning is enhanced when educators incorporate 3-D learning environments instead of relying solely on computer virtual 2-D environments, because children learn by manipulating objects physically.

- "When children build and come up with their own solutions to construction challenges they are encouraged to learn, not only about engineering, but also about science and math as well as reading and writing." *Chris Rogers, Assoc. Professor of Mechanical Engineering at Tufts University (USA).*

- Children learn easier by play according to Papert. But children need direction in play - they need a structured support plan that shows clear progression from one stage to the next with support before, during, and after and a method of assessing and evaluation.

- Creating simple machines assist and guides students to explore physical science as they build working models of levers, wheels, axles, chassis, pulleys, wheels, and gears. Robotics assist children in assessing and evaluating what they build, contributing to their development. Robotics increase children's desire to learn while allowing for progressive learning – at individualized rates of speed and level. Children are learning to think critically, improving their sequencing, communication, and tactile skills.

- Combining robotics technology with other disciplines will assist students to design a machine that will solve a real-world problem and apply mathematical and scientific principles for a concrete, practical purpose and solution. Some children plan their models; some jump right into action and begin building without planning. These kinds of learning styles will reveal themselves through the building process.

THE TIE-IN OF ROBOTICS

- **Constructivism ties** - robotics technology is learning by design – learning by investigative play to design meaningful projects – in other words, constructivism. It increases the desire to learn while allowing children to learn at their own rate of speed and level using their own unique learning style. Robotics is creating a learning environment that helps students use objects to think. Robots are designed to be a part of a lesson, not an end - they make learning fun.

- **Technology ties** - students will examine how incorporating robotics technology into pre-existing lesson plans will create investigative play through the design of meaningful projects, encourage group participation, enhance social skills, increase comprehension, retention, and thinking and learning skills. Students will examine and discuss how robot building involves probability, planning and predicting, designing, hypothesizing, measuring, and applying mathematical and scientific principles.

- **Robots encourage** group participation; enhance social skills, and increase comprehension, thinking, and learning skills, aids in retention, assists in improving verbal skills, engineering, technology, oral, and vocabulary skills, sequencing, following directions, reading, writing, journaling, vocabulary, history, social studies, geography, physical education, technology, physics, electronics, art, reading, science, history, English, vocabulary, creative writing and social studies, physical science, math, geography, physical education, technology, speech, and involves exploration, data management, investigation and problem-solving skills, probability, planning and predicting, designing, hypothesizing, measuring, and comparing and contrasting.

- **Building a robot includes using practical purposes and solutions and then applying that acquired knowledge to real-life situations.** Students in this class will explore robot fundamentals, types of robots and their practical applications, basic tools, robot kits, pre-built robots, basic electronics and mechanical aspects of beginning robotics.

- **For the more advanced,** robotics would include sensors and programming applications, all necessary to manipulate more advanced robots and can include soldering, propellers, buzzers, and lights

- Later we'll examine **robot dogs, and robotic virtual pets,** and where and how to purchase tools and supplies, as well as how to record robot movements (i.e. attach a laptop with a webcam to a robot and move around the building or playground to record events) will also be discussed. Ideas for developing discussion among students in the field of robotic technology will be explored.

- Robotics - relative to **recent news in Science:**

    - Nanorover on the moon to return in 2006 - http://www.enchantedlearning.com/subjects/astronomy/glossary/indexn.shtml
    - Spirit and Opportunity on Mars - http://marsrovers.jpl.nasa.gov/gallery/video/spirit01.html count down five pictures, read the article under '**Virtual Rover Drives Toward Rock'**, click on either of the two video links beneath the article
    - **Handouts for both nano-rover and Spirit and Opportunity**

Integrating robotics into content areas:
Content that can be incorporated into robot building is endless – individually choose a subject from the list below (you'll use this subject as the basis for searching activities and for your final project – you may change your mind as the class progresses) – i.e. creating a robot has been incorporated into the following subjects: speech (oral presentations), portfolios (writing, vocabulary, English), literature, social studies, history, mythology, geography, science, math, physics, current events, health, storyboarding, technology, music, PE, etc.

Basic content areas and benefits of robotics in the classroom:
Electronics: Creating movement – adding motor and batteries and switches – what movement involves and basic principals behind movement

Electronics / Technology: Making it 'pretty' and 'functional' – adding lights, sensors, line-followers (basic robotics 'jobs' for robots to perform)

Presentations and Demonstrations: Students will demonstrate what they've created, cite the standards and curriculum content of their project, how they plan to assess and use the lesson in their classrooms

Science & Physics: robotic vehicles on Mars - why are they sent there, what are the expectations, how do robots react to the environment – the value of gears, ratios, wheels, pulleys and fulcrum – push and pull.

History: robots and their uses throughout time – earliest robots, what the words 'robotics' and 'robot' mean today, robots in Hollywood, robots in everyday life - particularly in industry - why people use robots - on the job 24/7 and they never get sick, etc. etc. Students should be able to look at the book that came with the kit or research on the Internet to find robot uses.

Math: metric measurement, conversions, currency exchanges for robotic parts

Journaling, English, Vocabulary, Writing/Reporting, Oral presentations: have students journal their progress – or robots on Mars – write – compare and contrast - draw a robot, give it a job to do, create their own in their mind before creating a Lego robot

Technology: use the digital camera to take pictures or secure a video cam to one of robots as it races around the room – use a spreadsheet for measuring progress if they readjust the axels, gears, etc.

Art / GEORGRPHY / SCIENCE: create a landscaped maze, an obstacle course, a floor map, create the landform or a landscape using paper, or build a maze out of wood or clay, create a town, city, give the robots antennae and eyes, draw flames with markers, or use stickers and decals.

Basic Electronics: include safety of working with tools - besides cutting and gluing there are batteries, motors, wires, etc. that need to be connected properly, buzzers and lights can be added to the finished products, propellers, motors, shafts, gears, switches, etc. can be introduced

Combining / incorporating other discipline areas (more involved) into robotics:
Robots increase **technology** skills in many areas including word processing, researching and searching, spreadsheets and graphing, digital cameras, scanners, presentations, computerized drawing, and programming. Using a robot can assist students in building and improving **vocabulary** skills, and improve **writing and oral presentation** which would involve demonstrations.

Robot building may improve and enhance **social skills, diversity,** and incorporate learning **communities** within the school setting as students work in groups to complete a project.

Concerning **data management** and **probability,** robots will assist students in predicting the results of data entered, in comparing experimental results with predicted results, and in understanding that events will occur in a specific sequence.

In **science** robots may help demonstrate a theory, explore landforms and geological maps; in *physics* robots assist in understanding concepts such as force, torque, energy, pressure, velocity, Bernoulli, lift, drag, and lift and drag.

In **math** robots may be used to test an algebraic formula or compare ratios, develop word problems based on elements of design, proportions, conversions, and scales, discover geometric patterns and solve puzzles, use mathematical language to describe geometry ideas, measure angles using a protractor.

In **history** robots can be used to recreate an invention or a famous building or timeline.

In **English** robots can be a story, a book, or a journal.

In **communication** robots can assist students in oral speaking through demonstrations and discussions of problems related to robot creation and further assist as solutions are presented in oral discussions.

In **music** robots can be programmed to play music, speak or sing.

In **physical education** robots can demonstrate speed and maneuverability.

In **art** robots can stimulate creativity and design when students draw designs and redraw when miscalculations or flaws are recognized

In **general** robots can assist in comparing and contrasting patterns and describing similarities and differences, and sequencing and learning what comes next for the Pre-K, K, 1st , and 2nd grade students as well as assist the older students in recognizing the need for precision in reporting results of specific situations. ~

PRE-TEACHING – IDEAS

Students will be in a hurry to dig right in, but you need to pre-teach and you need to find activities to occupy those students who finish before others, or for when students are waiting for parts to set and glue to dry.

We're going to do what elementary students might do in a robotics lesson – first a pre-teaching exercise worksheet, and then build a basic chassis-based non-motorized nano-rover bot using Tech-Card (this is also a great way to begin using TechCard).

Later tonight you're going to create a worksheet/activity similar to one of these that will pre-teach robotics – either upper or lower grades – your choice.

- **For elementary students:** Listen to the song here first – all computers should have headphones connected http://www.learnenglish.org.uk/kids/archive/theme_robots.html then complete part ofthe activity sheet here http://www.learnenglish.org.uk/kids/print/docs/robot.doc

- **print out a metric ruler** http://www.vendian.org/mncharity/dir3/paper_rulers/
- The bounce bot bounces off obstacles and changes direction similar in design and purpose - at a very basic level - to the two robots that are on Mars – Spirit and Opportunity, it is relatively easy to build, almost any age group will enjoy it, it is aesthetically pleasing in design, makes sense, and does something.
- **Gather all pieces** according to the part's list
- we'll help each other, but each of you should make your own
- When the Bounce Bot is finished, we'll go out into the hallway to test drive
- See troubleshooting below for tips and suggestions
- As you're waiting for parts to dry and pieces to set, continue with the in-class activity below

- The nano-rover is a basic design that can **easily be made at little or no cost** – **handout idea sheets** – meaning that you can incorporate robotics into the curriculum even if you have zero funds – use straws for axles, i.e.
- Complete the bounce bot
- while waiting for glue to dry and parts to set, continue reading and visit the sites below
- when your bot is ready we'll have a 'race' in the hallway
- **share you're first experience** building a Tech-card chassis based bot

THE TEXT

- Ideas to explain to students how robots work in the real world

DOWN-TIME ACTIVITIES and DISCUSSION IDEAS

Read the topic ideas, the questions, the sample and topic ideas, activity web sites, questions, and sample ideas below, or locate robotic-related web sites on your own or use these sites:
http://athena.cornell.edu/educators/lp_06.html
http://www.42explore.com/robots.htm - describe robots and give examples of where robots can be found in the everyday world

Worksheet ideas might be as simple as creating a word search puzzle -
http://puzzlemaker.school.discovery.com/ - come up with a list of robotic terms and/or uses

Create a scavenger hunt, worksheet, question/answer sheet, or a word search puzzle relative to robotics (what are robots, what do they do, what are they used for, etc.)

Topic Ideas:

- what are smart dust robots? (look this one up on the Internet)
- http://news.nationalgeographic.com/news/2001/09/0914_TVdisasterrobot.html search and rescue robots
- explain the value of robots in everyday life, in movies and books
- types of robots and where can each be found
- what elements have to be present in a machine to be a robot
- examine and explain the three elements of a robot
- where did the word 'robots' come from
- history of robots, first robots, Asimov, father of robots and why
- analyze the history of robots and create a time line
- analyze the history of robots and discuss the Russian/American scientist and author, Isaac Asimov
- what types of robots might appear in industry and why
- what kinds of robots are sent to space and what do they do while in space
- what are virtual pet robots
- name some robots in books, comic books, Hollywood, etc.
- what might future robots look like and do
- discuss bots in medical science and their purpose - nanobots or nanorobots
- humanoids - how are they like man - how are they unlike man
- why use robots instead of humans
- for older students – explain the legal, moral, ethical, human issues involving robotics, i.e. are robots ethically right or wrong, should they have emotions?
- what are humanoids, spider bots, micro robots, artificial intelligence robots

Questions:

In 250 B.C., Ctesibius of Alexandria contributed to the history of robotics how?
In 1896 what was the title of the media that showed robot farmhands of the future?
In 1923 Who coined the word 'robot' and what was the name of the play?
In 1940 what did Isaac Asimov design?
What are the three laws of robotics in Asimov's book?
What was the name of Asimov's book?
What was the name of the movie in 1926 that portrayed robots in the year 2026?What was the robots name?
In 1956 what robot stared in 'Forbidden Planet'?
In the movie 'A Space Odyssey' what was the robots name?
In 1977 what two robots stared in George Lucas' movie?
What was the name of George Lucas' movie?
What type of robot was launched aboard the space shuttle Columbia?
What was the year of the shuttle launce Columbia?
What was the name of the first robot to be able to walk up stairs?
What was the date this robot was introduced?
When was the first operation using robots?
What is NEAR and when did this event take place?
In 2001 the first heart bypass operation was performed in the UK using a robot surgeon – what was the name of the surgical system?

Activity Web Sites

1. http://www.pltw.org/msprogram.shtml high school program
2. http://www.jcutting.freeserve.co.uk/
3. http://www.robotics.megagiant.com/index.html
4. http://www.littlefishsw.co.uk/software/rommy/index.html **Rommy Robot**
5. http://www.robotgames.net/Resources/Gears/gears.htm Gears for older kids
6. http://schoolscience.rice.edu/duker/robots/robotwhatis.html What is a robot?
7. http://www.42explore.com/robots.htm What is a robot?
8. http://school.discovery.com/lessonplans/programs/robbie/ help special needs people
9. robots in the real world - in the home, industry, and in business http://diwww.epfl.ch/lami/robots/K-family/vacuum.html vacuum cleaner
10. http://athena.cornell.edu/educators/lp_06.html Rover Race
11. http://deepspace.jpl.nasa.gov/dsn/educ/gavrt-connectthedots.html Deep Space Network for k-2 connect the dots
12. http://mars.jpl.nasa.gov/MPF/mpf/education/cutouts.html Build your own pathfinder
13. http://spaceplace.jpl.nasa.gov/muses3.htm The real rover and a movie
14. http://puzzlemaker.com/ Create word search puzzles
15. http://robotics.eecs.berkeley.edu/~pister/SmartDust/ Nanobots - 'SmartDust'
16. http://spaceplace.jpl.nasa.gov/muses2.htm How to build a nano rover
17. http://spaceplace.jpl.nasa.gov/muses3.htm The real rover and a movie
18. http://spaceplace.jpl.nasa.gov/robots/robot_puzzle.htm The spider bot
19. http://webpages.marshall.edu/~hamilton/LEGOWEEK/LEGOp3.htm balloon cars
20. http://www.androidworld.com/ a look at androids
21. http://www.androidworld.com/prod07.htm Androids in movies
22. http://www.bbc.co.uk/cbeebies/printables/printcolour/littlerobots/ color sheets
23. http://www.blackdog4kids.com/games/maze/shapes/index.html Robot mazes
24. http://www.bbc.co.uk/science/robots/techlab/sub_showcase.shtml Interact w robots

25. http://www.cartooncritters.com/onlinecoloring.htm Online coloring robot pages
26. http://www.chabotspace.org/vsc/exhibits/ws/robotics/pbjrobot.asp robot activity
27. http://www.imagiverse.org/activities/robotics/mer/elem/ Landscape ideas
28. http://www.gigglepotz.com/robotics.htm Classrooms and Robotics
29. http://www.jeffbots.com/starwars.html Hollywood and fiction robots – R2D2, C3P0
30. http://www.lego.com/eng/create/designschool/lesson.asp?id=1_c&page=2 Gears
    http://www.lego.com/eng/create/digitaldesigner/default.asp Design Legos online
31. http://www.lego.com/eng/racers/dromeduel/default.asp Lego Robot games
32. http://www.miamisci.org/robotzoo/hotlists.php Robot Zoo (traveling zoo of robots)
33. http://www.papert.org/articles/GearsOfMyChildhood.html Papert and gears
34. http://www.renfrew.edu.on.ca/grassroots/gr_alx/challenges.htm building robots
35. http://www.robotics.com/report.html what are robots?
36. http://www.robotics.com/robomenu/ Photos of robots that people made
37. http://www.robotstore.com/download/How_to_solder_1.pdf How to Solder
38. http://www.science-is.com/mechanical.htm Tools and Safety for Children
39. http://www.thetech.org/robotics/activities/page02.html What is a robot
40. http://www.thetech.org/robotics/atyourcommand/index.html Operate a land rover
41. http://www.virtualpet.com/vp/vpindex2.htm robot pet page
42. http://www.wfs.org/forema03.htm Robots of the future –
43. http://www.kidsdomain.com/down/pc/ballooncar.html Balloon Car Builder
44. http://vulcan.wr.usgs.gov/Miscellaneous/ConversionTables/conversion_table.html metric conversion
45. http://www.quia.com/cm/17840.html matching electronics
46. http://sln.fi.edu/pieces/knox/automaton/onlineactiv.htm electronics
47. http://www.starfall.com use for writing, reading, elementary robot story problem solving
48. http://spaceplace.nasa.gov/en/kids/ space games – problem solving, critical thinking, real-life situations
49. http://robotics.nasa.gov/students/faq.htm NASA, questions, educators, challenges, activities, ask a question to robotic engineers
50. http://www.aaamath.com/ math, conversions, metric measurements
51. http://prime.jsc.nasa.gov QWhiz, make a quiz
52. http://www.kidsolr.com/science/page1c.html Kids online resources - robots
53. http://chaoskids.com/ROBOTS/robots.html gingerbread kindergarten
54. http://www.thetech.org/robotics/ older students
55. http://www.thetech.org/robotics/activities/ robotics high school
56. http://www.thetech.org/robotics/activities/fhhs_activities.html gears - preteach
57. http://www.nasa.gov/audience/forkids/games/index.html nasa games, sequencing, space food, dancing robots
58. http://lemurbots.org/ music and robots
59. http://www.mape.org.uk/startower/unit/index.htm remote control robot
60. http://www.pbs.org/teachersource/mathline/concepts/neighborhoodmath/activity4.shtm Older students – math

Sample Ideas:

Sample B – w/o Internet: *Create your own worksheet using books from a library or bookstore:*

Use your text that came with the robot kit to answer the following questions:

a. In 250 B.C., Ctesibius of Alexandria contributed to the history of robotics how?
b. In 1923 who coined the word ‘robot’ and what was the name of the play?

c. What are the three laws of robotics in Asimov's book?
d. What was the name of the movie in 1926 that portrayed robots in the year 2026 and what was the robots name?
e. In 1977 what robots stared in George Lucas' movie - what was the movie?
f. What type of robot was launched aboard the space shuttle Columbia - what year?
g. What was the name of the first robot to be able to walk up stairs and when was it?
h. When was the first operation using robots?
i. In 2001 the first heart bypass operation was performed in the UK using a robot surgeon – what was the name of the surgical system?

Go to http://rubistar.4teachers.org/index.php?screen=NewRubric&module=Rubistar and create a basic rubric for assessing a bot - click on **'create a rubric'**

Refer to the following **troubleshooting tips** for ideas on what to access:

Troubleshooting the BounceBot – list for assessing the finished product

- problems, solutions – what can go wrong and how to fix it
- are the front wheels staying in position?
- are the two gears touching? (may have to raise the spur gear using paper punch or a pencil to make the holes larger.
- is it moving too slow? Too fast?
- does it bounce off the wall?
- if it goes in small circles something is wrong with the cardboard wheels – may have to use tubing to keep them in place
- if it goes too slow it may be the battery or the two gears are meshing too close – raise the wheels using tape to make the holes smaller

Tech Card and Commotion and alternatives to the kit – handout catalogs

- There are actually three ways to build the Bounce Bot – 1) multiple kit - **Ultimate Robot Kit** - kit and text, **ISBN**: 0789479451, **Publisher:** DK Publishing, Inc. 2) as a single unit kit from **The Commotion Company,** and 3) **duplicate the kit** parts once you have one in hand.
- The TechCard construction system and models were devised by David Eckold and are protected by patent and copyright. TechCard is manufactured and distributed by The Commotion, LTD, a leading educational retailer and trade distributor specializing in science and technology equipment to education.
- I have no affiliation with this company and TechCard
- If you duplicate the kit parts it requires a lot of measuring and shopping, but you can do it – you can also purchase sheets of TechCard to make it easier – they are not scored or cut but you can use a razor, cutting board, and template.
- To order a catalog from The Commotion Group go to: http://www.techcard.co.uk/
- Order via mail or FAX and be aware of pricing at this site – it is not US Dollars - look up currency exchange rates for the UK

Decorating, racing, finishing touches, filming and recording – what you might consider doing and ideas

- Have your students decorate their bots – do not use heavy or bulky decorations or anything that will drag the bot down or get caught in the wheels or gears

- If using legos, younger students will want to name their LEGO robot and explain the 'good things' that their robot does and have their picture or video presentation taped
- Take photos or videos of creating and racing the bots
- Create a maze and run the bots through it
- Attach a wireless web cam to the chassis based and let the robot run free
- Create a movie or slide show and use MovieMaker or slide show in Windows XP and include music

An activity idea for older kids – programming and robots:

What to Do (I substitute wrapped candy for the peanut butter)
One person will be the robot, and one will be the "programmer," who tells the robot how to make a peanut butter and jelly sandwich. The programmer's job is to use language that is as precise as possible, so the robot will do exactly what he or she wants. The robot's job is to follow instructions, but at the same time to try hard not to do what the programmer wants.

For example, say the programmer asks the robot to scoop "a little bit" of peanut butter out of the jar. The robot might scoop a microscopic amount of peanut butter out. Once the programmer gets the robot to put a good amount of peanut butter on the knife, the programmer will probably ask the robot to spread it on the bread. The robot can then spread the peanut butter all over the edges of the crusts. It's great fun to be the robot. Use your creativity! Count how many commands it takes to get your robot to do what it's supposed to do.

What does this have to do with robots? Robots can't do anything unless a human tells them (usually this is done through a computer program). As this activity shows, the human must be very careful when programming the robot. Robots can't think about whether they're going to do something destructive or harmful, so they will always do exactly as they're told, even if the person made a mistake in the program.

Purchasing options for incorporating robotics into classrooms:

How to build the Bounce Bot if you don't have the kit
- order one separately from The Commotion, Ltd.
- purchase the entire kit from a book store, duplicate one from the kit and buy cardstock
- purchase TechCard individually or card stock from another source then purchase other items separately

If building from scratch you'll need rulers – imperial and metric
- http://www.printmini.com/printables/rulers/index.shtml – US Measurements
- http://convert.french-property.co.uk/ metric conversion charts
- http://www.vendian.org/mncharity/dir3/paper_rulers/ paper printout metric rulers

Options / ideas / suggestions for cost-effective robot building
- Examine various outlets for purchasing robotic supplies and how to build a basic chassis from heavy card stock paper using the template, create wheels using hole punches, and add axils and gears – use scoring tools and hole punches - or purchase the items individually. (Most items can be purchased from Art Mart, Michaels, Office Max, or any arts and craft stores, hobby shops do not carry many of these types of supplies any longer.)

- To order a catalog from 'The Commotion Group' click on the link below, click on 'contact us,' and fill out the form. Make sure the first item is selected - the box next to 'Please send me your Technology - Solutions For Education Key Stages 3 & 4 2003 Catalogue.' http://www.commotiongroup.com
- http://www.commotionstore.co.uk/index.php?main_page=index&cPath=703_89 click on 'floor robots'
- http://www.solarbotics.com Solar bot supplies

Robot suggestions by age groups

- K to 2nd - **Lego robots** with movable parts and / or micro robots but with no batteries or motors
- 3rd to 4th - **Balloon vehicular bots** for 3-4, chassis, wheels, and balloons
- 5th to high school - **Bounce Bots, programmable string bots**

Supply / check list for Bounce Bot (these supplies may vary depending on your method of building)

- one 4-part set of directions ________
- one supply list (this sheet) _______
- TechCard chassis base_________
- TechCard axle support _________
- TechCard disc support _________
- TechCard bracket ___________
- Two – 30 mm discs for wheels __________
- One – 20 or 30 mm disc to keep main post in position _________
- One - 60 mm disc for top support for steering disk_________
- Two – 40 mm dowels for wheels _________
- One – 50 mm (or 55mm) dowel for post _________
- One – 100 mm dowel for spur gear _________
- One – 30 mm spur gear _________
- Colored steering disc _________
- One worm gear w/reducer _________
- One motor _________
- One battery holder NO_________
- Battery _______
- One paper clip NO_________
- One wire _________
- Four pieces of 5 mm lengths of plastic tubing _________
- 15 mm foam tape _________
- Double sided tape _______
- Decorations _________
- one paper metric ruler _______

Robotic definitions

- **Adaptable** - implies a modification according to changing circumstances.
- **Android** - a mobile robot usually with a human form .
- **AI** - Artificial Intelligence - the capability of a machine to imitate intelligent human behavior.
- **Autonomous** - existing or capable of existing independently .
- **Bionic** - a living creature that is enhanced by electronic or electromechanical devices.

- **Control** - to have power over.
- **Command** - to give orders.
- **Capek** - Czech novelist & dramatist; wrote plays satirizing science.
- **Cybernetics** - the science of communication and control theory that is concerned especially with the comparative study of automatic control systems.
- **Cyborg** - animal human crossbreed, combining a living creature with machine parts.
- **Chip** - a small wafer of semiconductor material that forms the base for an integrated circuit.
- **Circuit** - the complete path of an electric current including usually the source of electric energy.
- **Code** - a system of signals or symbols for communication.
- **Detect** - to discover or determine the existence or presence.
- **Humanoid** - having human form or characteristics.
- **Infrared** - situated outside the visible spectrum at its red end and can send messages.
- **NASA** - National Aeronautics and Space Administration.
- **Program** - a sequence of coded instructions that can be inserted into a mechanism (as a computer) .
- **Path** - the continuous series of positions or configurations.
- **Robot** - a device that automatically performs complicated often repetitive tasks.
- **Seek** - to go in search of .
- **Simulation** - the imitative representation of an action.
- **Sensor** - a device that responds to a physical stimulus (as heat, light, sound, pressure, magnetism, or a particular motion)

6. Final project - PREPARATION

- The final project will be completed and presented during the last night of class – you can have groups of two or three, or work alone
- Locate and create any object that involves force or motion and make it as inexpensive to create as possible – gather enough supplies so that each person can create one – we will be your students and you will be the instructors – in the past projects included pinwheels, mobile
- Create a lesson plan (half page explaining the project and include supplies needed to create the project, how the force or motion project ties in to a curriculum, and a method to assess (rubric or checklist)
- You and your partner(s) will give a short demo of your project and explain the tie in with curriculum and then instruct us on how to make it
- Turn in the rubric or checklist and the short lesson plan, not the object

7. Create projects

HYDRO (water)

Water powered calculator

PENUMATIC

Tipper truck and robotic arm

KIT

Create the bounce bot

Create another bot from the kit (your choice)

SOLAR (crickets, beads, paper, kits with leads)
When energy from the sun is used to create power, we have solar power – we'll work with solar beads, photo paper, kits with leads, solar motors, toy cricket and solar,

HYDRO
Calculator

GEARS
Gear windmills
Gear battery kits

WIND
Older students

- **Propeller chassis-based**

Younger students, and some students with special needs, are not able to connect motors, wires, or insert batteries without quite a bit of help. Even if some are capable of doing so, unless it would be a one–on-one project, it would be difficult for both student and teacher.

The balloon-powered car is an excellent way for younger students to create an object that does something, goes somewhere, and uses energy of some sort.

Balloon powered chassis based bots (There are CDs and diskettes of the balloon car builder, web site or downloaded program.) **Build a balloon powered Nanorover bot:**

- After the car is complete time it to the finish line – ideas include:
    - Compare and contrast
    - Try putting larger and smaller wheels on the bot and time it
    - Put larger axles on the car and time it

Troubleshooting a balloon powered bot:

- Check that the wheels spin properly – they must rotate freely on the axle but not too freely so that they won't move the axle - try to strike a happy medium
    - give the wheels a spin with your finger, if they don't spin freely then enlarge the holes in the chassis by inserting the end of a pencil or pen and rotate
    - if the wheels spin too freely, and the axle doesn't 'follow' the wheels, then apply some tape to the axle and put the wheels over the tape or try a different dowel rod

- **Merry go round (hand/wind powered – push/pull - for Pre-k + and special needs)**
    - Recreate playground equipment – push – pull

MORPHING
Morphing is not really energy or a robot, although robots are often used to demonstrate morphing. Morphing is really motion – it is included in our robotics class because of it's popularity and misconception by students that morphing is robotics.

a. Go to this site – morphing examples http://www.morpheussoftware.net/
b. Morphing balls
c. Morphing activity with math
http://pbskids.org/cyberchase/parentsteachers/lessonplans/lesson7.html

8. Microbots and Nanotechnology

a) Nanotechnology http://www.sciencefriday.com/kids/sfkc20030926-2.html
b) Palm sized bots http://mobilemag.com/content/100/102/C1547/

9. Androids

a) Androids today - http://www.androidworld.com/
b) Androids in the movies – http://www.androidworld.com/prod07.htm

10. Assessing the finished product

Is it working, is the curriculum you chose working, problems, solutions…

Items to consider:

- what it is supposed to do
- does it do what it's supposed to
- does it complete the task (complete what it is supposed to do)
- are the pieces to the bot placed appropriately
- does the bot stay together or does it fall apart as its running
- are the axels moving with the wheels, are the wheels aligned
- is it aesthetically pleasing or is it just slapped together
- are the gears turning
- if working in groups did members contribute equally
- were all members cooperative

Sample rubrics: (also click on the class photos)
http://www.renfrew.edu.on.ca/grassroots/gr_alx/Rubrics.htm

Kindergarten very basic sample rubric:

4 – WOW – The student exceeded the expectations for the science framework addressed, usually by doing extra work beyond the GOT IT requirements.
3 – GOT IT – The student fully meets the expectations for the science framework addressed.
2 – NOT YET – The student's work indicates understanding but the work does not meet all the requirements for the science framework addressed.
1 – TRY AGAIN – The student's work does not indicate understanding.
0 – NO EFFORT – Absent, Nothing turned in, etc.

11. Standards - MoSTEP not ISTE NETS

- Correctly use numbers, number systems, and equivalent forms including words, objects, and graphics, to represent theoretical and practical situations.
- Compute, measure, convert, and estimate to solve theoretical and practical problems using appropriate tools, including modern technology such as calculators, rulers, and computers.
- Apply the concepts of patterns, functions, and relations to solve theoretical and practical problems.
- Formulate and solve problems and communicate the mathematical processes used and the reasons for use

12. Learning outcomes / goals / objectives

- Students will analyze information to solve a given problem related to physics and robotics including torque, revolutions, fulcrum, push, pull, and rpms.
- Students will analyze the history of robots and create a time line
- Students will build and explain how simple structures and mechanisms work together to make an object move
- Students will communicate the procedures and results of investigations
- Students will compare various types of robots including artificial intelligence and androids
- Students will convert, analyze, estimate, and compare and contrast measurements in both metric and English unit of measurements
- Students will create a time line displaying important key events in the study of robotics.
- Students will define a lever as a rod or arm that tilts around a pivot to produce useful motion.
- Students will define a pulley as a wheel with a grooved rim for a belt or cord, which can transfer force or speed.
- Students will demonstrate an understanding of the factors that affect the stability of objects
- Students will demonstrate the ability to scale models of robots in both metric and Imperial measurements
- Students will describe the fulcrum, effort, and load (or resistance) of a lever
- Students will design a method for analyzing and evaluating a finished product
- Students will design and create a working chassis-based robot
- Students will design and demonstrate knowledge of a pulley and gear system
- Students will develop an understanding of the attributes and engineering of design and basic electronics and mechanical, including high and low torque, power, gears, gear teeth, gear rotations, and gear ratios, axels, chassis, turning force, simple machines, gear transmissions, gear stacks, sensors, control devices, pneumatics, components, pumps, valves, levers, pulleys, artificial intelligence, solar panels, batteries, wires, motors, and revolutions
- Students will discuss and evaluate Mars pathfinder and Mars Exploration Rover missions in relation to chassis, wheels, and gears
- Students will experiment and evaluate using problem-solving skills in regards to attachments to robots and robot movements (i.e. attach a laptop with a webcam to a robot and move around the building or playground to record events)
- Students will explain the value of robots
- Students will explain, define, and demonstrate the purpose of gears - , how to use gears to increase speed and force, how to use gears as a toothed wheel, which meshes with another toothed wheel to transfer force or speed, i.e.
- Students will identify and label parts of a robot
- Students will identify and use appropriate tools necessary to assemble a robot
- Students will investigate how motion is transferred from one system to another
- Students will investigate, explore, plan, predict, hypothesize, and design a robot
- Students will journal, write essays, or present oral reports and demonstrations on the results of their experiments from a robot that they built
- Students will make decisions and use critical thinking skills to problem solve unique robot designs by determining functions of their robot
- Students will recognize situations that call for division and interpret the answer correctly

- Students will synthesize robotics technology into many discipline areas
- Students will test the reliability, strength, and performance of a robot
- Students will understand geological terms related to landforms and terrain of Earth and other planets that involve the Mars Rover for example
- Students will use appropriate vocabulary to describe their investigation

13. Grouping students - via learning and teaching styles , self – quizzes – the best way to group is to know your students – the best way to know your students is to give them learning style quizzes – fun and easy and quick .

You don't want groups of students working together in a robotics class if the majority of students are verbal. They won't get anything accomplished! So determine how your students learn and pair them up accordingly.

- There are three main basic learning styles: visual, auditory and kinesthetic. Most educational experiences cater to only one of the three main learning styles – visual. In a school, everything is highly visual, catering to the visual learner – neat and organized - writing and drawings on display. Teaching is usually accomplished with charts and graphs. Those who learn best by listening or through a physical modality are out of luck. Robotics is a change for these people to shine!
- If a student wants to improve and expand their learning capabilities, recognizing how one learns is the first step. If an educator wants to improve their teaching capabilities, realizing that how they learn is most likely the way they teach is the first step to learning how and when to modify teaching strategies.
- When learning about counting, for example, a physical learner may need to use blocks, an abacus, or other concrete materials to practice the new concept. A visual learner will grasp the material more quickly by watching his teacher solve a problem in front of him. An auditory learner will remember the information if he can listen to the teacher explain it and answer his questions.
- Become knowledgeable. Recognize your learning preferences and that will assist you in recognizing your teaching preference and assist you in modifying if / when necessary.
- These learning styles aren't just speculative – studies have shown that when accommodating learning styles, an improvement in learning is increased significantly. In early 90s the U.S. Department of Education utilized learning styles as a strategy to improve test scores on national tests for special education students.
  "There are probably as many ways to "teach" as there are to learn." We are primarily concerned with linguistic and visual for robot building because we're concerned with how students are best able to follow directions – words or pictures?

  - http://www.metamath.com/lsweb/fourls.htm - styles explained
  - Take a self-test to determine how you learn, study, and take in information http://vark-learn.com/english/index.asp Click on 'questionnaire' at the top, right.

  - http://www.ldpride.net/learning_style.html 30 questions
  - http://www.ldpride.net/learningstyles.MI.htm#Multiple%20Intelligences%20Explained - seven types of multi intelligences
  - http://www.dushkin.com/connectext/psy/ch11/survey11.mhtml locus of control site

Suggestions for grouping when building robots

- In robotics you may want to group your students as they're building their robots but not when they decorate, or race.
- Three to a group is ideal - four might be better in case one student is missing, then the other three can continue
- Assign jobs and monitor often - for building and researching the following job responsibilities might work – writer (using computer and helping the researcher find pertinent items), researcher (using computer), two builders – the writer and the researcher will act as 'foreman' for the two builders when the time comes to build and until that time the two builders will take inventory of parts and label items.
- For the finished product assign job responsibilities to individuals and ungroup - have a timekeeper with a stop watch – another might stand at the finish line, another at the start line - another might be the note taker

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