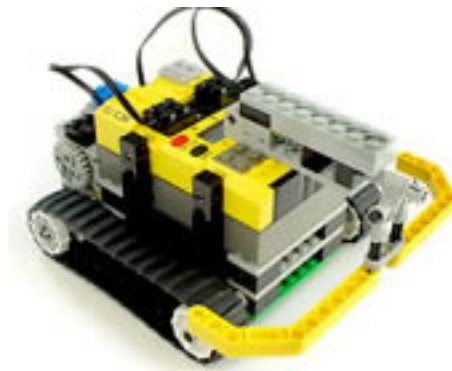


ROBOTICS CURRICULUM

USING LEGO® MINDSTORMS®
ROBOTICS KITS



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**Youth Engaged in Technology Program
(YET)**



PA New Community Project: Youth Engaged in Technology

Introduction to Robotics

The YET Robotics curriculum closely follows the lesson plans from the “Robotics Educator” CD from the Carnegie Mellon Robotics Academy.

This Robotics Module allows the educator to teach basic electronic control and some elements of advanced programming logic. This module also includes more time for several student explorations in mechanics. Students should be actively engaged in inquiry-based lessons that teach lessons on mechanical advantage, measurement, ratios and proportions. The last part of the module involves an open-ended challenge where students get practice with problem solving, teamwork, and project management.

Resources available on this CD-ROM

Building Instruction slideshows

- Tankbot
- Touch Sensor
- Light Sensor
- Rotation Sensor
- Gear Box / Gear Box Attachment
- Worm Gears
- Gripper I
- Gripper II

Programming examples for

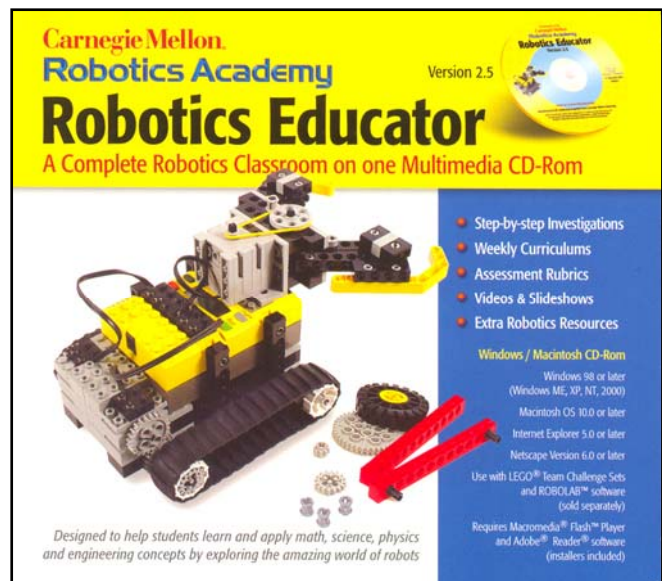
- Motors and Timers
- Touch Sensor
- Light Sensor
- Rotation Sensor

Mechanics Module investigations (demonstrations)

- Gears and Distance 1 (spur gears)
- Gears and Torque 1 (compound gear ratios)
- Gears and Torque 2 (worm gears)

Robolab instructional tools

- Robolab Icon guide (Adobe Acrobat / .pdf)
- Robolab Programming guide (Adobe Acrobat / .pdf)



Construction techniques / Mechanics helper links:

- LEGO Building Tips (slideshow)
- Sensors (slideshow)
- Cross Bracing
- Spur Gears
- Bevel Gears
- Worm Gears
- Compound Gear Ratios
- Balance
- Friction

Open Ended Design Challenges

Assessment tools

- Work habit evaluation form
- Workplace competencies evaluation form
- Robot design rubric / Presentation rubric / Daily log

Robotip:

It is extremely important to have students cover their IR tower and robot whenever multiple users are beaming programs. If a robot receives a signal from multiple IR towers at the same time the firmware becomes corrupt and needs downloaded again. (Open the “Download” Helper Link on the CD-Rom for details.)

Resources

Youth Engaged in Technology (YET): <http://cyfar.cas.psu.edu/>

The YET project is a program that uses technology as a tool to engage young people in learning and contributing. Through YET involvement, youth enhance their marketable job skills as well as develop leadership skills. The major focus of the meetings is technology such as robotics, GPS/GIS, web page development, and nano-fabrication. Club members participate in community service activities related to technology. The YET program also increases the likelihood that the youth will be successful and have a sense of belonging to their community.

Robotics Academy: <http://www-education.rec.ri.cmu.edu/>

The Robotics Academy is committed to using robotics to excite children about science and technology and to help create a more technologically literate society.

The Robotics Academy Mission Statement

- To develop a mathematically competent and technological literate workforce
- To influence children to become interested in robotics and related technologies as an area of study and future employment
- To grow future entrepreneurs and employees for the region and nation
- To enhance the economic development of these technologies in Southwestern Pennsylvania
- To develop standards-driven curriculum for middle and high school teachers
- To catch kids having fun experimenting with science and technology

LEGO Education MINDSTORMS:

<http://www.lego.com/eng/education/mindstorms/default.asp>

First launched in 1998, LEGO® MINDSTORMS® for Schools (LMfS) and ROBOLAB™, each year have helped countless students grasp science, technology, engineering, and math concepts with hands-on, naturally motivating building sets, programming software, and curriculum relevant activity materials.

To purchase the LEGO MINDSTORMS Robotics kits you can visit the LEGO Education site.

The LEGO Education store is located at the following Website: <http://www.legoeducation.com/>

Teamwork & Teamplay

Cain, J., & Jolliff, B. (1998). *Teamwork & Teamplay*. Dubuque, IA: Kendall/Hunt Publishing Company

A Guide to cooperative, challenge and adventure activities that build confidence, cooperation, teamwork, creativity, trust, decision making, conflict resolution, resource management, communication, effective feedback and problem solving skills

<http://www.teamworkandteamplay.com/>

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Robotics – LEGO® MINDSTORMS® Week 1

1st Session

Overview: The first few weeks of this module are used to teach basic electronic control and programming logic. The investigations for the first two weeks will use Tankbot and the Robotics Academy designed sensors that attach to Tankbot.

Install RoboLab software and test IR communications with the RCX.

Build several Tankbots and download programs that demonstrate the capability of sensors. This demonstration is to be used as an anticipatory set to excite the class about the robotics activities they will be exploring in the days and weeks ahead. Suggested robots:

- Tankbot with a touch sensor attachment – use the programs from Exercises 1, 2, & 3 of the Touch Sensor Exercises in the Programming Module.
- Tankbot with light sensor attachment – use the programs from Exercises 1, 2, & 3 of the Light Sensor Exercises in the Programming Module.

Demonstrate RoboLab software. Each teacher will have his or her own style of teaching. It is suggested that initially students be taught rudimentary RoboLab programming rules. Teach them how to use the help screen, then let them begin. Each day more complex RoboLab functions will be added. (If you have never used RoboLab, a RoboLab Programming Training Guide is available in the Teachers Resources section of this CD.) The following RoboLab functions need to be taught initially:

- Programmer mode
- Functions Pallet
- Tool Pallet
- IR Tower
- Downloading a program

2nd Session

Demonstrate the following:

- Motors and Timers
- Touch Sensors

Present the Touch Sensor slideshow.

- Demonstrate the "Wait-for-Push" icon (a conditional statement).
(Exercise 1 - Touch Sensors / Programming Module)
- Demonstrate the "Jump" and "Land" icons (example of an infinite loop).
(Exercise 5 - Motors and Timers / Programming Module)
- Demonstrate a loop.
(Exercise 5 - Motors and Timers / Programming Module)

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Robotics – LEGO® MINDSTORMS® Week 2

1st Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Magic Carpet (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 125)

Review BugBot Building Instructions .pdf

Present BugBot – Touch Sensor Exercise 3 / Programming Module.

2nd Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Human Knot (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 107)

QUIZ

Check for understanding the of basic programming concepts:

- Identification of Icons
- Conditional Statements
- Loops
- Wait states
- What is a sensor?

Present Light Sensor slideshow.

Administer basic programming Quiz.

Demonstrate Light Sensor applications

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Robotics – LEGO® MINDSTORMS® Week 3

1st Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Line Up (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 113)

Light Sensors

- Wait for Dark
(Exercise 1 - Light Sensors / Programming Module)
- Wait for Light
(Exercise 2 - Light Sensors / Programming Module)
- Line-Track Right
(Exercise 3 - Light Sensors / Programming Module)

2nd Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Just One Word (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 110)

Continue with Light Sensors

- Line-Track Left
(Exercise 3 - Light Sensors / Programming Module)
- Timer Sensor Forks
(Exercise 4 - Light Sensors / Programming Module)

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Robotics – LEGO® MINDSTORMS® Week 4

1st Session

Demonstrate rotation sensor using Tankbot

Present Rotation Sensor slideshow

Assign Rotation Sensor Programming Lessons (Programming Module) to students.

Overview: Some students will still be learning how to program while others complete the Programming Exercises and Open Ended Challenges from the Programming Module. As with all decisions made in today's classroom, it will be up to each teacher to decide the appropriate pace for his/her class. While students are developing competencies with electronic control and programming, each day in week 3 a new mechanical concept will be introduced. These modules are designed as student-driven investigations. Each investigation will take a team of students one class period. Once again, it will be up to the teacher to decide how much time they have to spend on these lessons.

2nd Session

Build and program several modified Tankbots from Gears and Distance Investigation 1 that demonstrate how gears change speed, torque and distance traveled.

Demonstrate robots

Review math related to fractions

Demonstrate how to calculate gear ratios.

Assign student worksheets calculating gear ratios.

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Robotics – LEGO® MINDSTORMS® Week 5

1st Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Plenty of Room at the Top (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 146)

Review measurement, if necessary.

Build and program several modified Tankbots with the Rotation Sensor from Gears and Distance Investigation 2.

Build the gearbox from Gears and Torque Investigation 1.

Build the worm gear assembly from Gears and Torque Investigation 2.

Demonstrate how to calculate compound gear ratios.

2nd Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Worm Hole (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 206)

Present the LEGO Building Tips slideshow.

Review balance and friction as they apply to robots.

Present a design challenge at the end of the week (based on students' progress to date) so students have a chance to think about possible solutions.

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Robotics – LEGO® MINDSTORMS® Week 6

1st & 2nd Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Tower Building (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 188)

Overview: All explorations until now have involved a mobile robot. During week 4, students will be introduced to End Effectors and Grippers. The mechanical design involved in designing effective grippers can be challenging for students. As you review the students' designs encourage them to try to increase mechanical advantage by using gears. Also encourage them to cross-brace the gripper to their robot for strength. There are several introductory ideas for grippers included in the slide shows.

Present the Gripper I and Gripper II Slideshows.

Identify a simple task (Design a robot with a gripper to move autonomously to an object and pick it up and bring it back to the start position. A ping-pong ball, film canister, empty pop can, or some similar object can be used.

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Robotics – LEGO® MINDSTORMS® Week 7

1st & 2nd Session

- *Team Building Activities* – start off with some team building activities to get the students used to working together.
 - Under the Doormat (Teamwork & Team Play, Jim Cain and Barry Jolliff, p. 194)

Present the Open Ended Design Challenge that will be used in weeks 5 & 6.
Present and discuss the Design Review handout.

Divide groups into teams and conduct a preliminary design review to discuss strategies on how to complete the challenge.

Have the students prototype solutions.

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Robotics – LEGO® MINDSTORMS® Weeks 8-9

Present Design Reviews

The students will be assigned to teams of 2-4 to a group. Younger students should be placed in smaller groups. (Read the section on dividing into teams under Workplace Competencies in the Teacher's Resources folder.) The last day of week 6 should be reserved for the competition. The rules should be spelled out in advance. Part of the project involves a student presentation of the mechanical and programming choices each team made to play the game. Each teacher will have a different emphasis on what they want to accomplish with this project.

Students will...

Observe teacher demonstration of the following:

- Robolab Programming demonstration
- Tankbot building instructions
- Sensor parts evaluation
- Touch Sensor and Light Sensor examples
- Gear demonstration

Complete teacher assigned programming exercises that reinforce the concept the teacher demonstrated that day.

Complete the Open Ended Design Challenge at the end of each activity to reinforce their understanding of:

- Programming Logic
- Motors and Timers
- Light and Touch Sensors
- Rotation Sensors

Participate cooperatively in the open-ended design problem at the end of the module.