GEARBOTS

ROBOTICS ENGINEERING PROGRAM ~ gearbots.org

History of Mindstorms Robotics:

Lego Mindstorms is a line of Lego sets that combine programmable bricks (8bit or 32bit) with electric motors, sensors, bricks, and Lego Technic pieces (such as gears, axles, beams, and pneumatic parts) to build robots and other automated or interactive systems. The first retail version of RCX Lego Mindstorms was released in 1998 and marketed commercially as the Robotics Invention System (RIS). The current version was released in 2006 as Lego Mindstorms NXT.

The original RCX Mindstorms Robotics Invention System kit contains two motors, two touch sensors, and one light sensor. The new NXT version has three servomotors and four sensors for touch, light, sound, and distance. Lego Mindstorms may be used to build a model of an embedded system with computer-controlled electromechanical parts. Many kinds of real-life embedded systems, from elevator controllers to industrial robots, may be modeled using Mindstorms.

Mindstorms kits are also sold and used as an educational tool, originally through a partnership between Lego and the MIT Media Laboratory. The educational version of the products is called Lego Mindstorms for Schools, and comes with the ROBOLAB GUI-based programming software, developed at Tufts University using the National Instruments LabVIEW as an engine.

Program Overview:

Robotics is a fun, highly engaging program that reinforces science, technology, engineering, and math concepts. It is also teaches leadership, teamwork, time management, organization, and design skills.

The participants will be introduced to the highly acclaimed and popular Lego NXT Mindstorms platform. In the course, students will learn how to engineer complex mechanical devices, while simultaneously learning how to program a robot to complete a number of tasks and challenges. Students will work together in engineering teams to solve tasks and challenges as well as compete against other teams in class competitions. The course will integrate core math, science, technology and employability skills needed for successful life long learning.

The Lego Philosophy: "Learning by Making"

- Problem (project) based learning (making observations and learning from their mistakes)
- Utilizes the engineering problem solving strategy (STEM approach)
- Modular (scaffolding) approach – self paced / guided discovery
- Focus on mastery of skills (formative / summative)
- Teamwork (engineering teams)
- Multidisciplinary approach:
  - Engineering (hard skills) + programming (soft skills) + problem solving (life skills)
- Focus on life skills: Employability Skills Profile 2000+ (Business Council of Canada)

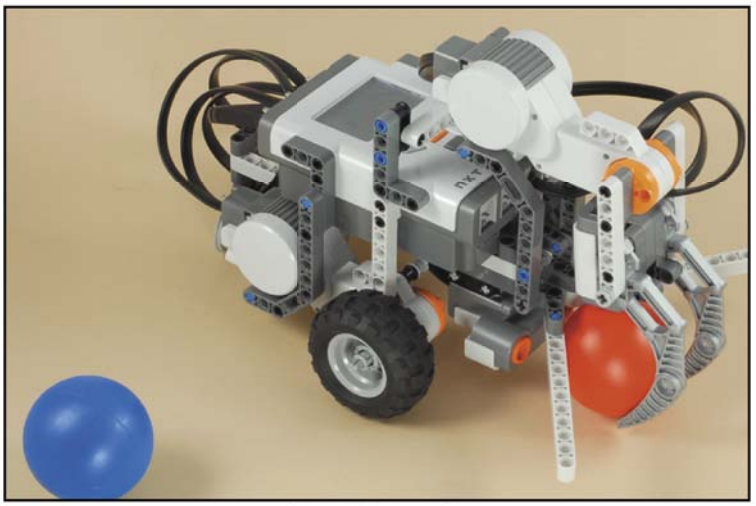
Connecting Robotics to the Curriculum:

Mathematics:
Means and thresholds (averages), fractions, ratios, proportions, unit conversion, Pi, comparisons, order of operations, angles and degrees, balancing equations, variables, plotting data, linear measurements, problem solving

Technology:
Sensors, mechanical elements, simple machines, troubleshooting, design inquiry, mechanical advantages, loops, debugging, programmatic logic statements, technology in society, purpose of technology, technology as a tool, teamwork to produce technology, unintended benefits

Science / Engineering:
Motion, direction, center of mass, engineering process, wavelength, amplitude, tone, reflectivity, torque, gears, ratios, observation

Employability Skills Profile 2000+
Teamwork, brainstorming, problem solving, learning from mistakes, summarizing, defending a position, compare / contrast, describing real world linkages, organizing information, reasoning with evidence, effective communication

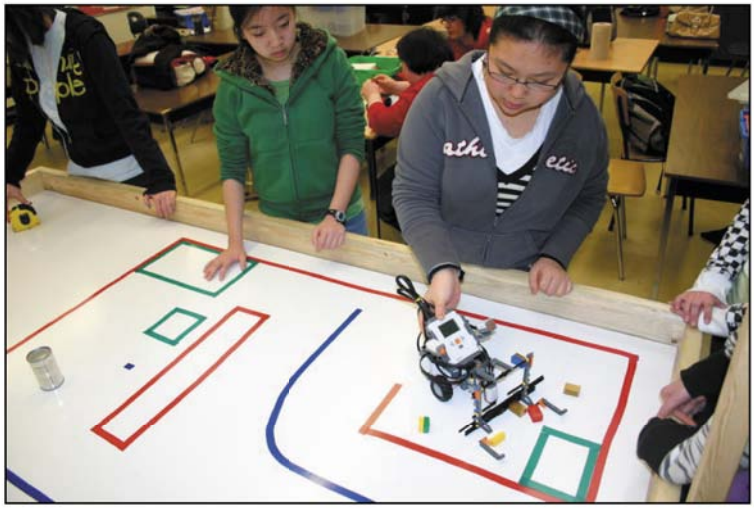


Ball Hunting Robot

Why Teach Robotics?

Robotics is fast becoming an integral part of the school curriculum with it's ability to integrate across a broad range of topics, most notably the Technology, Science and Math Key Learning Areas.

Robotics encourages kids to think creatively, analyze situations and apply critical thinking and problem solving skills to real world problems. Teamwork and co-operation are a cornerstone of any robotics project. Students learn it is acceptable to make mistakes, especially if it leads them to better solutions.



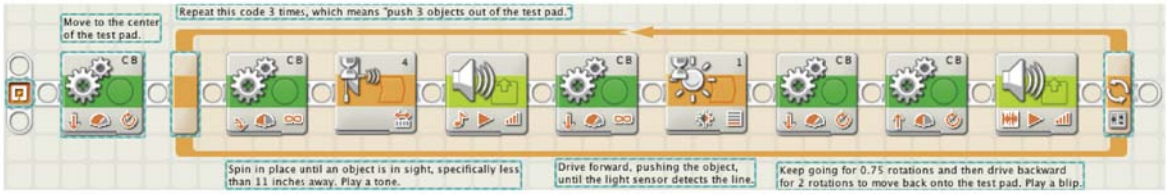
Team testing robot for the Clean House Challenge.

Robotics is a fun and engaging way to teach fundamental math, science (engineering) and technology concepts. There are several key facets that the teaching of robotics promotes:

Problem Analysis: Robotics encourages students to take a broad look at a situation and identify exactly what problem needs to be solved. Real world applications are easily found, giving students context for their project. Before any construction can begin, students must identify "what need will this robot fulfill?". With this in mind, how should the robot be designed to meet these need?

Real World Design: With an application in mind and an idea of implementation, students can now begin the design process. This stage provides great rewards for students as the as they produce physical realizations of conceptual ideas. There is plenty of opportunity for refinement and improvement as they discover errors in their plans and issues they would never have considered during the design stage. Prototypes are quickly built and just as quickly discarded with lessons learnt as students progress towards an optimal solution. Resources must be managed and compromise made between form, function and cost.

Programming: There are a variety of programming languages available for robotics, from graphical development environments to text based languages. Programming skills teach students to think logically and to consider multiple situations, as they learn a robot will do exactly as it is told, no more and no less. Information from a variety of sensors must be processed and dealt with logically and as with the design stage, there is ample opportunity for trial and error as students fine tune their robots to perform at their best.



Sample program using the NXT-G software language. The robot will look for a ball and push it out of a marked area

The Science, Technology, Engineering, and Mathematics (STEM):

The Science, Technology, Engineering, and Mathematics (STEM) fields are collectively considered core technological underpinnings of an advanced society. In many forums (including political/governmental and academic) the strength of the STEM workforce is viewed as an indicator of a nation's ability to sustain itself. Maintaining a citizenry that is well versed in the STEM fields is a key portion of the public education agenda of the United States of America. Substantial lobbying is underway in Washington, DC to raise awareness of STEM education issues.

In the State of the Union Address on January 31, 2006, United States President George W. Bush announced the American Competitiveness Initiative. Bush proposed the initiative to address shortfalls in federal government support of educational development and progress at all academic levels in the STEM fields. In detail, the initiative called for significant increases in federal funding for advanced R&D programs (including a doubling of federal funding support for advanced research in the physical sciences through DOE) and an increase in U.S. higher education graduates within STEM disciplines.

In 2006, the United States National Academies expressed their concern about the declining state of STEM education in the United States. Its Committee on Science, Engineering and Public Policy developed a list of 10 actions federal policy makers could take to advance stem education in the United States to compete successfully in the 21st century. Their top three recommendations were to:

- increase America's talent pool by improving K-12 science and mathematics education;
- strengthen the skills of teachers through additional training in science, math and technology; and
- enlarge the pipeline of students prepared to enter college and graduate with stem degrees.

The National Aeronautics and Space Administration also has implemented programs and curricula to advance STEM education in order to replenish the pool of scientists, engineers and mathematicians who will lead space exploration in the 21st century.

The NASA Means Business competition, sponsored by the Texas Space Grant Consortium, furthers that goal. College students compete to develop promotional plans to encourage students in middle and high school to study STEM subjects and to inspire professors in STEM fields to involve their students in outreach activities that support STEM education.

Generous support for this program provided by:

Mitchell Odyssey Foundation

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