

Robotics Curriculum Proposal - Middle School

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This is a description of a robotics curriculum proposal for our district's middle school, starting in grade six. The proposal requires purchasing a curriculum set and the robotics hardware/software that is made and marketed by Lego and used worldwide in the First Lego League Competitions. This proposal is to start with the sixth grade and eventually expand it so that the seventh and eighth grades would also have a robotics unit. This would also maximize the utilization of the hardware/software kits, although additional curriculum may be added at a later date. This proposal outlines the purpose and importance of this curriculum, technology required, curriculum standards, recommended activities, assessments and research used. Implementing this curriculum in our schools as this time is vitally important to teach students the skills that are needed as 21st Century learners and workers and to expose them to future technologies and career opportunities.

Plan Description

“One of the most important skills in society will be creative thinking” (Resnick).

Today’s workforce requires skills that students should learn to be able to work in a team, solve complex problems independently and understand the complexity of systems – problems are not islands but are parts of large systems and have influences on other parts. Workers need to develop the ability to create and build and also to articulate a description of what they create. Students should be introduced to the potentials of future technologies and be introduced to some of the skills that will enable them to adapt to using and working with technologies that we don’t even know what they will be yet. Learning to build and program robots introduces students to these skills in an interactive way that allows students to learn new skills and try to manipulate a robot to perform certain tasks. The immediate feedback allows students to gain an understanding of what they programmed. Students have the opportunity to try a variety of solutions and then visually see if what they thought would work did and if it doesn’t they can immediately attempt a different solution. This iterative process encourages creativity and problem-solving. There are usually a variety of solutions to any problem and working in this way can encourage students to think in a variety of ways and to try a variety of attempts to see which ones might work better.

Technology Requirements

The technology we will use in this curriculum will be the Lego NXT robots with Lego Mindstorms NXT software. It is packaged and sold as a kit: NXT Robotics Engineering I: Introduction to Mobile Robotics. The software is compatible with the computers we currently have in the classroom, which all run Windows XP. The set provides 12 Lego robots sets which will allow 24 students to work in pairs, the NXT Mindstorms

software, the Carnegie-Mellon developed curriculum which teaches programming, behaviors, systems, control, sensors, feedback, in the context of science projects.

Context

This curriculum is designed for the sixth grade science and technology units. We will work within the science unit on Newton's laws of motion, and extend it several weeks to allow time to implement builds and programming activities.

Force and Motion Unit:

- Define the force which causes an object to undergo a change in direction or speed.
- Design a simple experiment, which will demonstrate the effect of gravitational force on an object.
- Create and/or reassemble technological models and identify how they work.
- Identify and gather information needed to make a decision on a scientific and/or technological issue.
- Describe the various alternative decisions to a scientific or technological issue.
- Describe or conduct an investigation which illustrates that for every action there is an equal and opposite reaction.
- Design a simple experiment or demonstration to show the difference between potential and kinetic energy.

The curriculum activities will be a combination of staff-developed and the Carnegie Mellon's Mobile Robotics curriculum.

Standards:

Math:

Problem Solving and Reasoning:

- Determine, collect and organize the relevant data needed to solve real-world problems.
- Apply problem solving strategies to solve problems in the natural and social sciences and in pure mathematics.

- Formulate questions, conjectures, definitions, and generalizations about, data, information, and problem situations.
- Recognize that many real world applications require an understanding of use of mathematical concepts.
- Explain in oral or written form the relationships between a real-world problem and an appropriate mathematical model.

Science

Scientific Inquiry:

- Formulate questions and use appropriate concepts to guide scientific investigations and to solve real world problems.
- Use technologies as tools in conducting investigations.
- Construct and revise scientific explanations and models using logic and evidence.
- Explain how scientific knowledge is applied in the design and manufacture of products or technological processes.

Unifying Themes and Concepts:

- Convert data collected from measurements into graphs and derive mathematical relationships from the data and graphs.

Technology (new NETS standards):

Creativity and Innovation:

- Students think creatively, construct knowledge, and develop innovative products using technology.

Communication and Collaboration:

- Students use digital media and environments to communicate and work collaboratively to support individual learning and contribute to the learning of others.

Critical Thinking, Problem-Solving and Decision-Making:

- Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate technology tools.

Activities

The activities will come from the Carnegie Mellon developed curriculum. Students will work in teams of two.

“There are twelve major activities sequences in this unit, students will complete approximately two per week:

1. The Full Speed Ahead Activity guides students step-by-step through the process of setting up the programming environment, programming the robot, and running the basic moving forward program.
2. The Wheels and Distance Investigation involves students in an investigation of the relationship between wheel size and the distance the robot travels given a set number of wheel rotations.
3. The Right Face Activity which guides students step-by-step through the process of building two different programs each of which produces a different type of turn.
4. The Measured Turns Investigation, which involves students in an investigation of the relationship between robot geometry, motor degrees, and the amount the robot turns.
5. The Clap On, Clap Off Activity, which introduces students to sensors, specifically the sound sensor. Students are led step-by-step through the process of finding a threshold, programming the robot, and running through several programs that rely on the sound sensor to control their robots behavior.
6. The Frequency and Amplitude Exploration, which involves students in an investigation of the properties of a sound wave, and which properties of the sound wave that the sound sensor is able to distinguish.
7. The Follow the Guidelines Activity guides students step-by-step through the process of programming the robot, and running the basic line following program.

8. The Faster Line Tracking Exploration involves students in a study of the factors involved in line tracking, and explains how to modify their robot to line track more efficiently.
9. The Obstacle Detection Activity guides students step-by-step through the process of programming the robot to respond to two different types of sensory stimuli.
10. The Field of View Investigation has students further explore the detection abilities of the Ultrasonic Sensor but laying out a field of view plot and then scaling it to fit on a sheet of paper.
11. The Get in Gear Activity, which guides students step-by-step through the process of changing the robot's gears, running the basic moving-forward program, and observing the differences created by the different gear ratios.
12. The Gears and Speed Investigation, which involves students in a quantitative investigation of the relationship between gear ratio and robot speed.

The final culminating activity will involve an open-ended activity where students will work in teams of four and will compete in a challenge. The challenge will be selected from one of the prior year's FLL activities.

Assessment

"You can discover more about a person in an hour of play than in a year of conversation." (MIT Professor Mitch Resnick on creative play – Lego podcast #2) The Carnegie Mellon Curriculum provides activity completions which will be documented by photographs or video and each activity has assessment quizzes that will be taken online. These quizzes can be taken multiple times and are meant to provide feedback that will help students learn more and locate additional resource materials. In addition, students will each be keeping a journal on each activity in their Moodle course that will document their participation, learning, difficulties and questions. The

student will select an activity artifact to include in their online portfolio and provide a description why it is included and a reflection.

Research

Observations from the Jason Project found that the hands-on approach and inquiry process enable students to develop a firm understanding of the scientific process. (Goldenburg 2003)

At Indiana University, Purdue University Fort Wayne, they found that implementing an introductory technology course that utilized robotics increased program retention (the goal of the course offering) and encouraged students to develop problem solving and teamwork skills and fostered their creativity and logic. The project work allowed students to not only achieve basic computer knowledge but also built on their abilities to work in a team. (Pomalaza-Raez, Groff)

Randy Pausch in *A Curmudgeon's Vision for Technology in Education*, proposes that "Programming will become something that every child learns, both as potential vocational training, and as a mode of thought." He believes that students will learn to program robots in primary grades as a basic skill, much like art or physical education. (Pausch 2003)

R. Stanley Williams aptly quotes "the universal truth attributed to both Chinese and Native American wisdom: 'Tell me and I'll forget. Show me and I may remember. Involve me and I'll understand.'" Robotics integrated into multi-disciplinary curriculum projects provides the appropriate platform for students to gain the understanding that is necessary for them to utilize technology in the workplace.

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