PARSIPPANY-TROY HILLS TOWNSHIP PUBLIC SCHOOL DISTRICT

TEC818 ROBOTICS II - MIDDLE SCHOOL

Authored by: Heather Andres and Joseph Guartifierro

Reviewed by: Tali Axelrod and Rachel Villanova

Approval Date: August _______________

Parsippany-Troy Hills Township Public Schools
292 Parsippany Road Parsippany, NJ 07054
www.pthsd.net

I. OVERVIEW

Robotics II is an one quarter, elective course offered for students at the Middle School level who have previously taken Robotics I. The students will focus on hands-on methods for the design and development of robotic devices whose function is to accomplish prescribed tasks. Each individual will experiment with a variety of configurations while writing programs that allow the robot to navigate intelligently and autonomously.

The Robotics II course will utilize models and methods that facilitate student understanding. An emphasis will be placed on simple machines in terms of moving, turning, lifting, sensing the environment in terms of light, contact and proximity, monitoring interval states; and most importantly, solving problems that occur in everyday life. The entire program and lab experience is both kinesthetic and computer-based, to maximize student learning and understanding. Continuous assessment occurs to gauge student progress and inform instruction.

II. RATIONALE

Robotics II will be offered to a wide range of students who have varying abilities and interests. It provides strong interdisciplinary connections to areas of mathematics, science, engineering, and technology. Students will consistently be afforded the opportunity to make real-world connections to robotic devices that are currently being utilized in society today; and its engaging nature makes it very appealing to many Middle School students.

The Robotics II curriculum is aligned with the New Jersey Student Learning Standards for Science, 21st Century Life and Careers, English Language New Jersey Student Learning Standards for Science and Technical Subjects and Technology.

III. STUDENT OUTCOMES (Link to New Jersey Student Learning Standards)

In accordance with district policy as mandated by the New Jersey Administrative Code and the New Student Learning Standards, the following are proficiencies required for the successful completion of the above named course.

The student will:

1. Work in teams to solve problems that closely align with real world issues and needs using robotic technology.
2. Manage projects by successfully completing a variety of performance-based robotics tasks.
3. Communicate effectively with their partners to ensure that the robotics projects are properly constructed and effectively utilized.

4. Process information in a manner that enables them to formulate solutions to real world technology-based problems using robotic interventions.
5. Synthesize and assimilate knowledge to help them better understand complex problems, and to develop effective strategies to achieve workable solutions.
6. Become researchers and innovators who are technologically literate in today's society.
7. Investigate and incorporate engineering principles ito student develop projects.

Link to NEW JERSEY STUDENT LEARNING STANDARDS

- 3 - English Language Arts
- 4 - Mathematics
- 5 - Science
- 8 - Technology
- 9 - 21st Century Life and Careers

Modifications/Differentiation and Adaptations:
For guidelines on how to modify and adapt curricula to best meet the needs of all students, instructional staff should refer to the Curriculum Modifications and Adaptations included as an Appendix in this curriculum. Instructional staff of students with Individualized Education Plans (IEPs) must adhere to the recommended modifications outlined in each individual plan.

IV. ESSENTIAL QUESTIONS AND CONTENT

Overarching Essential Questions:

a) How can an autonomously programmed robot be designed to perform specific tasks using a variety of sensors that acquire information about the world external to the robot?
b) How can autonomous robots be designed and used to perform manual and repetitive tasks safely? In the workforce? In the home?
c) What are the benefits and drawbacks of using automated machines rather than human labor?
d) How do engineers solve problems using the engineering design process?
e) How is creativity and innovation used in engineering design?
f) How do teams efficiently and effectively solve problems in an increasingly complex world?
g) Under what circumstances does the human element remain indispensable to good design? Why?
h) A very large part of designing is re-designing: the first solution to a problem is rarely the best; improvements continue to suggest themselves. • How does one decide when the design- and redesign- process has reached its ultimate goal?

Content:

Basic Skills/Building and Programming:

- What is the function of diagnostics in a Robotics setting?
- What problems do you encounter when constructing the driving base?
- How does the driving base influence the capability of the robot?
- How can you use the design process when building the driving base?
- How would you utilize wheel rotation and ratios to perform controlled turns and distances?
- What did you discover when using the different turn methods?
- What is the purpose of the Wait Block?
- How did you overcome the problem of moving a larger sized object?
- What did you discover when using the Medium Motor Module?

Mathematics connection:

- What are some of the challenges a self driving car needs to be able to overcome?
- How is programming used to instruct a robot to perform a task?
- How does an EV3 robot connect to the EV3 programming software?
- How are the big ideas of Computational Thinking applied to programming a robot?
- How are the motor blocks in the EV3 programming environment used to make the robot move in a given direction for a specified distance?
- How is the EV3 programming environment used to solve a problem which simulates a real-life robotics application?
- How is the diameter or Circumference of the robot's wheel used to program the robot to travel a specified distance?
- How can proportions be used to simplify the process of determining how to make a robot move a specified distance?

Skill Challenges:

- What does a gyro sensor help the robot to do?
- Why does the autonomous mower use a Gyro Sensor if it already has GPS?
- Why should your robot use a gyro sensor if it already has rotation sensors?
- What will your EV3 color sensor need to detect?
- How does an EV3 robot detect that it is near or far from another object?
- How do the wheels of an EV3 robot work together during a turn?
- What are the different types of turns performed by an EV3 robot?
- How are the EV3 Move Steering and Move Tank blocks and controls to make the robot turn?
- How is the angle of an EV3 robot turn controlled?
- How can proportions be used to simplify the process of making the EV3 robot turn at different angles?
- How can turns be combined with movement to create more complex robot behaviors?
- Explain and use the Wait block in Touch sensor mode to detect the pressing or release of the Touch sensor.

- Explain and use the Touch sensor to simulate a button or a bumper.
- Derive and program a solution to a robotics challenge requiring the use of a touch sensor which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Battlebots and Bluetooth Technology:

- How does bluetooth technology and its applications worth with the robot?
- How does an EV3 robot interact with its environment?
- What physical design characteristics makes a robot stay in the ring the longest during the Battlebots challenge?
- After the analysis of the Battle bot competition, which strategy should be used to make the robot a winner? competition?
- Describe and document the physical design characteristics of the SumoBot robot and programming strategy used to compete.

V. STRATEGIES

- Student projects
- Group discussion
- Individual conferencing

VI. EVALUATION

Projects: 50% - Construct, program, and test robot tasks

Class Participation: 30% - Participation and the ability to work collaboratively and effectively in the Robotics classroom is critical to ensure equitable responsibility and mastery for each member of the team. Assessment includes the use of a rubric multiple times throughout the quarter to help students monitor and take ownership of their progress and may include collaboration, preparation and contributions to discussions.

In Class Assignments: - 10% - This can include, but is not limited to analysis and comprehension of programming directions, various skill challenges, and daily journal entries.

Quizzes, Assessments, and Final: 10% -Based on knowledge and understanding of Robotics vocabulary and procedure

VII. REQUIRED RESOURCES

Software

- Lego® Mindstorms® Education Ev3 Programming (Lego Software)
- Lego® Mindstorms® EV3 Teacher Guide

REQUIRED WEBSITES

http://cmra.rec.ri.cmu.edu/previews/ev3_products/ev3_curriculum/
http://www.damienkee.com/classroom-activities-ev3/

VIII. SCOPE AND SEQUENCE

1. **Basic Skills/Building and Programming: (About 5-7 days)**
   ***Standards Covered*: 8.2.8.A.2, 8.2.8.A.3, 8.2.8.C.5, 8.2.8.D.2, 8.2.8.E.1, 9.1**

   Suggested Activities:
   a. Basic build of the driving base with sensors: color, gyro, motor control arm, touch sensor and ultrasonic sensor.
   b. Finding software, utilizing the software.
   c. Basic skills such as 50 cm challenge and cargo retrieval.
   d. Students review building basics, utilizing software and basic skills such as moving straight.
   e. Basic build of the driving base with sensors: color, gyro, motor control arm, touch sensor and ultrasonic sensor.

2. **Mathematics connection: (5-10 days)**
   This prepares the students with the math skills needed for programming.
   ***Standards Covered*: MS-ETS1.B, MS-ETS1.C, MS-ETS1.A, 7.EE.3, 7.SP,8.2.8.E., 1, CRP2, 6, 8, 9, 11, 12**
   Math Topics To Cover:
   a. Diameter
   b. Circumference
   c. Gear Ratios
   d. Torque + Speed

   Suggested Activities
   a. Construct a robot that needs to move from its starting box to three different lines on a game board, stopping at each one to perform an inspection, represented by lowering and raising the robot's arm. When the robot is done inspecting all three locations, it should back up and return home to its starting box to recharge.
   b. Construct a robot that moves from its starting area through three rows of fruit trees. You may choose your own path through the orchard, but the robot must pass along both sides of each row.
   c. Construct a "race car" bot and select gear ratios to maximize potential in a given category.

   Teacher's Notes: Sensabot Challenge and Orchard Challenge: http://cmra.rec.ri.cmu.edu/previews/ev3_products/ev3_curriculum/

3. **Skill Challenges (10 days)**
   ***Standards Covered*: 8.2.8.B.2, 8.2.8.C.4, 8.2.8.D.1, 8.2.8.E.1, 8.2.8.E.2, 8.2.8.E.3, 8.2.8.E.4, CRP2, 6, 8, 9, 11, 12, NJSLSA.W1, NJSLSA.W3, NJSLSA.W6**

   Suggested Activities:
   a. Program the robot's arm to move into the "Up" position when the "Up" button on the EV3 is pressed, no matter where the arm started. The robot will then move forward five (5) rotations to pick up a cargo container, and bring it back to the starting location.
   b. Program your EV3 robot to move from the starting area through a maze with tall

vertical walls. Use the Ultrasonic Sensor to navigate through the maze without touching any walls and ultimately reaching the goal zone regardless of what the distances were between the walls.
c. Program your EV3 robot to erase or clear the entire gameboard of either markings or parts. The robot is able to move freely in straight lines, using any method you want. However, there are three mud zones marked on the game board. When turning in one of these areas, the robot must be picked up by hand, and placed back down.
d. Program your EV3 robot to go through three different intersection, each of which has a traffic signal. The traffic signal, which can be either the colored block or the red/green card, is held by hand at a set height. Unlike a camera, the detection range of the Color Sensor is short, so you will need to modify its placement on the robot so that it can see the traffic signal and react appropriately.

Teacher's Notes: ***Arm position Challenge, Maze Challenge, Mower Challenge and Traffic Signal Challenge:***
http://cmra.rec.ri.cmu.edu/previews/ev3_products/ev3_curriculum/

4. **Battlebots and Bluetooth Technology (11-17 days)**
Standards Covered: 8.2.8.C.4, 8.2.8.D.1, 8.2.8.E.2, 8.2.8.E.3, 8.2.8.E.4, CRP2, 6, 8, 9, 11, 12, NJSLSA.W3, NJSLSA.W6

Suggested Activities:
a. Assemble a remote control for the "face-bot" and explore Bluetooth interface between the "two".
b. EV3 Trainer video lessons and discussion:
Final Challenge Resources Project: Battlebots Competition – As part of a team, students will design, build and program a Battlebot to compete against other robots in the Battlebot competition.
c. Students will write a document describing the physical design of their robot and the strategy used for the competition.
d. Using the design, building and programming techniques learned have students design, build and program a robot to compete in the Battlebots competition.

Teacher's Notes:
- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage
- Google Classroom/Drive class notes and exercises