Course Title: Introduction to Robotics

Subject: Computer Science

Grade Level: 8th grade

Duration: 18 weeks (3 days per week)

Prerequisite: None

Elective or Required: Elective

Computer Science, Engineering, and Technology Mission Statement

Since computational thinking and problem solving are integral parts of our lives and 21st century learning, students must be actively involved in their Computer Science, Engineering, and Technology (CSET) education. The CSET curricula will emphasize thinking skills through a balance of computation, intuition, common sense, logic, design, analysis, and technology. Students will use a combination of technology and critical thinking to solve real-world problems. To achieve these goals, students will be taught a standards-based curriculum that is aligned with the New Jersey Curriculum Standards.

Course Description:

Introduction to Robotics is an 8th grade elective. Students will be introduced to Robotics, Programming and the Engineering process using the Lego® MindStorms® EV3 system. Using basic robotics concepts and the EV3 programming environment, students will instruct the robot to move, turn, sense light, sound, touch and objects in its path. Working as part of a team, students will build several robots and program the robots to navigate obstacle courses of increasing complexity.

Introduction to Robotics will meet three days a week for approximately 18 weeks. The Carnegie Mellon Robotics Academy EV3 video trainer will be used as a basis for this course and supplemented with several digital and printed Robotics resources.

Author: Mayra Bachrach
Date Submitted: Summer 2016
**Resources**


**Digital resources**

Carnegie Mellon Robotics Academy EV3 video trainer

EV3 programming software Robot Educator

Artbotics EV3 resources: [http://artbotics.cs.uml.edu/wordpress/?page_id=183](http://artbotics.cs.uml.edu/wordpress/?page_id=183)

Tufts University Center for Engineering Outreach YouTube channel: [https://www.youtube.com/channel/UCcm-UYpl0umxgIC3-Atv7rA/videos?view=0&sort=dd&shelf_id=0](https://www.youtube.com/channel/UCcm-UYpl0umxgIC3-Atv7rA/videos?view=0&sort=dd&shelf_id=0)

*A world in Motion* video: [https://www.youtube.com/watch?v=D_i3PJIYtuY](https://www.youtube.com/watch?v=D_i3PJIYtuY)


Dr. Graeme’s Mountain Climber Gear Tutorial ([http://www.drgaeme.net/DrGraeme-free-NXT-G-tutorials/Ch30/Ch30V1BCG/default.htm](http://www.drgaeme.net/DrGraeme-free-NXT-G-tutorials/Ch30/Ch30V1BCG/default.htm))

Educational Robots for absolute beginners [https://cs4hsrobots.appspot.com/course](https://cs4hsrobots.appspot.com/course)


**Software Tools**

Google Chrome (or other web browser, such as Safari, Internet Explorer, etc)

Lego® Mindstorms® EV3 Programming environment
### Curriculum Standards

#### Technology

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>8.2.8.B.2</td>
<td>Identify the desired and undesired consequences from the use of a product or system.</td>
</tr>
<tr>
<td>8.2.8.C.4</td>
<td>Identify the steps in the design process that would be used to solve a designated problem.</td>
</tr>
<tr>
<td>8.2.8.D.1</td>
<td>Design and create a product that addresses a real world problem using a design process under specific constraints.</td>
</tr>
<tr>
<td>8.2.8.E.1</td>
<td>Identify ways computers are used that have had an impact across the range of human activity and within different careers where they are used.</td>
</tr>
<tr>
<td>8.2.8.E.2</td>
<td>Demonstrate an understanding of the relationship between hardware and software.</td>
</tr>
<tr>
<td>8.2.8.E.3</td>
<td>Develop an algorithm to solve an assigned problem using a specified set of commands and use peer review to critique the solution.</td>
</tr>
<tr>
<td>8.2.8.E.4</td>
<td>Use appropriate terms in conversation (e.g., programming, language, data, RAM, ROM, Boolean logic terms).</td>
</tr>
</tbody>
</table>

#### 21st Century Life and Careers – Career Ready Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>CRP1</td>
<td>Act as a responsible and contributing citizen and employee.</td>
</tr>
<tr>
<td>CRP2</td>
<td>Apply appropriate academic and technical skills.</td>
</tr>
<tr>
<td>CRP4</td>
<td>Communicate clearly and effectively and with reason.</td>
</tr>
<tr>
<td>CRP6</td>
<td>Demonstrate creativity and innovation.</td>
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<tr>
<td>CRP8</td>
<td>Utilize critical thinking to make sense of problems and persevere in solving them.</td>
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<tr>
<td>CRP12</td>
<td>Work productively in teams while using cultural global competence.</td>
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</table>

#### Mathematics

<table>
<thead>
<tr>
<th>Practice</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Math Practices.1</td>
<td>Make sense of problems and persevere in solving them.</td>
</tr>
<tr>
<td>Math Practices.2</td>
<td>Reason abstractly and quantitatively.</td>
</tr>
<tr>
<td>Math Practices.3</td>
<td>Construct viable arguments and critique the reasoning of others.</td>
</tr>
<tr>
<td>Math Practices.4</td>
<td>Model with mathematics.</td>
</tr>
<tr>
<td>Math Practices.5</td>
<td>Use appropriate tools strategically.</td>
</tr>
<tr>
<td>Math Practices.6</td>
<td>Attend to precision.</td>
</tr>
<tr>
<td>Math Practices.7</td>
<td>Look for and make use of structure.</td>
</tr>
<tr>
<td>Math Practices.8</td>
<td>Look for and express regularity in repeated reasoning.</td>
</tr>
</tbody>
</table>

#### English Language Arts

<table>
<thead>
<tr>
<th>Practice</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>RI.8.1</td>
<td>RI.8.1. Cite the textual evidence and make relevant connections that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.</td>
</tr>
<tr>
<td>RST.6-8.3</td>
<td>Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.</td>
</tr>
</tbody>
</table>
| RST.6-8.4 | Determine the meaning of symbols, key terms, and other domain-
specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

<table>
<thead>
<tr>
<th>RST.6-8.10</th>
<th>By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJSLSA.W4</td>
<td>Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</td>
</tr>
<tr>
<td>NJSLSA.W9</td>
<td>Draw evidence from literary or informational texts to support analysis, reflection, and research.</td>
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Introduction to Robotics

Unit 1: Intro to Robotics and the Engineering Process

Approximate # Of Weeks: 1 week

Essential Questions:

- What is a Robot?
- Why have people developed robots?
- How does the use of Robotics impact society?
- What are the steps in the Engineering process?
- How does the Engineering process apply to robotics?
- How can the components of a Lego® MindStorms® EV3 robotics kit be used to build a product?

Upon completion of this unit students will be able to:

- Explain what a robot is.
- Describe a real-life application of robotics and its impact.
- Discuss the impact of robotics on society.
- Explain and apply the steps of the engineering process.
- Identify and use the components of the Lego® MindStorms® EV3 robotics kit.
- Design and build a robotics product using the EV3 robotics kit.

Interdisciplinary Standards

- 8.2.8.B.2, 8.2.8.C.4, 8.2.8.D.1, 8.2.8.E.1, Math Practices 1 and 3, 21st Century Career Practices 1, 2, 3, 4, 8 and 12, RI.8.1, RST.6-8.3, RST.6-8.4, RST.6-8.10, NJSLSA.W4, NJSLSA.W9,

Activities:

- Lecture and class discussion
- Activity: With a partner, students will discuss “What is a robot?” and “Why do people build robots?” A class discussion will follow to identify the characteristics of a robot and applications of robotics.
- Class discussion: Positive and Negative impact of Robotics.
- Activity: With a partner, students will compare and contrast similar components of the EV3 robotics kit to determine their characteristics and applications.
- Project: Students will research a real robot, describe its function and use, and how it interacts with its environment. Students will write a journal entry summarizing their research and share the information with the class.
- Journal Entry: Students will write a journal after viewing a video on the Engineering process.
- Video and discussion: Building Sturdy Structures
• Project: Working in pairs, students will use the EV3 robotics kit to build a box with a hinged lid of their own design. Students will write a journal entry on how the Engineering process applied to designing and building the box.

Enrichment Activities:

• Project: Students will add a locking mechanism to the hinged lid on the box designed as a class project.
• Pandora’s Box: Following instructions in *STEM by Design*, Students will enhance the box to make a sound using the Gyro sensor when the hinged lid is opened.

Methods of Assessments/Evaluation:

• Building projects
• Journal entries
• Class discussions
• Verbal assessment
• Think/Pair/Share
• Thumbs up/Thumbs down
• Exit slips

Resources:

• Bratzel, Barbara, *STEM by Design: Teaching with Lego Mindstorm EV3*, College House Enterprises LLC, Knoxville, Tennessee, 2014

Online Resources:

• Stem Robotics website: [http://stemrobotics.cs.pdx.edu/](http://stemrobotics.cs.pdx.edu/)
• Building Sturdy Structures video (Tufts University Center for Engineering Outreach YouTube channel): [https://www.youtube.com/watch?v=vo7_97qO6Xw](https://www.youtube.com/watch?v=vo7_97qO6Xw)
• Teacher Webpage and YouTube channel
• Google Classroom/Drive class notes and exercises
Unit 2: Building a robot

Approximate # Of Weeks: 1 week

Essential Questions:

- How can the components of a Lego® MindStorms® EV3 robotics kit be used to build a robot?

Upon completion of this unit students will be able to:

- Identify and use the components of the Lego® MindStorms® EV3 robotics kit
- Explain and use technical building instructions to build a Robot.

Interdisciplinary Standards


Activities:

- Lecture and class discussion
- Project: Working in pairs, students will follow technical instructions provided in the EV3 programming software Robot Educator to build the EV3 Base robot. Students will write a journal entry describing the components of the EV3 robotics kit used to build the robot and the challenges encountered in completing the assignment.

Enrichment Activities:

- Project: Students will design and build a pen attachment for the base robot.

Methods of Assessments/Evaluation:

- Building projects
- Journal entries
- Class discussions
- Verbal assessment
- Think/Pair/Share
- Thumbs up/Thumbs down
- Exit slips

Online Resources:

- EV3 Programming environment Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 3: Introduction to Programming and Moving Straight

Approximate # Of Weeks: 1 week

Essential Questions:

- 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?

Upon completion of this unit students will be able to:

- Identify the sensor and motor ports of the EV3 robot.
- Explain and use the big ideas of Computational thinking to program the robot.
- Explain and use the Move Steering and Medium Motor blocks to program the robot to move forward or backward.
- Explain and use the properties of the motor blocks to control the distance and direction travelled by the robot.
- Explain and use the diameter or circumference of the robot’s wheel to determine the settings of the motor blocks used to control the distance travelled by the robot.
- Explain and use proportions to determine the settings used to control the distance travelled by the robot.
- Derive and program a solution to a robotics challenge which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards

- 8.2.8.B.2, 8.2.8.E.1, 8.2.8.E.2, 8.2.8.E.3, 8.2.8.E.4, Math Practices 1, 2, 4, 6, and 7, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- EV3 Trainer video lessons and discussion: Basics=>Getting Started and Using the Software.
• First programming Lab: Students will view the EV3 trainer Move Steering lesson, program the robot to move forward for 3 rotations, download the program to the robot and run the program
• Diameter/Circumference-Distance travelled activity: Working in pairs, students will calculate the settings value for the move steering block using the diameter or the circumference of the wheel to make the robot move a specified distance.
• Video Trainer lab: 50Cm challenge
• Video and Class discussion: Students will view the EV3 trainer video on the big ideas of Computational Thinking and how they apply to programming a robot. A class discussion will follow. Students will write a reflection journal entry on one of the big ideas of Computational Thinking as applied to robotics.
• Project: Stop for Pedestrians! (STEM by Design)
• Building Activity: Working in pairs, students will follow technical instructions on the EV3 Robot Educator to build the Arm control mechanism of the base robot.
• Video Trainer lesson: Students will view the Arm Control lesson and use the medium motor block to program the robot to make the arm move up and down.
• Lab: EV3 Video Trainer Mini Challenge 1: Cargo Retrieval

Enrichment Activities:

• Project: Sensabot Challenge (EV3 video trainer).
• Project: Robot Wave (Classroom Activities for the Busy Teacher)

Methods of Assessments/Evaluation:

• Building projects
• Programming projects
• Programming labs
• Obstacle Challenges
• Journal entries
• Class discussions
• Verbal assessment
• Think/Pair/Share
• Thumbs up/Thumbs down
• Exit slips

Resources:

• Bratzel, Barbara, STEM by Design: Teaching with Lego Mindstorm EV3, College House Enterprises LLC, Knoxville, Tennessee, 2014

Online/Digital Resources:
- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 4: Gears

Approximate # Of Weeks: 1 week

Essential Questions:

- What is a gear?
- What is gearing down or gearing up?
- What is the difference between the driving gear and the driven gear?
- How can gears be used to increase the power or speed of a robot?

Upon completion of this unit students will be able to:

- Explain and use gears.
- Explain and build a gear-train consisting of 2 gears
- Explain how gearing can be used to increase the power or speed of a robot.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 6, and 7, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- Video and class discussion: A World in Motion. Students will view the video, participate in a class discussion and write a journal entry on the impact of gears on the speed and power of a robot.
- Video and class discussion: Intro to gears (Tufts Center for engineering outreach). Students will view the video as a resource to building a two gear gear-train using the EV3 kit as a resource for labs.
- Lab: Slow Bot
- Lab: Fast Bot
- Project: Mountain Climber
- Project: Snail’s Pace

Enrichment Activities:

- Project: Advanced Gear Challenge (Stem Robotics)

Methods of Assessments/Evaluation:

- Building projects
- Programming projects
- Programming labs
- Obstacle Challenges
- Journal entries
- Class discussions
- Verbal assessment
- Think/Pair/Share
- Thumbs up/Thumbs down
- Exit slips

Online/Digital Resources:

- Intro to gears (Tufts Center for Engineering outreach) YouTube channel https://www.youtube.com/watch?v=G09_gHPATH8
- A world in Motion Gears video: https://www.youtube.com/watch?v=D_i3PJIYtuY
- STEM Robotics Get in Gears: http://stemrobotics.cs.pdx.edu/node/530
- Dr. Graeme’s Mountain Climber (http://www.drgraeme.net/DrGraeme-free-NXT-G-tutorials/Ch30/Ch30V1BCG/default.htm
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 5: Turning

Approximate # Of Weeks: 1 week

Essential Questions:

- What is an Algorithm?
- 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 used 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?

Upon completion of this unit students will be able to:

- Explain and derive algorithms to program robot behaviors.
- Explain and use the Move Steering and Move Tank blocks to program the robot to turn.
- Explain and use the settings of the Move Steering and Move Tank blocks to control the direction and angle of a turn.
- Explain and use proportions to determine the settings used to control the angle of a turn.
- Derive and program a solution to a robotics challenge which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, and 7, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- EV3 Trainer video lessons and discussion: Turning
- Video Trainer Turning in Place labs: Turn Right, Turn Left, Mini Challenge Turn 90 Degrees.
- Video Trainer Other Turn labs: TankMove, Mini Challenge 1 - Dizzy Drill, Try It - Different Motions.
- Video and Discussion lesson: Students will view the Iterative Design lesson under the Final project resources in EV3 Video Trainer and participate in a
class discussion. Students will write a journal entry describing the Iterative process used to solve a programming challenge.

- Journal Entry: Describe the different types of turns and explain the blocks used to program the robot to complete the turns.
- Activity: Robot role play – Students pretend to be a robot and follow directions to complete a task and write a journal entry on the precision required when writing Algorithms in response to a teacher prompt.
- Project: Haunted House (STEM by Design)
- Project: Labyrinth – Students will program their robot to navigate a labyrinth
- Building and Programming Project: Clean Sweep (STEM by Design) – Students will design a sweeping mechanism that can clean a board with 100 Lego pieces in 30 seconds (max size: 30 by 30)

Enrichment Activities:

- Project: Orchard Challenge: Students will view a video of a real-life robot, an autonomous tractor, used to spray pesticide in an orchard and program the robot to simulate the functionality of the autonomous tractor (EV3 video trainer).

Methods of Assessments/Evaluation:

- Building projects
- Programming projects
- Programming labs
- Obstacle Challenges
- Journal entries
- Class discussions
- Verbal assessment
- Think/Pair/Share
- Thumbs up/Thumbs down
- Exit slips

Resources:

- Bratzel, Barbara, STEM by Design: Teaching with Lego Mindstorm EV3, College House Enterprises LLC, Knoxville, Tennessee, 2014

Online/Digital Resources:

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 6: Introduction to Loops

Approximate # Of Weeks: 1 week

Essential Questions:
- What is a loop?
- How is a loop used to program repetitive behavior?
- What are the EV3 programming blocks and controls used to program a loop?
- How are loops used in real-life applications of robots?

Upon completion of this unit students will be able to:
- Explain and program a loop.
- Explain and use a loop block and its controls to program repetitive behaviors.
- Derive and program a solution to a robotics challenge requiring the use of loops which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards
- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:
- Lecture and class discussion
- EV3 Trainer video lessons and discussion: Loops – sections 1 through 4
- Video Trainer Looped Movement labs: MoveLoop, Mini Challenge 1 – Square lap 1
- Video Trainer Loop with Count Control labs: MoveLoopCount, Mini Challenge 1 – Square lap 2
- Journal Entry: Using the Internet research an example of a real-life robot that displays a repetitive behavior. Describe the robot and its function.
- Project: Robo500 Looped Challenge

Enrichment Activities:
- Project: Snake (STEM by Design)

Methods of Assessments/Evaluation:
- Programming projects
- Programming labs
- Obstacle Challenge
- Journal entries
- Class discussions
- Verbal assessment
- Think/Pair/Share
- Thumbs up/Thumbs down
- Exit slips

Resources:


Online/Digital Resources:

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 7: Move until Touch

Approximate # Of Weeks: 1.5 week

Essential Questions:

- How does an EV3 robot interact with its environment?
- How does the EV3 touch sensor work?
- What are the EV3 programming blocks and controls used to make the robot detect that it has touched an object?
- How is a touch sensor used in real-life applications of robots?

Upon completion of this unit students will be able to:

- 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.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- EV3 Trainer video lessons and discussion: Move until Touch
- Building Activity: Working in pairs, students will follow technical instructions on the EV3 Robot Educator to add the touch sensor to the base robot.
- Video Trainer Wait for Touch labs: WaitTouch program, Try It – already pressed, Try It – EV3 Buttons, Did you know? How the touch sensor works
- Video Trainer Forward Until Touch labs: ForwardTouch, ForwardRelease, Mini Challenge 1 – Vacuum Challenge
- Journal Entry: Using the Internet research an example of a real-life robot that uses a touch sensor. Describe the robot and its function.
- Activity: Analyze a program containing Touch sensor logic to find the error
- Project: Arm Position challenge (EV3 Video Trainer)
- Design, build and program project: Push-button Fan (STEM by Design)

Enrichment Activities:

- Project: Help, I am Stuck! (Classroom Activities for the Busy Teacher)
- Project: Touch Tally (STEM by Design)
Methods of Assessments/Evaluation:

- Design projects
- Building projects
- Programming projects
- Programming labs
- Obstacle Challenge
- Journal entries
- Class discussions
- Verbal assessment
- Think/Pair/Share
- Thumbs up/Thumbs down
- Exit slips

Resources:


Online/Digital Resources:

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 8: Move until Near

Approximate # Of Weeks: 1.5 weeks

Essential Questions:

- How does an EV3 robot detect that it is near or far from another object?
- How does the ultrasonic sensor work?
- What is a threshold value?
- What is the unit of measure of the ultrasonic sensor threshold value?
- What are the EV3 programming blocks and controls used to make the robot detect that it is near or far from another object?
- How is an ultrasonic sensor used in real-life applications of robots?

Upon completion of this unit students will be able to:

- Explain and use the Wait block in Ultrasonic sensor mode to detect whether the robot is near or far from another object
- Identify and use the unit of measure of the ultrasonic sensor threshold value.
- Derive and program a solution to a robotics challenge requiring the use of the ultrasonic sensor which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards

- 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,
  Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4,
  6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- EV3 Trainer video lessons and discussion: Move until Near
- Building Activity: Working in pairs, students will follow technical instructions on the EV3 Robot Educator to add the ultrasonic sensor to the base robot.
- Video Trainer Wait for Near labs: UltrasonicHello program, Mini Challenge 1 – Threshold value, Try It 1 – Missing Object Alarm,
- Video Trainer Forward Until Near labs: ForwardNear, Mini Challenge 1 – Backward until Far
- EV3 Trainer video lessons and discussion: Loops – Lesson 5
- Video Trainer Loop with Sensor control labs: MoveLoopUltrasonic, Try It 1 – Other Sensors, Mini Challenge 1 – Square lap 3.
- Journal Entry: Using the Internet, students will research a real-life robot that uses an ultrasonic sensor and describe the robot, its capabilities and impact.
- Activity: Analyze a program containing Ultrasonic sensor logic to find the error
- Project: Maze challenge (EV3 Video Trainer)
• Design, build and program project: Puppy Bot (STEM by Design)

**Enrichment Activities:**

• Project: Container Handling challenge (EV3 Video Trainer)
• Project: Range Puppy (STEM by Design)

**Methods of Assessments/Evaluation:**

• Design projects
• Building projects
• Programming projects
• Programming labs
• Obstacle Challenge
• Journal entries
• Class discussions
• Verbal assessment
• Think/Pair/Share
• Thumbs up/Thumbs down
• Exit slips

**Resources:**

• Bratzel, Barbara, *STEM by Design: Teaching with Lego Mindstorm EV3*, College House Enterprises LLC, Knoxville, Tennessee, 2014

**Online/Digital Resources:**

• Carnegie Mellon Robotics Academy EV3 video trainer
• EV3 programming software Robot Educator
• Teacher Webpage and YouTube channel
• Google Classroom/Drive class notes and exercises
Unit 9: Color Sensor

Approximate # Of Weeks:  1.5 weeks

Essential Questions:

- How does an EV3 robot detect colors?
- What is the difference between ambient and reflected light as used by the EV3 color sensor?
- How does an EV3 robot detect the intensity of reflected light?
- What are the EV3 programming blocks and controls used to make the robot detect colors?
- What are the EV3 programming blocks and controls used to make the robot detect the intensity of reflected light?
- How are color sensors and light sensors used in real-life applications of robots?

Upon completion of this unit students will be able to:

- Explain how the EV3 color sensor works.
- Describe reflected light and ambient light as used by the EV3 color sensor.
- Explain and use the Wait block in Color sensor mode to detect when the Color sensor sees a specific color
- Explain and use the Wait block in Color sensor mode to detect the intensity of reflected light.
- Derive and program a solution to a robotics challenge requiring the use of the color sensor which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- EV3 Trainer video lessons and discussion: Move until Color
- Building Activity: Working in pairs, students will follow technical instructions on the EV3 Robot Educator to add the color sensor to the base robot.
- Video Trainer Wait for Green labs: WaitGreen program, Try It – No Color, Try It – Port View, Mini Challenge 1 – Railroad Crossing, Did you know? How the Color Sensor works
- Video Trainer Forward Until Red labs: ForwardRed, Mini Challenge 1 – Forward to stop line
• Journal Entry: Using the Internet, students will research real-life robot that uses a color sensor, describe the robot, its capabilities and its impact.
• Activity: Analyze a program containing Color sensor logic to find the error
• Project: Traffic Signal Challenge (EV3 Video Trainer)

**Enrichment Activities:**

• Project: Cockroach Project (STEM by Design)

**Methods of Assessments/Evaluation:**

• Programming projects
• Programming labs
• Obstacle Challenge
• Journal entries
• Class discussions
• Verbal assessment
• Think/Pair/Share
• Thumbs up/Thumbs down
• Exit slips

**Resources:**

• Bratzel, Barbara, *STEM by Design: Teaching with Lego Mindstorm EV3*, College House Enterprises LLC, Knoxville, Tennessee, 2014

**Online/Digital Resources:**

• Carnegie Mellon Robotics Academy EV3 video trainer
• EV3 programming software Robot Educator
• Teacher Webpage and YouTube channel
• Google Classroom/Drive class notes and exercises
Unit 10: Switches

Approximate # Of Weeks: 1.5 weeks

Essential Questions:

- How does an EV3 robot make decisions?
- How is a Switch block used to program the robot to make a one-time decision?
- How are a Switch block and a Loop block combined to program the robot to make repeated decisions?
- How are Switch blocks and Loop Blocks used in real-life applications of robots?

Upon completion of this unit students will be able to:

- Explain and use the Switch block and its controls to program the robot to make a one-time decision.
- Explain and use a Switch block and a Loop block to program the robot to make repetitive decisions.
- Derive and program a solution to a robotics challenge requiring the use of Switch blocks and Loop blocks which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- EV3 Trainer video lessons and discussion: Switches
- Video Trainer Move If Clear labs: MoveIfClear, Mini Challenge 1 – Color Sensor Compare Switch
- Video Trainer Looped Decision labs: MazeRunner, Try It 1 – Maze Runner, Mini Challenge 1 – Smarter Decisions Challenge
- Journal Entry: Using the Internet, students will research a real-life robot that displays repetitive decision behavior, describe the robot, its capabilities and its impact.
- Project: Strawberry Plant Challenge (EV3 Video Trainer)
- Project: Stay Away from the edge (Classroom Activities for the Busy Teacher)

Enrichment Activities:

Last Updated: August 10, 2016
- Project: Outside the Box (STEM by Design)
- Project: Bug Battle (STEM by Design)

**Methods of Assessments/Evaluation:**

- Programming projects
- Programming labs
- Obstacle Challenges
- Journal entries
- Class discussions
- Verbal assessment
- Think/Pair/Share
- Thumbs up/Thumbs down
- Exit slips

**Resources:**


**Online/Digital Resources:**

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 11: Obstacle Detection

Approximate # Of Weeks: 1 week

Essential Questions:

- How is a robot programmed to detect obstacles in its path as it performs other tasks?
- How are a Switch block and a Loop block combined to program the robot to detect obstacles in its path?
- How are Switch blocks and Loop Blocks used in real-life applications of robots to program obstacle detection logic?

Upon completion of this unit students will be able to:

- Explain and use a Switch block and a Loop block to program the robot to detect obstacles in its path as it performs another task.
- Derive and program a solution to a robotics challenge requiring obstacle detection logic which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- EV3 Trainer video lessons and discussion: SwitchLoops
- Video Trainer Obstacle Detection Failure labs: ObstacleAttempt1, ObstacleAttempt2
- Video Trainer Obstacle Detection labs: Obstacle Attempt3, Mini challenge 1 – Obstacle Detecting Move until black line.
- Journal Entry: Student will describe the pattern used to program repetitive decisions and how it is applied to obstacle detection.
- Journal Entry: Using the Internet, students will research a real-life robot that is capable of obstacle detection. Students will describe the robot, its capabilities and impact.
- Project: Automated Sentry Challenge

Enrichment Activities:

- Obstacle Orchard Challenge (EV3 Video Trainer)
Methods of Assessments/Evaluation:

- Programming projects
- Programming labs
- Obstacle Challenges
- Journal entries
- Class discussions
- Verbal assessment
- Think/Pair/Share
- Thumbs up/Thumbs down
- Exit slips

Resources:


Online/Digital Resources:

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 12: Line Following

Approximate # Of Weeks: 1 week

Essential Questions:

- What is the algorithm used to program a robot to follow a line?
- What are the EV3 blocks used to program the line following algorithm?
- How is line following behavior used in real-life applications of robots?

Upon completion of this unit students will be able to:

- Explain and use a Switch block and a Loop block to program the robot to detect obstacles in its path as it performs another task.
- Derive and program a solution to a robotics challenge requiring obstacle detection logic which simulates a real-life application of Robotics.
- Describe a real-life application of robotics and its impact.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- Lecture and class discussion
- EV3 Trainer video lessons and discussion: Line Follower
- Video Trainer Line Follower 2 lab: LineTrack, Mini Challenge – Track Line for Rotations
- Journal Entry: In your own words, describe the algorithm used to program a robot to follow a line.
- Journal Entry: Using the Internet, students will research a real-life robot that displays line following capabilities, describe the robot, its capabilities and impact.
- Project: RoboSlalom

Enrichment Activities:

- Project: Line Track Challenge (EV3 Video Trainer)

Methods of Assessments/Evaluation:

- Programming projects
- Programming labs
- Obstacle Challenges
- Journal entries
• Class discussions
• Verbal assessment
• Think/Pair/Share
• Thumbs up/Thumbs down
• Exit slips

**Online/Digital Resources:**

• Carnegie Mellon Robotics Academy EV3 video trainer
• EV3 programming software Robot Educator
• Teacher Webpage and YouTube channel
• Google Classroom/Drive class notes and exercises
Unit 13: SumoBot Competition

Approximate # Of Weeks: 2 weeks

Essential Questions:

- What physical design characteristics make a robot stay in the ring the longest during the SumoBot challenge?
- What factors must be considered when deriving an algorithm for the SumoBot competition?
- What strategy will make a robot a winner in the SumoBot competition?
- Which EV3 programming blocks can be used to program the SumoBot algorithm?

Upon completion of this unit students will be able to:

- Using the design, building and programming techniques learned, design, build and program a robot to compete in the SumoBot competition.
- Describe and document the physical design characteristics of the SumoBot robot and programming strategy used to compete.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- EV3 Trainer video lessons and discussion: Final Challenge Resources
- Project: SumoBot Competition – As part of a team, students will design, build and program a SumoBot to compete against other robots in the SumoBot competition. Students will write a document describing the physical design of their robot and the strategy used for the competition.

Methods of Assessments/Evaluation:

- Project will be graded according to rubric.

Online/Digital Resources:

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Teacher Webpage and YouTube channel
- Google Classroom/Drive class notes and exercises
Unit 14: Final Challenge (Option 1) – Search and Rescue

Approximate # Of Weeks:  2 weeks

Essential Questions:

- What physical design characteristics are required to meet the requirements of the Search and Rescue challenge?
- What factors must be considered when deriving an algorithm for the Search and Rescue challenge?
- What strategy will allow the robot to satisfy the requirements of the Search and Rescue challenge?
- Which EV3 programming blocks and patterns can be used to program the Search and Rescue challenge?

Upon completion of this unit students will be able to:

- Using the design, building and programming techniques learned, design, build and program a robot able to meet the requirements of the Search and Rescue challenge.
- Describe and document the physical design characteristics of the Search and Rescue robot and the programming strategy used to meet the requirements.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities:

- EV3 Trainer video lessons and discussion: Final Challenge Search and Rescue Challenge
- Project: Search and Rescue challenge – As part of a team, students will design, build and program a Search and Rescue robot able to navigate through the 4 rooms of the Search and Rescue challenge. Students will write a document describing the physical design of their robot and the strategy used for the competition.

Methods of Assessments/Evaluation:

- Project will be graded according to rubric.

Online/Digital Resources:

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Google Classroom/Drive class notes and exercises
Unit 14: Final Challenge (Option 2) – Kinetic Sculpture

Approximate # Of Weeks: 2 weeks

Essential Questions:

- What physical design characteristics are required to build a robotic kinetic sculpture?
- What factors must be considered when deriving an algorithm for a robotic kinetic sculpture?
- Which EV3 programming blocks and patterns can be used to program the robotics kinetic sculpture?

Upon completion of this unit students will be able to:

- Using the design, building and programming techniques learned, design, build and program a robotics kinetic sculpture which meets the class rubric requirements.
- Describe and document the physical design characteristics of robotic kinetic sculpture and the programming strategy used to meet the requirements of the project.

Interdisciplinary Standards

- 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, Math Practices 1, 2, 4, 5, 6, 7, and 8, 21st Century Career Practices 1, 2, 4, 6, 8 and 12, RST.6-8.3, RST.6-8.4, RST.6-8.10, RI.8.1, NJSLSA.W4

Activities (STEAM activities):

- Students will review the Artbotics project resources to view examples of mechanisms (cam and crank) that have been incorporated into kinetic sculptures made with the EV3 kit.
- Project: Robotic Kinetic Sculpture– As part of a team, students will design, build and program a robotic kinetic sculpture that satisfies the project rubric. Students will write a document describing the physical design of their sculpture and the programming used for the moving parts. The program will be documented using a flowchart.

Methods of Assessments/Evaluation:

- Project will be graded according to rubric.

Online/Digital Resources:

- Carnegie Mellon Robotics Academy EV3 video trainer
- EV3 programming software Robot Educator
- Google Classroom/Drive class notes and exercises
- Artbotics EV3 resources: http://artbotics.cs.uml.edu/wordpress/?page_id=183