SCHOOL DISTRICT OF THE CHATHAMS

Robot Design Studio
Grade 6
Marking Period

Course Overview

In this course, students develop a working knowledge of the basic hardware and software required to construct and program robots that can navigate and manipulate real-world situations. Students will be exposed to concepts related to structures, mechanisms, control systems, and basic coding frameworks. They will then be challenged to apply these concepts at varying levels of complexity using the engineering design process to solve problems and develop solutions to unique contextualized design challenges.

New Jersey Student Learning Standards
The New Jersey Student Learning Standards (NJSLS) can be located at www.nj.gov/education/cccs/2020/.

Computing Systems
8.1.8.CS.2: Design a system that combines hardware and software components to process data.
8.1.8.CS.4: Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.

Algorithms & Programming
8.1.8.AP.1: Design and illustrate algorithms that solve complex problems using flowcharts and/or pseudocode.

Engineering Design
8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.

Technology Standards
9.4.8.TL.5: Compare the process and effectiveness of synchronous collaboration and asynchronous collaboration.

21st Century Integration | NJSLS 9
9.4.8.CI.4: Explore the role of creativity and innovation in career pathways and industries.

Career Ready Practices
CRP2. Apply appropriate academic and technical skills.
CRP4. Communicate clearly and effectively and with reason.
CRP6. Demonstrate creativity and innovation
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.

Interdisciplinary Connections

Science

- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Mathematics

- 6.EE.A.2.a Write expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation "Subtract y from 5" as 5 – y.
- 6.EE.A.2.c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6s^2$ to find the volume and surface area of a cube with sides of length $s = 1/2$.

Units of Study

Unit 1: Critical Thinking, Robotics, and the Design Process (~5 days)

- Why is failure inevitable and important for successful designs?
- What are the advantages and disadvantages of various computer applications?
- What does it mean to be a robot?
- How can we define technology?
- How does robotic technology present itself in our day-to-day life and decision-making processes?
- What are robots used for in everyday life and what kinds of tasks do they help accomplish?
- How does the hardware of a robot affect the capabilities of a robot?
- How does the structure of a robot lend itself to the tasks a robot is able to accomplish?

Unit 2: Robotic Hardware and Software (~10 days)

- How can the EV3 robot interact with the environment around it?
- How can we use brainstorming to develop and organize ideas and thoughts?
- How does a robot's code directly affect its behavior?
- How can we troubleshoot or identify an issue in a piece of code?
- How does the application of sensors help a robot understand, interact, or navigate the world around it?

Unit 3: Robotic Applications & Design Challenges (~24 days)

- In what ways could a robot be programmed to assist in a real world scenario?
- How does the application of sensors help a robot understand, interact, or navigate the world around it?
- What are some ways we can improve a program if the robot does not react in the way we want it to?
- In what ways can a robot's structure be improved to better meet the needs of a goal?

Learning Objectives/Discipline Standards of Practice

Revision Date: *December 2021*

Learning Objectives:

- Utilize robotic parts to create a fully functioning robot.
- Identify a robot's capabilities by looking at its hardware.
- Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.
- Create a robotic structure to solve a problem.
- Identify functions of basic sensors.
- Demonstrate how to program a basic or single sensor.
- Utilize flow control while programming.
- Explain the importance of flow control while programming.
- Students will be able to utilize the Engineering Design Process to solve a real-world problem.
- Explain how different teams/groups can contribute to the overall design of a product.
    - Totes McGoats
- Implement problem-solving strategies to solve a problem that meets certain constraints.
- Program multiple sensors to accomplish a given task.
- Utilize or improve elements to the structure of the robot to help the robot accomplish its goals.
- Utilize flow control while programming advanced sensors.
- Program a robot to multitask using separate strings of code to be carried simultaneously.
    - Special Delivery
    - Battle Bots!

Discipline Standards of Practice:

- Computing Systems
    - People interact with a wide variety of computing devices that collect, store, analyze, and act upon information in ways that can affect human capabilities both positively and negatively. The physical components (hardware) and instructions (software) that make up a computing system communicate and process information in digital form.
- Networks and the Internet
    - Computing devices typically do not operate in isolation. Networks connect computing devices to share information and resources and are an increasingly integral part of computing. Networks and communication systems provide greater connectivity in the computing world.
- Impacts of Computing
    - Computing affects many aspects of the world in both positive and negative ways at local, national, and global levels. Individuals and communities influence computing through their behaviors and cultural and social interactions, and, in turn, computing influences new cultural practices.
- Data & Analysis
    - Computing systems exist to process data. The amount of digital data generated in the world is rapidly expanding, so the need to process data effectively is increasingly important. Data is collected and stored so that it can be analyzed to better understand the world and make more accurate predictions.
- Algorithms & Programming
    - An algorithm is a sequence of steps designed to accomplish a specific task. Algorithms are translated into programs, or code, to provide instructions for computing devices. Algorithms and programming control all computing systems, empowering people to communicate with the world in new ways and solve compelling problems.
- Engineering Design

    - People design for enjoyment and to solve problems, extend human capabilities, satisfy needs and wants, and improve the human condition. Engineering Design, a systematic approach to creating solutions to technological problems and finding ways to meet people's needs and desires, allows for the effective and efficient development of products and systems.
- Interaction of Technology and Humans
    - Societies influence technological development. Societies are characterized by common elements such as shared values, differentiated roles, and cultural norms, as well as by entities such as community institutions, organizations, and businesses. Interaction of Technology and Humans concerns the ways society drives the improvement and creation of new technologies, and how technologies both serve and change society.
- Nature of Technology
    - Human population, patterns and movement focus on the size, composition, distribution, and movement of human populations and how they are fundamental and active features on Earth's surface. This includes understanding that the expansion and redistribution of the human population affects patterns of settlement, environmental changes, and resource use. Patterns and movements of population also relate to physical phenomena including climate variability, landforms, and locations of various natural hazards and their effects on population size, composition, and distribution.
- Effects of Technology on the Natural World
    - Many of engineering and technology's impacts on society and the environment are widely regarded as desirable. However, other impacts are regarded as less desirable. Effects of Technology on the Natural World concerns the positive and negative ways that technologies affect the natural world.
- Ethics & Culture
    - Ethics and Culture concerns the profound effects that technologies have on people, how those effects can widen or narrow disparities, and the responsibility that people have for the societal consequences of their technological decisions.

Instructional Resources and Materials
Whole class resources have been identified with an asterisk.

Resources
- LEGO EV3 Programming Software
- LEGO EV3 Curricular Materials
- LEGO EV3 Robotics Kits

Materials
- *Robot Architecture, Design, Programming and Game Strategies* by Sanjeev Dwivedi
- *The LEGO MINDSTORMS EV3 Idea Book: 181 Simple Machines and Clever Contraptions* by Yoshihito Isogawa
- *The Art of LEGO MINDSTORMS EV3 Programming* by Terry Griffin
- *LEGO EV3 Robotics: A Guide for Educators* by Mariappan Jawaharlal

Assessment Strategies
Assessment is designed to measure a student's mastery of a course standard and learning objective. Assessment can be used for both instructional purposes (formative assessment) and for evaluative purposes (summative assessment).

Assessment Methods:

- Students will complete approximately three (3) projects between unit 1 and 3.
- When a student completes a project, s/he will complete a checklist, reflect on their work and answer thoughtful questions on their design process.
- A rubric is outlined on the checklist sheet, delineating the project parameters and expectations.

Course Specific Assessments Include:

- Totes McGoats
    - Totes McGoats Graded Rubric
- Special Delivery
    - Special Delivery Graded Rubric
- Battle Bots
    - Battle Bots Graded Rubric