Unit 2: Application of Robotics (8 weeks)

Content Area: **STEM**
Course(s):
Time Period: **Full Year**
Length: **8 Weeks**
Status: **Published**

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Unit Rationale

In Unit 2, students explore the world of robotics and programming. They use their understanding of mechanical design, robotics, and programming to work collaboratively to develop solutions to real-world-problems. Students continue their career exploration through investigating different pathways to higher education and determine their best course of action to make themselves good candidates for postsecondary education opportunities. Students learn concepts such as programming, using and applying sensors, and artificial intelligence. Students utilize their collaboration, communication, project management, and additional transportable skills throughout the unit to solve in-depth problems.

Essential Questions

2.1 - 1 What characteristics define a robot?

2.2 - 1 What practices do programmers use to write effective code?

2.2 - 2 How do engineers use sensors to solve design problems?

2.3 - 1 What is artificial intelligence, and how do engineers use it to solve problems?

2.3 - 2 What are some of the ethical implications of artificial intelligence?

2.4 - 1 How can you apply your understanding of mechanics and programming to solve a design problem?

Pre-Assessments

Catapult design using given materials and measuring out mass using a gram scale and rice.

Instructional Plan

MODULE 1

LESSON 2.1

Introduction to Robotics In this lesson, students begin their introduction to robotics by creating their own robot that moves forward without the use of wheels. They then investigate what constitutes a robot compared to other programmable mechanical devices. Students conclude this lesson with detailed research in the history of robotics and predict opportunities for the future of the field.

Activity 2.1.1

Silly Walks: The goal of this activity is to get students to construct a robot from scratch that meets a simple set of design criteria.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Construct and program a robot using the VEX® V5 POE Kit. • Develop, test, and evaluate a potential solution to verify it meets project constraints and criteria. • Contribute to the efforts of a team.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- Working Robot
Formative Assessment (drives instructional decisions)	- Successfully satisfies criteria and constraints
Activities and Resources	- See Above

Activity 2.1.2

A Robotic Revolution: Students will determine the defining characteristics of a robot and create a definition.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Conduct research to generate a definition of a robot. • Explore the history of robotics. • Brainstorm ideas to solve a future problem.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- 2 min Presentation about given topic
Formative Assessment (drives instructional decisions)	- 3 slides with notes
Activities and Resources	- See Above
Suggested Modifications	See Activity 1.1.1

LESSON 2.2

Robotics in Action In lesson 2.2 students develop best coding practices, differentiate between open and closed loop systems, apply conditional statements, utilize a variety of different sensors, and apply their understanding to solve a problem. Students build and program a simple robot vehicle that can drive as close as possible to an obstacle without the use of sensors. Students are then introduced to bumper and limit switches, a potentiometer, a servo motor, and optical sensors and program each device to solve different problems. They conclude this unit by applying their understanding of programming to design and build a robot that replicates an animal's behavior.

Activity 2.2.1

Going the Distance: In this activity, you'll design and code both types of systems. However, instead of a washing machine, your context is a vehicle. Along the way, you'll learn basic coding conventions to help you write code as efficiently and clearly as possible.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Develop habits that promote best coding practices. • Differentiate between open- and closed-loop

	control systems. • Analyze software to predict the behavior of a control system. • Explain what conditional statements are.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- Properly formatted code - Motor Spins at correct rate and direction
Formative Assessment (drives instructional decisions)	- Python Code
Activities and Resources	- See Above
Suggested Modifications	See Activity 1.1.1

Activity 2.2.2

Chain Reaction: In this activity, you'll become more familiar with some of the sensors in the VEX® V5 POE Kit, and learn to program them for a whole-class challenge. In this challenge, you will be divided into teams. Each team will build a vehicle. The first vehicle will be activated by a sensor, move forward, and somehow engage the sensor on the second vehicle. When it does that, it stops moving, and the second vehicle starts moving. This vehicle triggers the sensor on the third vehicle, shuts itself off, and the third vehicle starts moving, and so on until all vehicles have moved in a chain reaction. The final vehicle must complete some task like pushing a ball into a cup.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Program a variety of sensors. • Differentiate between analog and digital inputs and outputs. • Use sensor data to control motors. • Define and toggle variables. • Apply what you've learned about programming to complete a class challenge.
Student Learning Strategies	Journaling Collaboration Cooperative Learning

	APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- Properly attached and aligned sensors - Properly formatted Python code
Formative Assessment (drives instructional decisions)	- Python Code
Activities and Resources	- See Above
Suggested Modifications	See Activity 1.1.1

Activity 2.2.3

Moving with Color: In this activity, you will use an optical sensor to control a VEX® V5 Smart Motor. This motor can be used like a servo motor, in that you can program it to rotate to a certain position.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Program sensors to respond to the environment. • Combine multiple conditional expressions. • Use nested if statements. • Evaluate expressions using variables.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- Arrow points to correct color
Formative Assessment (drives instructional decisions)	- V5 Python Code
Activities and Resources	- See Above
Suggested Modifications	See Activity 1.1.1

Activity 2.2.4

Biomimicry: In this project, you will design, build, and program a robot that mimics an animal’s behavior or characteristic.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Program sensors to respond to the environment. • Combine multiple conditional expressions. • Use nested if statements. • Evaluate expressions using variables.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- Biomimicry Device based
Formative Assessment (drives instructional decisions)	- V5 Python Code
Activities and Resources	- See Above
Suggested Modifications	See Activity 1.1.1

LESSON 2.3

Artificial Intelligence Students continue their exploration of robotics with artificial intelligence and machine learning. They design and build a robot, using a supervised machine learning algorithm, a distance sensor, and a bumper switch to train their robot to give a physical greeting. Students then investigate ethical concerns involved in the implementation of artificial intelligence and conduct research to determine the best course of action in a given scenario. To finish this unit, students apply their understanding of artificial intelligence to design and build a robot that can help someone.

Activity 2.3.1

AI Robotic Greetings: In this activity, you will train a robot to give you a high-five, fist bump, handshake, wave, or another physical greeting. Instead of using a conditional statement to trigger the motion of your robot, you will teach your robot when to be in a “waiting for greeting” state, and when to move to the “action” state to make physical contact or greet a person.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Gain awareness of artificial intelligence and

	machine learning. • Understand the three main types of machine learning. • Use a supervised machine-learning algorithm to train a robot to accomplish a specific task.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions Print
Success Criteria	- Working Device
Formative Assessment (drives instructional decisions)	- V5 Python Code
Activities and Resources	- See Above
Suggested Modifications	See Activity 1.1.1

Activity 2.3.2

Ethics in AI: In this activity, you will investigate two AI scenarios and determine the best ethical solutions.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Investigate trade-offs in artificial intelligence. • Conduct research to determine potential solutions to future artificial intelligence problems. • Create and deliver an effective presentation.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions Game
Success Criteria	- Journal Responses

Formative Assessment (drives instructional decisions)	- Journal Responses
Activities and Resources	- See Above.
Suggested Modifications	See Activity 1.1.1

Activity 2.3.3

Robots for Good: In this project, you'll develop an assistive robot using the VEX® V5 POE Kit that also uses machine learning. This could be a tool to assist a differently-abled family member or friend, a device that keeps a baby safe from some sort of hazard, or something else entirely. Whatever the context, you will first train a machine-learning model to differentiate between two conditions, assigning the conditions a value of green or red.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Apply your knowledge of artificial intelligence and robotics to solve an authentic design problem.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- Fully Working Assistive Prototype
Formative Assessment (drives instructional decisions)	- Teachable Machine Program - V5 Python Code
Activities and Resources	- See Above.
Suggested Modifications	See Activity 1.1.1

LESSON 2.4

An Electronic Ensemble In this unit problem, students create a robotic system that can perform a piece of music They research different instruments from around the world, construct a functional prototype of their chosen instrument, then design, build, and program a robot that can play their instrument. Students coordinate and collaborate with their individual robots and each other to create a system of robots that can play a piece of musi

Activity 2.4.1

Robotic Symphony: You and your classmates are tasked with creating a robotic system that will perform a piece (or part of a piece) of music. You will divide into teams, and each team will use the engineering design process to develop a robotic musical instrument. You may use VEX® parts, as well as everyday household items or consumables.

Student Learning Intentions (SLI) WALT: (We are learning to…)	• Apply knowledge of robotics to a musical performance.
Student Learning Strategies	Journaling Collaboration Cooperative Learning APB Approach (Activities, Projects, Problems) Class Discussions
Success Criteria	- Working 3D Vex File
Formative Assessment (drives instructional decisions)	- OnShape File
Activities and Resources	- See Above.
Suggested Modifications	See Activity 1.1.1

Modifications and/or Accommodations

Suggested Modifications (ELL, Sp. Ed, GIfted, At-risk of Failure)

English Language Learners

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing the students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

Special Education Students

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

Students with 504 Plans

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Gifted & Talented Strategies

Extensions/Enrichments: Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

Modify/Change Activities: Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

Students at Risk of School Failure

Directions or Instructions: Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

Peer Support: Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for clarification before going to you.

Alternate or Modified Assignments: Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

Increase One to One Time: When other students are working, always touch base with your students at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

Contracts: It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

Hands On: As much as possible, think in concrete terms and provide hands-on tasks. This means a child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.

Integration of Diversity, Equity and Inclusion, Climate Change, Informational and Media Literacy

New Jersey Student Learning Standards: Content Area

New Jersey Core Curriculum - Grade 10 - Technology

8.1.12.A.4

Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

8.1.12.D.1

Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.

8.2.12.C.5

Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.

TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.1.12.D.1	Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.
TECH.8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.

Integration of Career Readiness, Life Literacies and Key Skills

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).

TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).

Integration of Computer Science and Design Thinking

CS.9-12.8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback.

Interdisciplinary Connections: NJSLS for ELA, Social Studies, Science and/or Math

CCSS.Math.Content.HSF-IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
CCSS.Math.Content.HSG-MG.A.1	Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
CCSS.Math.Content.HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
CCSS.Math.Content.HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
CCSS.Math.Content.HSS-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).

21st Century Life and Career

CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.

CRP.K-12.CRP11.1	Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.
CRP.K-12.CRP12.1	Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.