* Unit 1: Introduction to Engineering *

Content Area:	**Applied Tech**
Course(s):	**Generic Course**
Time Period:	**Marking Period 1**
Length:	**weeks**
Status:	**Published**

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.3	Translate between decimal numbers and binary numbers.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
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.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

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.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).

TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Transfer Goals

Students will be able to independently use their learning to determine how an engineering solution to a problem is different from a scientific inquiry. Engineering is the application of scientific principles to design, build, and invent. "Technologies result when engineers apply their understanding of the natural world and of human behavior to design ways to satisfy human needs and wants". (National Research Council, 2012). Also, engineers follow hunches, make mistakes, re-think, start over, argue, collaborate, and make connections to solve problems with no clear, unambiguous step-by step solutions.

Concepts

Essential Questions

- Did the engineer's knowledge of science and mathematics factor into the engineering solution?
- Have the engineers considered the social, economic, and ecological impact of their solutions?
- How would you enhance this product solution?
- What are the engineering backgrounds of these engineers?
- What engineering career paths would you like to explore?
- What problem is solved by this engineering solution?
- What types of engineers have worked on this product?

Understandings

- Engineering design uses math, science, economics, and ethical considerations.

Critical Knowledge and Skills

Knowledge

Students will know:

- Marketing is key to launching a product.
- Communication is key among team members.
- Design constraints must be identified and factored in to the design process.
- No one person can do it all, the team must decide responsibilities and a timetable.

Skills

Students will be able to:

- Evaluate a product - does it work?, is it cost effective?
- Understand how science and mathematics play a role in the engineering solution.
- Use the engineering process: Identify the problem, research, develop solutions, select the best solution design solution given the constraints, construct a prototype, evaluate the solution, redesign if necessary.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

At least 3 times a week at the start of class, students are presented with an article about a new invention and the team that built it. Students identify the problem that was solved and discuss the engineering solution. Social, environmental, and economic considerations are discussed. If information is available, the educational backround of the engineers is explored especially if they are non-traditional engineers like women and people of color. The teacher leads the discussion which are intended to pique a student's interest in engineering and counteract social stereotypes about teh engineering profession.

School Summative Assessment Plan

Instead of the teacher picking the topic, a student picks the topic, informs the class, and then leads the discussion.

Primary Resources

Technology and Entrepreneurial articles from the IEEE Spectrum Magazine, the Philadelphia Inquirer, and the Wall Street Journal.

Supplementary Resources

Google Search and YouTube videos related to the primary resources.

WDHS Graduates with STEM experiences (academic and professional) are invited to address the class. Each year Professor Pramod Abichadani, founder of LocoRobo, returns to address both engineering classes.

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
  - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
  - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.
- **One to One Student's laptop**
  - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

● **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❏ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❏ All assignments have been created in the student's native language.

❏ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❏ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❏ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Establish what higher order mathematics is used in the product development.

SCIENCE - Establish the fact that a foundation in physics, chemistry and biology is necessary to understand and/or required to participate in the design process.

SOCIAL STUDIES - Does the product have a historical significance? Do the designers see the need for their product to accomodate cultural differences among its users?

WORLD LANGUAGES -Does language (Engish, Spanish, Chineese) play any role in the product development?

VISUAL/PERFORMING ARTS - Is the product designed for an entertainment application?

BUSINESS EDUCATION - Is the product priced appropriately? How will it be marketed?

GLOBAL AWARENESS - Is the product good for the environment, help people live better lives, culturally unbiassed, ethically sound?

Learning Plan / Pacing Guide

Articles of STEM interest are discussed at the start of class when available and/or pertinent.

STEM guest speakrers address the class to talk about their projects, jobs, and. academic experiences.

<u>Pump Building Unit - 3 - 4 Weeks</u>

1) Experiment with Bell Jar Apparatus

2) Activity: Boiling Water in a Bell Jar

3) Activity: Measuring Air Density using a Bell Jar

4) Explain Air Flow in a Bell Jar Apparatus using an air pressure model

5) Culminating Activity: Using PVC Piping, construct a Water Pump

* Unit 2: Computer Programming *

Content Area:	**Applied Tech**
Course(s):	**Generic Course**
Time Period:	**Marking Period 1**
Length:	**weeks**
Status:	**Published**

Computer Science and Design Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.2	Create generalized computational solutions using collections instead of repeatedly using simple variables.
CS.9-12.8.1.12.AP.3	Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
CS.9-12.8.1.12.AP.4	Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.9	Collaboratively document and present design decisions in the development of complex programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
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CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
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.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.ED.5	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).

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.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
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Transfer Goals

Develop proficiency with Python lanugage and associated programming concepts such data types, conditional statements, iterative execution, program control, expression evaluation, functions, classes and objects, libraries, and testing and debugging required to perform computational problem solving for associated robotics problems.

Concepts

Essential Questions

- How are expressions evaluated in python?
- How can a conditional statement like "if, then, else "be useful for program branching?
- How do I design my program for testing?
- Why is a library useful and how do I import it into my program?

- How and why do I associate functions with a class definition?
- How can I get user input, strings or numbers in my application?
- How can prints be used as a debugging tool?
- How does program control occur through main(), statements and functions?
- How specific should my function be?
- Regarding iteration, what's the difference between for loops and while loops?
- When should code be written as a function?
- Why do I need to understand the difference between signed and unsigned integers, strings, characters and floats for my application?
- Why is a class useful?

Understandings

Students will understand that:

- Debugging a program is not straightforward because hardware issues result in poor performance and not necessarily an error.
- Programming a solution requires designing an algorithm that is workable with the used programming language.
- Programming an engineering solution requires knowledge of the programming language and IDE as well as the hardware devices (eg. sensors) the program is interacting with.
- Programming is a creative design process that is a fundamental skill required by all STEM practitioners.
- Solving simple problems (code and test) and incorporating the code in a final design is preferable to writing code for one large program and debugging it can be inefficient.
- Typically, the more a programmer is familiar with the programming language capabilities, the more programimng options are available.

Critical Knowledge and Skills

Knowledge

Students will know:

- The different data types in python -boolean, integer, character, string, float, unsigned and signed int..
- The difference between "if then else" and "if then elif and else"
- How to construct a for loop() and a while Loop()
- How control passes to and returns from a for loop
- How control passes to and returns from a function call.
- How to use parenthesis to force expression evaluation?

- When a global variable might make sense.
- When to use a nested for loop.
- The syntax of creating a function along with passing parameters.
- The use and placement of break, continue
- Understand the definition of an object.

Skills

Students will be able to:

- Use appropriate data types in a program.
- Use conditional statements where appropriate.
- Use iterative statements where appropriate.
- Understand program control so that one can build and debug an algorithm.
- Write complicated expressions with the rules of expression evaluation for python in mind.
- Know how to construct a function in python with parameters and a return "value".
- Knowing what parts of a program can be replaced with a function not only for repetition but program readability and debugging.
- How to use and create library functions for a class.
- What strategies are useful for debugging and testing code?
- Put comments in code.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

A project that requires students to demonstate their understanding of algorithm design, conditional statements, program control, functions, looping (While & For) and LocoExtremes LED Light ring. See Related Documents for trace_rectangle() in FunctionAssignment.docx and LightWaveProject.docx .

Quiz on LocoRobo's LED array lights, namely how to change the value using a hexadecimal number.

Primary Resources

- LocoRobo Academy Coding Environment
- The Python3 Standard Library from Anaconda
- Sublime Text Editor

Supplementary Resources

- *Think Python: How to Think Like a Computer Scientist, 2nd ed.*

https://greenteapress.com/thinkpython2/thinkpython2.pdf

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
  - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
  - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.
- **One to One Student's laptop**
  - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

Differentiated Instruction

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❏ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1:

Use LocoRobo Gui to program the robot to move in a rectangle or square

Introduce Repeat Command (For Loop)

Hex Color Wheel (decimal, binary, octal, and hex nymbering systems)

Week 2:

Identify Locationof Led#0 on the LED Array,

Create white, red, green, black, yellow, or orange array

Work on Light Wave Assignment

Week 3:

Practice Binary and Hexadecimal conversions. Assign Hwk.

Convert GUI program to python, Best Practice for Code Writing

For Loops

Conditional Decisions #1: If/Else Conditions

Week 4:

Conditional Decisions #2 If/Else Conditions in a Loop

Conditional Decisions #3: Logical Operators

Conditional Decsions #4: While Loops

Nested Loops.

Python Math and The Print Function

Week 5:

Project (see Summative Assessment)

* Unit 3: Robotics and Sensors *

Content Area:	**Applied Tech**
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CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
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CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.2	Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.

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.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or

	practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
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TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
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Transfer Goals

Formulate complex robotics and sensor engineering oroblems as smaller and manageable sub-problems. Design and critically analyze solutions to the sub-problems. Use standard data structues, algorithms, conditional flow logic, recursion, descriptive and predictive satatistics, and sensor physics to computationally solve the sub-problems. Implement functionality to extract and process data in real-time from ultrasonic, accelerometer, gyroscope, temperature, and encoder sensors to make robot behavior decisions.

Concepts

Essential Questions

- How much about the physics of a sensor do I need to know before I start using it?
- What's the difference between initializing a sensor and reading its measurement data in real-time?
- How will calibrating the sensor increase its accuracy?
- How do I test whether the calibration has improved the sensor data stream?
- How do I make judicious use of pause() and/or LocoRobo.wait() so the sensor stabilizes before the next reading?

- How many ways can I control LocoExtreme's motion?
- How can a design a robotics program that will preform consistently despite the battery level?
- How do I determine the sensor error and how does using calibration minimize it?
- What sensors and programming constructs does LocoExtreme require to avoid an obstacle?
- How many unique color combinations can be generated on the the 8 bit RGB LocoExtreme LED?
- How many unique instructions can be generated from a 32 bit instruction set?

Understandings

To design an algorithm executing on the LocoRobo Robot(LocoExtreme), one must have a basic understanding of the python programming language, a detailed knowledge of the LocoExtreme library functions found in the LocRobo Academy's Application Programmers Interface(API), and the specific sensors/hardware found on LocoExtreme (ultrasonic, accelerometer, gyroscope, temperature, and encoder). Applications/Programs/Algorithms usually do not run correctly the first time. They must be methodically debugged. Sometimes, it makes sense to debug the main program by writing a simpler (single task) program to isolate the error.

Critical Knowledge and Skills

Knowledge

Students will know:

- How to control LocoExtreme's motion using encapsulated wait types, motor speeds, rotation angles, and motor encoders.
- Apply geometric knowledge of length and angles in constructing a shape.
- The python math import module includes the constant pi and square root, sine, and cosine functions.
- The existence and use of python data structures including strings and lists.
- Understand the Ultrasonic sensor design and algorithm through the hardware specification document and experiments in class.
- Realize msec delays occur when moving data from LocoExtreme to the PC to the LocoRobo Academy WebApp back to the PC and out to LocoExtreme using Bluetooth.
- Using the motor encoder in algorithm design is the better choice over 'time ' control because a motion controlled by time is dependent on the battery's current energy supply.
- Accelerometer is an achievement of MEMS technology and can be modeled as behaving like a damped mass on a spring.
- An accelerometer measures proper acceleration, being the acceleration in its rest frame., not corrdinate acceleration. An accelerometer will measure 1 g for an object at rest and 0g for an object in

free fall.

- Algorithms are used to statistically characterize the error in the accelerometer's readings for when each axis is oriented with gravity. The calculated error is ten removed from the sensor data.
- Determine how accurate the accelerometer calibration was.
- How does sample size affect the calibration?
- How are binary, octal, and hexadecimal numbering systems constructed?
- What Python structured programming elements are useful for designing their robot motion algorithm.

Skills

Students will be able to:

- Read a hardware specification document or consult the LocoRobo API for information how to initialize and read data from a sensor.
- Learn to recognize patterns in geometric shapes that can be coded in a function and called multiple times to construct the final shape.
- How LocoExtreme play a note, song, or display a unique LED during parts of its geometric motion.
- Prompt user for input and store the result in a 'string' expression. These string expressions create conditions which change execution behavior.
- Identify the ultrasonic transmitter and receiver, create a wave model for its operation which is used to explain why cylindrical objects are harder to detect than flat surface objects.
- Design experiments to determine the error in ultrasonic data values and the sensor's range.
- Create an algorithm that avoids collision with a wall.
- Using collision avoidance, build an algorithm having LocoExtreme traverse a left or right hand pure maze of varying lengths and number of turns.
- Identify LocoExtreme's accelerometer axes and verify at rest readings for each axis.
- Calibrate each accelerometer axis and by statistically determining the error and then remove the error from all future raw data.
- Determine if the calibration is working and adjust the sample size if needed.
- Convert vector acceleration data into angles.
- Develop accelerometer applications with LocoExtreme movement, LED arrays, and sensors.
- Convert binary, octal, and hexadecimal numbers in base 10 decimal numbers, necessary for converting hex color wheel values into base 10 for LocoExtrem set_light() command.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.

- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Program LocoExtreme to traverse a geometric pattern or a well known shape. Demonstrate simple and complex shapes.

Program LocoExtreme so it can traverse a pure left or right turn maze.

Program LocoExtreme to use its accelerometer to control robot LED's based on the tilt angle, or to sound a musical note whenever the robot changes its oriention from right side up or upside down, or for LocoExtreme to drive up and down a see-saw type ramp until the ramp is level with the ground.

Primary Resources

Supplementary Resources

Usel Apple IOS Slow Shutter APP to record robot motion, so students can view errors in their robot motion so they can make modifications.

The "Engineering Guy" video on the design and use of the accelerometer.

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks,

Additional Resources/ Support, Homework, etc.)

- GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
  - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

- **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❏ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❏ All assignments have been created in the student's native language.

❏ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❏ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❏ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Use 3D coordinate systems to make sense of accelerometer axes. Use trigonmetry to find accelerometer angles from raw data. Covert from radians to degrees and vice versa. Use the inverse tan function. Use statistical data analysis to calibrate accelerometer data.

SCIENCE - Use the scientific method to test and debug code. Observe patterns in data.

SOCIAL STUDIES - Who invented the accelerometer and ultrasonics sensor and how have they advanced technology?

WORLD LANGUAGES - Can an accelerometer help a person learning sign language?

VISUAL/PERFORMING ARTS - Can an application be written to help a musician hold an instruemnt at the correct angle or choreograph a swarm of drones?

BUSINESS EDUCATION - How expensive are accelerometers? Is price a barrier to include a sensor like an accelerometer in a smartphone? Is it a key sensor or a nice add-on?

GLOBAL AWARENESS - What applications are people around the world using accelerometers?

Learning Plan / Pacing Guide

Week 1:

Create a model of how the ultrasonic sensor acquires distance data and explain how the measurement data is affected due to the surface shape of the object it is detecting.

Use LocExtreme's real time graphical display of ultrasonic readings to determine measurement error and range.

Write a python program that will initialize LocoExtremes Ultrasonic sensor, read sensor data, and display it on the screen.

Week 2:

Write a python program that will initialize LocoExtremes Ultrasonic sensor, read sensor data, and display it on the screen.

Program LocoExtreme so when starting from a random location, it will travel straight to a wall and start rotating when it is within 15 cm of the wall. The rotation needs to be a large enough angle

so it can continue moving forward without hitting the wall. Use the motor encoder to control rotation.

Week 3:

Use the above algorithm to create a program that can traverse a pure right turn maze.

Adapt the maze program so that the user is prompted to input to the program as to the type of maze, left or right turn. The code is then

modified to handle either maze type using srtuctured python programming techniques.

Week 4:

Create an algorithm for which LocoExtreme can traverse a combination maze composed of left and right turns.

Week 5:

Build a straw model of LocExtreme's x, y, and z accelerometer axes by rotating the robot in order to obtain a 1 g reading along the current vertical axis, while the other axes have a 0 g reading,

Initialize LocoExtreme's accelerometer, read x, y, and z data in units of g, and verify the 1 g axis readings when LocoExtreme is rotated such that the appropriate axis is aligned with the z axis in a fixed coordinate system.

Write a program that provides screen output to the user if LocoExtreme is right side up or upside down.

Week 6:

Make a case as to why the raw x, y, z accelerometer data needs to be calibrated - document each axis.

Use user input provided prompts to calibrate the accelerometer sensor using a statistical analysis.

Did the calibration work?

Wite a program to alert the user whether the robot is right side up or upside down.

Week 7:

Write a function to convert calibrated accelerometer vector data to into angles.

Based on the tilt angle of the robot, create a function that will use LocoExtreme's LED's to light up in the same direction the robot is being tilted, with the adjacent two LED's lightning up at a partial intensity of the center LED. As the rotation angles change, the LED's follow the direction.

Week 8:

Program Balance the See-Saw or beep a unique note whenever LocoEXtreme changes it's orientation from upside down to rightside up or vice-versa.

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* Unit 4: 3D Printing *

Content Area: **Math**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.3	Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.AP.8	Evaluate and refine computational artifacts to make them more usable and accessible.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.ED.5	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.

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.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or

	practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Transfer Goals

Students will use 3D printing as a tool for creating an engineering solution to a problem. The problem can be as simple as creating a replacement for a wooden part or as complicated as a complete design. Students will use online training videos to learn how to use the 3D printing software. Students must factor in strength, functionality, precision, and eas of use when building their design.

Concepts

Essential Questions

- How can I insure by 3D designed object will be printed with the expected tolerances?
- How do I go about learning to use the 3D design software?
- How do I design by 3D object so that repated parts of the design are easily replicated?
- Which parts of my design should be printed individually and fastened to other parts with hardware or glue to make the final design?

Understandings

- A single 3D digital design software package is not suited to easily build every conceivable 3D digital design.
- Makerbot Desktop creates the file that control the object's creation on the 3D printer.
- The 3D design software creates an STL or OBJ file which needs to be manipulated by another piece of software which prepares it to be printed by the 3D printer called the Makerbot Desktop.
- There is a learning curve to becoming proficient with a 3D design software package.

Critical Knowledge and Skills

Knowledge

Students will know:

- How 3D Print settings:(layers, rafts. infills and default settings) affect the object's printing.
- How the 3D design process works:design idea, using 3D design software to build the design, and the steps needed to get it successfully printed on the 3D printer(Makerbot- Fifth Generation).
- How to select the 3D printing parameters of a design so it can be successfully printed- see how much material and how much time.
- How to use the Thingiverse application to start with a design.

Skills

Students will be able to:

- Create a digital design using a 3D Design software application.
- Learn to use a caliper to make measurements to include in the design.
- Move, rotate, scale, make, and group objects in a 3D design software application.
- Use align, spline, extrude, loft, splines, workplane helper, and panning in 3D design software.
- Use grouping strategically to create shapes not available from primitives.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.

- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Design a device or part of a device using 3d Modeling software. The device can be either a student or teacher idea.

Primary Resources

MakerBot 3D Printer

TinkerdCad Design Tool

Supplementary Resources

Thingiverse - web based depostory of 3D designs

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and

see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
    - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

- **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❏ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Use measurement and concepts of geometry to create a design.

SCIENCE - Strategize how to build a device using reusable objects.

SOCIAL STUDIES - Does the device satisfy a pain point? is there a device history?

WORLD LANGUAGES - Do different countries have different designs for this device?

VISUAL/PERFORMING ARTS - Does this device need to be attention getting?

BUSINESS EDUCATION - Is there a market for this device? How much would an independent 3D builder charge to build 5 of your devices?

How does 3D printing decrease product design cycle time?

GLOBAL AWARENESS - Could you device help people the tasks of daily living? What pain-point does it solve?

Learning Plan / Pacing Guide

<u>Week 1:</u>

Build a simple 3D device like a name tag to see how the thread works from the design file to the 3D built device.

Work at own pace using online tutorial videos forlearning how to use the 3D design software.

<u>Week 2:</u>

Print the protype of the design on the class 3D printer. See the resource douments for ideas. If not completed within two weeks,

students can work during the rest of the year afterschool or in class when they are caught up with their other projects.

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* Unit 5: Arduino and Circuit Design *

Content Area:	**Applied Tech**
Course(s):	**Generic Course**
Time Period:	**Marking Period 1**
Length:	**weeks**
Status:	**Published**

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.3	Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.AP.8	Evaluate and refine computational artifacts to make them more usable and accessible.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
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CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.ED.5	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.2	Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.

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.3	Investigate new challenges and opportunities for personal growth, advancement, and

	transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Transfer Goals

Students will be able to independently use their learning to construct electronic circuits, some independent and some connecting to the Arduino. Starting with copper foil circuits and ending with breadboard circuits, students will acquire experience building circuits, measuring current and voltage with meters, and analyzing them with Kirchoff's Voltage and Current Laws. Troubleshooting skills including isolating a problem will be developed. Students will then study the Arduino and its IDE platform. The Arduino uses a "C" like programming language which is much different than Python. Students will breadboard circuits for the first time. Simple Arduino applications(hardware and software) are done including blinking an LED and using a pushbutton to control an LED. The point is to develop a skill set which will be put to use when building(hardware and software) an advanced Arduino project.

Concepts

Essential Questions

- How are voltage, current, and resistance related?
- How does the resistance of a resistor affect power consumption within a circuit?
- What is electric charge, and how is it distinct from other properties of matter?
- What is required for an electrical circuit?
- Why are most building wired in parallel?

- Which is brighter, bulbs in a series or parallel circuit?
- What isn't the Arduino as powerful as my laptop?
- How do I troubleshoot a hardware problem?
- What is meant by isolating a hardware or software problem?
- What is an Arduino? Arduino IDE?

Understandings

Students will intuitively build models for current flow in DC series, current and combination circuits to the extent that they can use their model to justify why disconnecting a lightbulb turns the entire circuit off or makes some light bulbs in the circuit brighter than others. A model of resiistance is developed and Ohm's law is cited. A model for electrical power, that it depends on the product of current and voltage, is created. Students are intuitively devleloping Kirchoof's current and voltage laws, though a quantitative application of these laws is best left to a physics class due to the lack of time. Attempts are made to apply energy concepts to explain $V = IR$ i.e How much work must be done(V) to push a specific quantity of charge (I) across a particular obstacle(R)? Students will understand the fundamentals of the Arduino, enough to breadboard a basic circuit connected to the Arduino and controlled by software the student writes.

Critical Knowledge and Skills

Knowledge

Students will know:

- Batteries push current through resistances, they are not current sources.
- Series is an "and", same current flows through every device no matter how wired.
- In a series circuit, all devices are dependent on each other. - All on or All fail.
- More devices = more total resistance
- For a given voltage or energy source, increasing the number of devices decreases the current flow.
- In Parallel circuits, each device has its on path, and each device can be on or off regardless of the other devices.
- More devices = more potential pathways for current flow
- For a given voltage(energy) source, increasing the number of devices increases the current flow.
- Kirchoof's loop rule is a statement of energy conservation: You can't get out more than you put in.
- Kirchoof's Junction Rule is charge conservation, you can't lose electrons.
- Breadboard a circuit controlled by the Arduino using wires, LED's resistors, and a voltage source.
- How to use a breadboard.

- Arduino Program is called a sketch.
- Circuits need to be connected to ground.
- Understand the use of Arduino IDE setup() and loop().
- Difference between Analog and Digital Pins.
- Uses for the Arduino Serial Port.

Skills

Students will be able to:

- Build series, parallel, and combination circuits using lightbulbs, batteries, wires, and switches.
- Troubleshoot a circuit when it does not work.
- Provide an explanation for the brightness of light bulbs in a circuit.
- Apply Ohm's Law, Power equation, and Kirchoff's Laws in analyzing the brightness of Light bulbs in a circuit.
- Breadboard a circuit.
- Write C Programming Code to control an Arduino breadboard application..
- Troubleshoot Arduino Hardware and Software.
- Use a Voltmeter for measurement and conductivity testing.
- Use PhET DC Circuit Simulator to build and test complicated circuits.
- Learn How to Solder.
- Qualitatively apply Ohm's Law, Power, and Kirchoff Laws in analyzing

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Performance Assessment- Given a 4 light bulb bathroom bar circuit wired by this teacher, students are tasked with determining how it is wired by systematically removing light bulbs from the circuit.

Quiz/Test on DC circuit fundamentals using light bulb circuits.

Breadboard a LED circuit and control it through the Arduino.

Primary Resources

PhET DC Circuit Analysis Simulator

Circuit Construction Materials(wires, bulbs, batteries, voltmeters)

College Physics by Etknia, Pearson 2014

Make: Getting Started with Arduino 3rd Edition Massimo Banzi & Michael Shiloh

Supplementary Resources

Universe and More "Crack the Circuit" Game http://the universeandmore.com

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.
- **One to One Student's laptop**

- All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

- **Additional Support Videos**

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be assigned from the Pearson enVisions 2.0 online textbook from the teachers' login.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student's native language.

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All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Develop the mathematical models for Ohm's Laws, and Kichoff's Current and Voltage Laws.

SCIENCE - Use Conservation of Energy to explain voltage sums around a ciruit loop and the conservation of charge to explain Kirchoff's Current Law.

SOCIAL STUDIES - The Arduino microcontroller was invented in Italy by self-proclaimed tinkerer Massimo Banzi.

WORLD LANGUAGES - How many languages has "Getting Started with Arduino" been translated into?

VISUAL/PERFORMING ARTS - Arduino was created for artists and designers to build projects without requiring a sophisticated knowldege of electronics.

BUSINESS EDUCATION - Is Arduino still a viable option for artists and hobbyists to prototype and electromechanical devices?

GLOBAL AWARENESS - How has Arduino been used as an education device for introducing programming and electronics to students from around the world?

Learning Plan / Pacing Guide

Week 1:

Experiment with building paper, foil, and battery LED circuits.

Devise a model for Charge flow - what happnes if two LED's are wired in series or in parallel?

Week 2:

Build 8 lightbulb circuits and account for the brightness of each bulb.

Define series and paraleel circuits and account for current and voltage for each of these circuits.

Continue analyzing combiantion series and parallel circuits qualitatitvely, but OK to develop the mathematical model for the law if students desire.

Introduce PhET DC circuit analysis as a tool for analyzing circuits. Can make voltage and current measurements with this tool.

Week 3:

Quiz on DC circuit Fundamentals(Randking Voltage, Current, and Bulb Brightness)

Introduction to Arduino.

Fundamentals of Breadboarding.

Soldering Experience: Makey Badge and/or Electronic LED Game.

Week 4:

Breadboard LED(s) Arduino Circuit. Start with one LED and progress to multiple LED's, pusbutton applications, etc.

* Unit 6: Arduino & Micro:bit Projects *

Content Area:	**Applied Tech**
Course(s):	**Generic Course**
Time Period:	**Marking Period 1**
Length:	**weeks**
Status:	**Published**

Computer Science and Design Thinking Standards

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CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
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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).
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TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
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TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Transfer Goals

Students will be able to independently use their learning to create devices that sense the outside world using electronic sensors and respond to this stimuli through software running on a microprocessor. These physical computing projects require students to grapple with electronics and the software to control them. This is a messy world because multiple errors or bugs can produce strange outcomes that must be understood in order to be repaired. Finally, these devices are capable of running autonomously untethered to a laptop or PC.

Concepts

Essential Questions

- Besides my teacher, how can I use the world wide web to research all aspects of my project?
- How do I subdivide my project into smaller pieces that are testable?
- How do I integrate the parts together?
- How do I test the individual parts and the final project?
- Is there an advantage to working on a large project with others, or would the project get done a lot faster if one person did it alone?

Understandings

Research a project and learn the necessary math, science, electronics, and programming skiils needed to complete the project. Subdivide the project into smaller more manageable parts. Get these parts working.

Integrate all the parts into the final project. Test and retest.

Critical Knowledge and Skills

Knowledge

Students will know:

- Determine how to divide the project into parts or sub systems that are testable.
- Understand how to isolate problems.
- Be aware of online resources that can be used for assistance during all phases of the design process.

Skills

Students will be able to:

- How do I set a reasonable time table for project completion?
- Document trials, errors, and redesigns.
- To set a time table for project completion and stick to it.
- Develop a sub-system testing strategy.
- Integrate all the subsystems and perform complete project test.
- Use structured programming techniques and comment code.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom

- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Create an Arduino Project with a partner. Current Projects Include: Encoder, Electric Candle, and Pulse Meter.

Primary Resources

LocoRobo Innovations Inc

Make: Getting Started with Arduino 3rd Edition Massimo Banzi & Michael Shiloh

Nuts and Volts Magazine

IEEE Spectrum

Supplementary Resources

www.instructables.com

Technology Integration and Differentiated Instruction

Technology Integration

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Interdisciplinary Connections

MATH - Learn any mathematics required for your project.

SCIENCE - Research any applicable physics, chemistry, biology, environmental or medical concepts that you must fully understand to succesfully implement the project in hardware and software.

SOCIAL STUDIES - Is your project a first? If not, when was it first designed?

WORLD LANGUAGES - Does your project require any language input? If you prompt the user for input, how will you handle this for a language other than English?

VISUAL/PERFORMING ARTS - Do you think if you create a video of your working project and advertise it on the web, will you be contacted by others interested in making it?

BUSINESS EDUCATION - How can your product be re-engineered so it can be ready for manufacturing? How will you market yor product?

GLOBAL AWARENESS - What countries would your project be used in? Is it universal or cultural, or economic, or resource dependent for use?

Learning Plan / Pacing Guide

Week 1:

Study the design specifications of the project. Research aspects of the design (electronics, computer programming, science, math) which are unfamiliar.

Decide if the device can be subdivided into mini-projects which can be separately tested.

Week 2:

Work on each system(hardware and software) and test. Create testing procedures along the way. Keep a notebook of findings.

Week 3:

Integrate the systems together, solve problems, and do final test.

Week 4:

Show off final working project!

Specific Micro:bit Projects:

1) Touch Your Nose

2) Magnetic Compass

3) Flipper Servo Activity

4) Marble Maze Construction

5) Marble Maze Game

* Unit 7: Lightwave Communications *

Content Area:	**Applied Tech**
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CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
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Transfer Goals

In this unit, light is explored as a carrier of informtation and entertainment data. Students are exposed to amplitude modulation which is how AM radio works. Students assemble a laser communication circuit. The circuit uses a radio signal modulated with a 1.5 mW red laser. The laser signal is sent to a solar cell at least 1 meter away. The solar cell output is demodulated through a Radio Shack Amplifier/Speaker Combo. The student performs qualitative activities to assess the strength of the signal. The student is led to discover a way to remove environmental noise at the site of the demodulation, and finally the student devises a circuit to modulate their voice through the laser circuit.

Concepts

Essential Questions

- Are lasers <= 5mW power hazardous to one's eyes?
- What precautions need to be taken when work with lasers and in a room where laser activity is simultaneously occurring?
- How must the circuit be modified to modulate one's voice instead of a radio signal?

- How does a laser work?
- Why is fiber optic communication so fast?
- Can the solar cell demodulator be constructed in such a way so as to receive less ambient noise?
- If the laser beam hits a mirror, does the reflected signal lose sound clarity?
- On the demodulation side, does hooking solar cells in series or in parallel augment signal clarity?

Understandings

How light can be used to effectively communicate large amounts of information through the air. The only drawback is that there must be an unobstructed path from laser to solar cell thereby making our method impractical.

Critical Knowledge and Skills

Knowledge

Students will know:

- The dangers of working with a laser in a laboratory setting.
- Use laser protective eyeware and work with lasers standing up at lab table are two safety measures.
- The difference between AM & FM systems.
- The model for cancelling ambient noise.

Skills

Students will be able to:

- Build and test a circuit consisting of the output of a radio, a capacitor, and 6V DC.
- Build a demodulation circuit using an solar cell and an amplifier.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Instead of using your smartphone, build a circuit that uses voice as the audio input.Use an 8 ohm speaker as a microphone, amplify it, then modulate it with your red brick laser found in your kit. Test it on ONLY at the teacher's Solar Cell Receiver one at a time. You will lose 3 points if you build a solar cell receiver at your desk to check your circuit. If it fails, return to your area to try again.

Primary Resources

Dollar Store Lightwave Communicatios System "The Physics Teacher" Vol. 53. Decemeber 2015

Supplementary Resources

Videos on Amplittude and Frequency Modulation Theory

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Interdisciplinary Connections

MATH - Take music and draw its waveform, then teh amplitude modulated waveform.

SCIENCE - Use the scientic method to create testing hypotheses. Research the physics behind a laser.

SOCIAL STUDIES - Reasearch if this communication system was ever envisioned by Alexander Graham Bell.

WORLD LANGUAGES - Where was the laser first invented?

VISUAL/PERFORMING ARTS - Could this circuit be revised to produce a laser light show for a bedroom sized room?

BUSINESS EDUCATION - Is this laser sytem cheap to make? Did we make the Dollar Store circuit discussed in the article?

GLOBAL AWARENESS - In light of 4G, are line of sight laser communication systems practical? How does our circuit apply to Verizon's Fiber Optic Network in West Deptford?

Learning Plan / Pacing Guide

Week 1:

Build Laser Communication Circuit. Wear laser eye protection and work standing up at lab station table.

Work on Laser Communication Activities. Document Results.

Week 2:

Continue Week 1 Activities.

Create a model for noise cancelation using batteries. Addapt the model to the laser communication circuit, namely the demodulation side

and test.

Week 3:

See Summative Assignment

-