Unit 03: Smarter Machines

Content Area: **Template**
Course(s):
Time Period: **Full Year**
Length: **FY**
Status: **Published**

Standards Alignment

New Jersey Student Learning Standards

Practice 1. Asking questions (for science) and defining problems (for engineering)
Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.

Ask questions to determine relationships between independent and dependent variables and relationships in models.

Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.

Ask questions that require sufficient and appropriate empirical evidence to answer.

Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.

Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

Practice 2. Developing and using models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Evaluate limitations of a model for a proposed object or tool.

Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed.

Use and/or develop a model of simple systems with uncertain and less predictable factors.

Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.

Develop and/or use a model to predict and/or describe phenomena.

Develop a model to describe unobservable mechanisms.

Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.

Practice 3. Planning and carrying out investigations
Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

Evaluate the accuracy of various methods for collecting data.

Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Practice 4. Analyzing and interpreting data
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

Analyze and interpret data to provide evidence for phenomena.

Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).

Practice 5. Using mathematics and computational thinking
Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.

Create algorithms (a series of ordered steps) to solve a problem.

Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.

Use digital tools and/or mathematical concepts and arguments to test and compare proposed solutions to an engineering design problem.

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.

Construct an explanation using models or representations.

Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.

Practice 8. Obtaining, evaluating, and communicating information
Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts.

Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.

Connections to Engineering, Technology and Applications of Science
Interdependence of Science, Engineering, and Technology

Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.

Science and technology drive each other forward.

Influence of Engineering, Technology, and Science and the Natural World

The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Integration of Career Readiness, Life Literacies and Key Skills

CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP3	Attend to personal health and financial well-being.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP5	Consider the environmental, social and economic impacts of decisions.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP9	Model integrity, ethical leadership and effective management.
CRP.K-12.CRP10	Plan education and career paths aligned to personal goals.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.

Technology / Integration of Computer Science and Design Thinking

TECH.8.1.8	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.8.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.8.A.1	Demonstrate knowledge of a real world problem using digital tools.
TECH.8.1.8.A.3	Use and/or develop a simulation that provides an environment to solve a real world problem or theory.
TECH.8.2.8	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.8.A	The Nature of Technology: Creativity and Innovation: Technology systems impact every aspect of the world in which we live.
TECH.8.2.8.A.2	Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system.
TECH.8.2.8.A.5	Describe how resources such as material, energy, information, time, tools, people, and

	capital contribute to a technological product or system.
TECH.8.2.8.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.8.C.1	Explain how different teams/groups can contribute to the overall design of a product.
TECH.8.2.8.C.2	Explain the need for optimization in a design process.
TECH.8.2.8.C.3	Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
TECH.8.2.8.C.6	Collaborate to examine a malfunctioning system and identify the step-by-step process used to troubleshoot, evaluate and test options to repair the product, presenting the better solution.
TECH.8.2.8.C.8	Develop a proposal for a chosen solution that include models (physical, graphical or mathematical) to communicate the solution to peers.
TECH.8.2.8.C.5b	Create a technical sketch of a product with materials and measurements labeled.
TECH.8.2.8.D	Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
TECH.8.2.8.D.1	Design and create a product that addresses a real world problem using a design process under specific constraints.
TECH.8.2.8.D.3	Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.
TECH.8.2.8.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.
TECH.8.2.8.E.2	Demonstrate an understanding of the relationship between hardware and software.
TECH.8.2.8.E.3	Develop an algorithm to solve an assigned problem using a specified set of commands and use peer review to critique the solution.
TECH.8.2.8.E.4	Use appropriate terms in conversation (e.g., programming, language, data, RAM, ROM, Boolean logic terms).

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

	Range of Reading and Level of Text Complexity
LA.K-12.NJSLSA.R10	Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed.
LA.RI.8	Reading Informational Text
LA.K-12.NJSLSA.W	Writing
LA.K-12.NJSLSA.W2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
LA.K-12.NJSLSA.W8	Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
LA.RI.8.10	By the end of the year read and comprehend literary nonfiction at grade level text-complexity or above, with scaffolding as needed.
LA.K-12.NJSLSA.W9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
LA.W.8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and

	information through the selection, organization, and analysis of relevant content.
LA.W.8.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.
LA.W.8.2.E	Establish and maintain a formal style/academic style, approach, and form.
LA.W.8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
LA.W.8.9.B	Apply grade 8 Reading standards to literary nonfiction (e.g., “Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced”).

Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media LiteracyNew Section

see Crosswalks

21st Century Life and Careers

Stage I: Desired Results

Transfer/Overview/Rationale

Transfer / Overview / Rationale
Unit Rationale The purpose of this unit… **Sensors, Controls, and Programming** Until now, the machines students have built have been very controlled, and so unable to sense, think, and act on their own. With the addition of sensors and controls, and with more involved programming, students will be able to drive their machines to be more autonomous.

Meaning

Essential Questions

Essential Questions

How are sensors used with an Arduino to deliver information?

In what way do human senses and machines sensors differ? How are they similar?

What kinds of information can we receive through sensors?

How is an Arduino programmed to act on different values from a single sensor input?

Enduring Understanding/Indicators of Understanding

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Machines receive input through sensors and controls.

Machines and people are similar in how sensory information is collected.

To be autonomous, a robot needs sensors to deliver information from the outside world and programming to process and then react upon it.

For a robot to act on sensor readings, it must be programmed to have different actions for different values.

Acquisition (Student Learning Objectives)

Knowledge

Knowledge

Students will know…

How to connect several different sensors to an Arduino.

The similarities and differences between human senses and their machine sensor counterparts.

Machines are able to sense far more things and far better than humans.

The commands necessary to monitor and apply the information gained through machine sensors in their Arduino programming.

Skills

Skills

Student will be skilled at …

Choosing the correct sensor for each of several different possible scenarios.

Assembling circuits that include sensors.

Applying sensors and controls to an Arduino program to generate varied, appropriate, planned responses.

Stage 3: Learning Plan

Resource and Mentor Texts

Resources and Mentor Texts

Sensors/Controls:

"Arduino How-To: Arduino_Sensors" - https://arduinoinfo.mywikis.net/wiki/HowToArduino#ARDUINO_SENSORS:

"Arduino Lesson 6: Digital Inputs" - https://learn.adafruit.com/adafruit-arduino-lesson-6-digital-inputs

"Lesson: Human and Robot Sensors" - https://www.teachengineering.org/lessons/view/umo_ourbodies_lesson02

"Curricular Unit: How do Sensors Work?" - https://www.teachengineering.org/curricularunits/view/umo_sensorswork_unit

"Experimenter's Guide for Arduino" - http://www.ardx.org/src/guide/2/ARDX-EG-SOLA-WEB.pdf

"Arduino 'How To's', Goodies, and Projects" - http://sheepdogguides.com/arduino/ahttoc.htm

***Make: Getting Started with Sensors*, by Kimmo Karvinen and Tero Karvinen**

***Make: Sensors*, by Tero Karvinen, Kimmo Karvinen, and Ville Valtokari**

Arduino Programming:

"Arduino Course" - http://sheepdogguides.com/arduino/FA1main.htm

"Arduino Lesson 8: Analog Inputs" - https://learn.adafruit.com/adafruit-arduino-lesson-8-analog-inputs

“Using Processing to Visualize Arduino Data” - https://docs.google.com/document/d/1YJxElEbr0NuTnblUfhlc7PH79zxh9TGr0Tt3RGpzlgA/pub

“Arduino Programming Notebook”, by Brian Evans - https://playground.arduino.cc/uploads/Main/arduino_notebook_v1-1.pdf

“Arduino Lesson 5: The Serial Monitor” - https://learn.adafruit.com/adafruit-arduino-lesson-5-the-serial-monitor?view=all

Formative Assessment Strategies

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Teacher observation

Class discussion

Arduino example activities

Sensor and control activities

Programming practice

Google Classroom Questions

Learning Activities/Unit of Study

Learning Activities/Unit of Study

Google Classroom Daily Questions

Discussion of Human v. Machine Senses/Sensors

Discussion and exploration of different sensors

Building circuits with sensor inputs discussion/activity

Interpreting sensor data using the Arduino Serial Monitor

Discussion and practice of varied programming strategies in reaction to sensory input

Arduino sensor/programming/output activities

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.