Unit 6: Bio-medical Engineering

Content Area: **Applied Technology**
Course(s):
Time Period: **Marking Period 3**
Length: **5-6 weeks**
Status: **Published**

Summary

Introduction:

Students will explore how a robot can be used in medical procedures, including diagnosis and surgery. Topics explored include hardening of the arteries-stenosis, cataracts, and skin lesions. Sensors will be used to analyze properties-color, sound, touch-analogous to human senses. Students will explore using LEGO assemblies and programming.

Revision Date: July 2025

Essential Questions/Enduring Understandings

Essential Questions:

How do robots use sensors to interpret the physical world and make informed decisions, and what are the limitations of this sensory information? 🤖

In what ways does prototyping serve as a critical iterative process for engineers to test, refine, and optimize robotic systems and their applications? 🧪

What specific advantages do robotic surgeries and procedures offer over traditional methods, and how do these benefits translate into improved patient outcomes?

Enduring Understandings:

Robots use sensors to measure characteristics of materials and phenomena.

Prototyping is a valuable way to understand and improve a process.

Robotic surgeries and procedures can produce better outcomes than traditional methods.

Objectives

Students Will Know:

what feedback loops are and how they regulate systems.

flow charts are useful aids in computer programming

how sensors work to replicate human sensory response.

about biomedical engineering careers.

the educational path to becoming a biomedical engineer.

how to use the NXT LEGO Mindstorms programming software, or other prototyping software.

the specific characteristics of touch, distance, light, and sound sensors.

how surgeries or procedures relate to different sensory objectives.

how to apply the properties of sensors to prototyping medical surgeries.

specific vocabulary relating to anatomy (heart, eye, circulatory system, skin), vocabulary related to engineering: feedback loop, flow chart terminology: processes, decisions, start/stop, units relating distance, intensity of light, lumen, foot candles, ambient light, pink and white noise, sound terminology: decibels, frequency, sone, ultrasonic, echolocation, spurious noise.

Students Will Be Skilled At:

how to make a flow chart to diagram processes and systems.

integrating sensors with microcontrollers.

how to model surgeries and procedures with robotic systems.

Learning Plan

Preview the essential questions and connect to learning throughout the unit.

Formative assessments will be conducted throughout the process using class discussion, student writing, and practice quizzes.

Formative assessments will be conducted to determine knowledge of computers, robotics, and mechanical engineering.

Lectures and lessons will be provided to develop an understanding of computer programming fundamentals.

Lectures and lessons will be provided to develop an understanding of sensors and how they are integrated into microcontrollers

Formative assessments will be conducted throughout the design process.

Proposed activity: Problem-based learning: Generally in groups of 2 students, surgeries will be modeled using NXT LEGO Mindstorms kits, Arduino microcontrollers, and Basic Stamps. Students will be provided with an anatomical/biological background for the surgeries. Students will be provided with a design brief that indicates the expectations of the procedures, including what properties the sensors evaluate and what the robot will do depending on circumstances. Flow charts will be made to analyze processes and to facilitate computer programming. Students will maintain design logs and create a presentation of their experience. The presentation will document the use of the design loop (unit 1) and include failures and successes. Depending on resources, procedures will be chosen that explore different senses: heart bypass surgery or cataract surgery, light sensor, heart murmur sound sensor, skin lesions surgery ultrasonic distance sensor.

Proposed activity: Student-generated project to explore a surgical procedure or test.

Proposed activity: Students can make parts with the 3-D printer to use in a surgery.

Assessment

Formative Assessment:

proper use of biomedical engineering vocabulary

participation in class discussion

exit tickets

Summative assessment:

use flow charts to describe how complicated surgeries progress.

explain how flow charts help synthesize complicated processes.

prototype a surgery defined by the teacher, applying the design log to develop a solution. The process and solution will be graded using rubrics. prototype a surgery of their own design. The process and solution will be graded using rubrics.

use the design process to develop solutions that employ microcontrollers

complete written tests and quizzes on the history of microprocessors and the function of microcontrollers

demonstrate knowledge of computer memory capability and limits through hands-on activities.

complete writing prompts: Explain how your surgery applies the definition of engineering: the application of science to benefit mankind. Explain the benefits of using robotic surgery vs. traditional surgery. Explain what echolocation is and how it is employed in your surgery. Explain several differences between a modeled surgery and a real surgery. “Explain how a surgeon might perform a procedure many miles away from the patient, and what possible impacts that might have.

answer the essential questions.

Alternate Assessment:

present on the robotic surgery system, ex. The Da'vinci Model

Benchmark assessment:

Final exam.

Materials

LEGO mindstorm kits or Arduino /Basic Stamp with sensors, motors and peripherals.

Computer lab with software to run: Arduino, Basic Stamp, Lego Mindstorm

Various sensors: touch, ultrasonic, light, sound and flex.

Various motors:

On-line videos

Email and e-board

Web sites

CAD and other software programs

SmartBoard use for presentation and interactive lessons

Standards

ELA.L	Language
ELA.L.SS.9–10.1	Demonstrate command of the system and structure of the English language when writing or speaking.
LA.RST.9-10	Reading Science and Technical Subjects
	Key Ideas and Details
LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
LA.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
SCI.HS-LS4	Biological Evolution: Unity and Diversity

SCI.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
SCI.HS.ETS1.B	Developing Possible Solutions
	Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.
SCI.HS-ESS3	Earth and Human Activity
SCI.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
SCI.HS-ETS1	Engineering Design
SCI.HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
SCI.HS.ETS1.A	Delimiting Engineering Problems
SCI.HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
SCI.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
SCI.HS.ETS1.B	Developing Possible Solutions
SCI.HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
SCI.HS.ETS1.B	Developing Possible Solutions
	Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.
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.9-12.8.2.12.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.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.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
CS.9-12.AP	Algorithms & Programming
CS.9-12.ED	Engineering Design
WRK.9.2.12.CAP	Career Awareness and Planning
WRK.9.2.12.CAP.4	Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

WRK.9.2.12.CAP.5	Assess and modify a personal plan to support current interests and post-secondary plans.
WRK.9.2.12.CAP.6	Identify transferable skills in career choices and design alternative career plans based on those skills.
WRK.9.2.12.CAP.12	Explain how compulsory government programs (e.g., Social Security, Medicare) provide insurance against some loss of income and benefits to eligible recipients.
WRK.9.2.12.CAP.13	Analyze how the economic, social, and political conditions of a time period can affect the labor market.
TECH.9.4.12.CI	Creativity and Innovation
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT	Critical Thinking and Problem-solving
	Innovative ideas or innovation can lead to career opportunities.
	Engineering design is a complex process in which creativity, content knowledge, research, and analysis are used to address local and global problems. Decisions on trade-offs involve systematic comparisons of all costs and benefits, and final steps that may involve redesigning for optimization.
	Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.
	Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.

Integrated Accommodation and Modifications...

Integrated Accommodation and Modifications, Special Education students, English Language Learners, At-Risk students, Gifted and Talented students, Career Education and those with 504s