Unit 6: Bio-medical Engineering

Content Area: **Applied Technology**
Course(s):
Time Period: **Marking Period 3**
Length: **25**
Status: **Published**

Summary

Introduction:

Students will explore how a robot can be used to diagnose and replace or repair a body part. Topics will include how arteries stiffen (stenosis) and are replaced with grafts. Sensors will be used to analyze properties-color, sound, touch-analogous to human senses. Students will explore robotic surgery by making a controller for a servo motor using a microcontroller and a sensor modeling robotic surgery.

Revision Date: July 2020

CS.9-12.ED	Engineering Design
CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they

	thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.
CRP.K-12.CRP12.1	Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.
SCI.HS.ETS1.B	Developing Possible Solutions
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-ETS1-4	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-ETS1-3	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	Engineering Design
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-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.
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.8.1.12	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.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.A.CS1	Understand and use technology systems.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.2.12	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.8.2.12.A	The Nature of Technology: Creativity and Innovation: Technology systems impact every aspect of the world in which we live.
TECH.8.2.12.A.CS1	The characteristics and scope of technology.
TECH.8.2.12.A.CS2	The core concepts of technology.
TECH.8.2.12.B	Technology and Society: Knowledge and understanding of human, cultural and society values are fundamental when designing technology systems and products in the global society.
TECH.8.2.12.B.1	Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.
TECH.8.2.12.B.CS1	The cultural, social, economic and political effects of technology.
TECH.8.2.12.C.1	Explain how open source technologies follow the design process.
TECH.8.2.12.C.2	Analyze a product and how it has changed or might change over time to meet human needs and wants.
TECH.8.2.12.C.3	Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics).
TECH.8.2.12.C.4	Explain and identify interdependent systems and their functions.
TECH.8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
TECH.8.2.12.C.CS1	The attributes of design.
TECH.8.2.12.C.CS2	The application of engineering design.
TECH.8.2.12.C.CS3	The role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.
TECH.8.2.12.D.1	Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
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.
	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.
	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.

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.

Essential Questions/Enduring Understandings

Essential Questions:

What is biomedical engineering?

What are robotic surgeries and procedures?

What is prototyping?

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 that 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 understanding of computer programming fundamentals.

Lectures and lessons will be provided to develop 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 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 dependent 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. Dependant on resources, procedures will be chosen that explore different senses: heart bypass surgery or cataract surgery-a light sensor, heart murmur-a sound sensor, skin legions surgery-an ultrasonic distance sensor.

Assessment

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.

Formative Assessment:

proper use of bio medical engineering vocabulary

participation in class discussion

exit tickets

Alternate Assessment:

present on robotic surgery system ex. The Davinci 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

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