STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**The Body Guardian**
Economic Cluster	Human Performance & Medicine Materials & Advanced Manufacturing
Targeted Grades	11-12
STEM Disciplines	Science Technology Engineering Mathematics
Non-STEM Disciplines	English Language Arts

Section I: STEM Unit Overview

Unit Overview

In this unit, students will investigate the effects of an impact force on the human body system, and design a method of protection from harmful contact. Students will apply knowledge of human tissues and genetic disorders, impact forces and materials analysis to design a protective gear system that can withstand the effects of multiple impact forces and serve to protect the underlying tissues. Following an investigation of hemophilia and sex-linked traits, students will design and analyze their gear using an Arduino interface, accelerometers and a pendulum force apparatus. Students will use a ballistics gelatin to simulate the presence of human flesh, as it will serve as the target of an applied force (by the pendulum). Data will be analyzed using linear regression lines and comparisons will be made regarding the effectiveness of the protective gear. Students will collect and measure the acceleration of the ballistics gel and relate it to the initial force of impact on the guard. Following analysis and redesign, student teams will compose a proposal to the Hemophilia Foundation containing information that might sway the Foundation to invest in their design for use with patients.

Essential Question

How can materials be used to build a protective gear system for wear by a person with hemophilia, and how can those materials be analyzed regarding their protection from extensive damage due to impact forces?

Enduring Understanding

STEM professionals concerned with the health and maintenance of the human body, such as human performance or biomedical engineers, must determine the effects of impact forces on simulated tissues when inferring possible effects on human body systems.

Genetic disorders such as hemophilia cause extensive issues for the sufferers, and extra protection must be considered when participating in normal physical activity.

Regression analysis can be used to determine relationships between data points and for extrapolation of data points for unknown values.

Materials can be tested and analyzed for their behavior under stressful conditions, and decisions regarding material selection for products with intended use can be made utilizing such analyses.

Engineering Design Challenge

Student teams will be presented with the scenario that the National Hemophilia Foundation is soliciting proposals for a protective gear system for patients with hemophilia to use during daily routine and exercise activity. Student design teams are asked to develop a system that will protect human tissue from harmful contusions that can be serious for a patient with hemophilia. Using the materials provided, student teams must construct, test and analyze the effectiveness of the design. A ballistics gelatin will be used to represent human flesh, and the protective gear should work to dampen the force the gelatin experiences. During testing, students must determine the impact force of a pendulum apparatus, investigate materials for use in construction of the protection gear, and analyze the data obtained from the apparatus. Students will generate regression analyses of the data collected during the procedure, and should make comparisons between iterations of their design and their competitors (other design teams). Following completion of testing and redesign, students will compose a proposal to the National Hemophilia Foundation in support of the team prototype.

Time and Activity Overview

Day	Time Allotment	Actvities
1	50 minutes	Pre-Test, Introduction to Contusions, Hemophilia & Pedigrees
2	50 minutes	Introduction to Engineering Design Challenge & Baseline Data Collection/Analysis
3	50 minutes	Protection Guard Construction
4	50 minutes	Protection Guard Construction and Testing

5	50 minutes	Protection Guard Analysis & Redesign
6	50 minutes	Final Protection Guard Testing & Analysis
7	50 minutes	Protection Guard Showcase & Hemophilia Foundation Proposal
8	50 minutes	Hemophilia Foundation Proposal Submission & Post-Test

Pre-requisite Knowledge & Skill

Microsoft Excel
Linear Functions
Algebraic Equation Manipulation
Mendelian Genetics
Punnett Squares
Conservation of Momentum

Academic Content Standards

Add Standard	Mathematics
Grade/Conceptual Category	High School - Functions
Domain	Interpreting Functions
Cluster	Interpret functions that arise in applications in terms of the context
Standards	4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. 5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function. 6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Add Standard	Mathematics
Grade/Conceptual Category	Algebra
Domain	Reasoning with equations and Inequalities
Cluster	Understand solving equations as a process of reasoning and explain the reasoning.
Standards	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Add Standard	Mathematics
Grade/Conceptual Category	Statistics and Probability
Domain	Interpreting Categorical and Quantitative Data
Cluster	Summarize, represent, and interpret data on two categorical and quantitative variables
Standards	6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models. b. Informally assess the fit of a function by plotting and analyzing residents. c. Fit a linear function for a scatter plot that suggests a linear association.

Add Standard	Mathematics
Grade/Conceptual Category	Statistics and Probability
Domain	Interpreting Categorical and Quantitative Data
Cluster	Interpret Linear Models
Standards	7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. 8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

Add Standard	Mathematics
Grade/Conceptual Category	Number and Quantity
Domain	Quantities
Cluster	Reason quantitatively and use units to solve problems
Standards	1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. 2. Define appropriate quantities for the purpose of descriptive modeling. 3. Choose a level of accuracy appropriate to limitations on measurement reporting quantities

Add Standard	English Language Arts
Grade	11-12
Strand	Literacy in History/Social Studies, Science, and Technical Subjects
Topic	Text Types & Purposes
Standard	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

Add Standard	Social Studies
Grade	
Theme	
Strand (pk-8 only)	
Topic	
Content Standard	

Add Standard	Science	Ohio
Grade		
Theme		
Topic		
Content Standard		

Add Standard	Science	Ohio
Strand	Physics	
Course Content	Newton's Laws Applied to Complex Problems	
Content Elaboration	The equation a = Fnet/m that was introduced in physical science can be used to solve more complex problems involving systems of objects and situations involving forces that must themselves be quantified (e.g., gravitational forces, elastic forces, friction forces).	

Add Standard	Science	Ohio
Strand	Biology	
Course Content	Heredity	
Content Elaboration	In high school genetic mechanisms, both classical and modern including incomplete dominance, sex-linked traits, goodness of fit test (Chi-square) and dihybrid crosses are investigated through real-world examples.	

Add Standard	Fine Arts
Grade	
Subject	
Standard	
Benchmark	
Indicator	

Add Standard	Technology
Grade	12
Standard	Design Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.
Benchmark	Recognize the role of teamwork in engineering design and of prototyping in the design process.
Indicator	Solve a problem as a group with students each taking a specific engineering role (e.g., design a light rail hub with students taking the roles of architect, civil engineer, mechanical engineer). Build a prototype to use as a working model to demonstrate a design's effectiveness to potential customers.

Add Standard	Technology
Grade	11
Standard	Design Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.
Benchmark	Recognize the role of teamwork in engineering design and of prototyping in the design process.
Indicator	Collaborate with peers and experts to develop a solution to a specific problem. Demonstrate the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills in the design process.

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Engineering Design Challenge Engineering Design Challenge Rubric National Hemophilia Foundation Proposal
Quizzes, Tests, Academic Prompts	Pre-Test Post-Test Pedigree Practice Worksheet Muscle Contusions Worksheet Mid-Construction Review Homework
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Protection Gear Data Analysis Recording Log Student Design Plan Student Design Summary
Student Self- Assessment	Engineering Design Challenge Rubric National Hemophilia Foundation Proposal

Technology Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	Calculator Goniometer
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Arduino Accelerometer Computer Microsoft Excel
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	Internet Computer Goniometer Breadboard Resistors
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	Ballistics Gelatin Pendulum Apparatus
C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	Microsoft Word Microsoft Excel Calculator
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Connections

Career Description

Athletic Trainer - Athletic trainers specialize in preventing, diagnosing, and treating muscle and bone injuries and illnesses. They work with people of all ages and all skill levels, from young children to soldiers and professional athletes.

Computer Engineer - Computer engineers research, design, develop, test, and oversee the manufacture and installation of computer hardware, including computer chips, circuit boards, computer systems, and related equipment such as keyboards, routers, and printers.

Electrical Engineer - Electrical Engineers specialize in power systems, equipment manufacturing or building design. They handle the development of lighting, wiring systems, electrical motors, navigation systems and utilities.

Ergonomist – Ergonomists, also known as human factors engineers, assist in the design of machines, tools, and other equipment to ensure that they can be used easily and correctly.

Exercise Physiologist - Exercise Physiologists oversee the analysis, improvement, and maintenance of health and fitness; rehabilitation of heart disease and other chronic diseases and disabilities; and the professional guidance and counsel of athletes and others interested in sports training.

Hematologist - A Hematologist is a physician who specializes in the diagnosis, treatment, prevention or investigation of the hematopoietic, hemostatic and lymphatic systems. They can focus on diseases of the red or white blood cells and also diseases of the bone marrow.

Histologist - A histologist plays an important role in the detection, diagnosis and treatment of disease. He or she examines and analyzes cells and body fluids. They search for parasites, bacteria and other microorganisms. A histologist must be able to match blood for transfusion purposes and be able to test drug levels in the blood that shows how a patient may be responding to treatment.

Human Factors Engineer - Human Factors scientists and engineers study the intersection of people, technology, policy, and work across multiple domains, using an interdisciplinary approach that draws from cognitive psychology, organizational psychology, human performance, industrial engineering, systems engineering, and economic theory.

Materials Scientist/Engineer - Materials Science and Engineering (MSE) is a field of engineering that encompasses the spectrum of materials types and how to use them in manufacturing.

Occupational Therapist - Occupational therapists treat patients with injuries, illnesses, or disabilities through the therapeutic use of everyday activities. They help these patients develop, recover, and improve the skills needed for daily living and working.

Phlebotomist - A Phlebotomy Technician (Phlebotomist) is an integral member of the medical laboratory team whose primary function is the collection of blood samples from patients by venipuncture or micro techniques. The Phlebotomy Technician facilitates the collection and transportation of laboratory specimens, and is often the patient’s only contact with the medical laboratory.

Physical Therapist - Physical Therapists help people who have injuries or illnesses to improve their movement and manage their pain. They are often an important part of rehabilitation and treatment of patients with chronic conditions or injuries.

Physicist - A physicist is a scientist who does research in physics. Physicists study a wide range of physical phenomena in many branches of physics spanning all length scales: from sub-atomic particles of which all ordinary matter is made (particle physics) to the behavior of the material Universe as a whole (cosmology). The three major employers for physicists are academic institutions, government laboratories and private industries.

Software Engineer - Software engineers apply the principles of engineering to the design, development, maintaining, testing, and evaluation of the software and systems that make computers or anything containing software work.

Section II: STEM Lesson Plan

Title of Lesson — **Day 1: Introduction & Background**

Time Required — 50 minutes

Materials

Pre-Test (Appendix D) - one per student
Muscle Contusions Contusions Worksheet (Appendix E) - one per student
Pedigree Practice Worksheet (Appendix F) - one per student
Hemophilia Investigation Homework (Appendix G) - one per student
Force Impact Testing Apparatus (1 per class)
Ballistics Gel (1 per class)
"Blood" Packet (1 per class)

Objectives

Students will demonstrate any prior knowledge of genetic traits, linear functions, forces and conservation of energy in a diagnostic assessment.
Students will describe how a contusion (bruising) of the skin occurs and how the body reacts when bruising occurs.
Students will investigate and infer how hemophilia affects the body and how a person inherits the disease.

Instructional Process

1. Administer the Pre-Test.
2. Demonstrate the Force Impact Testing Apparatus with the ballistics gel and a simulated "blood" packet. Lead a discussion about what kinds of protection could be applied to the apparatus to prevent damage to the gel and blood.
3. Introduce students to contusions and their impacts on the body. Lead a discussion about types of contusions and their symptoms (see Appendix A).
4. After the discussion, break class into the pre-assigned Engineering Design Challenge teams. At this point, it is not necessary to formally introduce the roles and challenge itself, but students should work in their teams throughout Day 1.
5. Distribute the Muscle Contusions Worksheet and allow student teams time to read and respond to provided questions. Reconvene for a brief class discussion.
6. Briefly review the concept of a Punnett Square, and introduce sex-linked traits, including hemophilia.
7. Distribute the Pedigree Practice Worksheet (Appendix F) and allow student teams time to read, respond and analyze the genetic trends indicated on the worksheet. Address any misconceptions or concerns about the use of pedigrees for analysis of a genetic disorder.
6. Assign Hemophilia Investigation Homework (Appendix G) for each student to complete by the start of Day 2.

Differentiation

The Pre-Test assessment can be modified and/or accommodated based on the students' individual learning needs.
Student teams can be structured in either heterogeneous or homogeneous nature with consideration of student readiness.
The Background Information can be presented in a variety of ways including, but not limited to, a PowerPoint presentation, guided reading or brief student presentations.

Assessments

Pre-Test
Muscle Contusion Worksheet
Pedigree Practice Worksheet
Hemophilia Investigation Homework

Section II: STEM Lesson Plan

Title of Lesson

Day 2: Introduction to Engineering Design Challenge & Baseline Data Collection

Time Required

50 minutes

Materials

Engineering Design Challenge & Rubric (Appendix H)
Protective Gear Analysis Data Recording Log (Appendix I)

Force Impact Testing Apparatus (Building Instructions Appendix B)
Ballistics Gel (one per student team)
Arduino (1-2 per class)
Accelerometers (2-4 per class)
Laptop computer (1-2 per class)
AB - USB cord (1-2 per class)
Assorted Wires (1-2 per class)
Bread Board (1-2 per class)
Resistors (1-2 per class)
Steel Plate (1-2 per class)
Wooden Spacers for Apparatus (1-2 per class)
Microsoft Excel
Calculators
Goniometer (1-2 per class)

Objectives

Students will describe the set up of the pendulum apparatus including Arduino and accelerometers.
Students will employ appropriate lab technique in a whole-class demonstration of the use of the apparatus.
Students will generate a scatter plot with a linear regression line in order to make future comparisons with new design.
Students will calculate the impact force of the pendulum apparatus onto a steel plate for use in making data comparisons.

Instructional Process

1. Introduce the Engineering Design Challenge. Distribute the Engineering Design Challenge & Rubric (Appendix H). Explain the requirements and expectations of the challenge as well as the materials that will be available to the students. Allow time for each student team to assign roles to team members.
2. Distribute the Protection Gear Analysis Recording Log (Appendix I) to each student.
3. Display and describe the testing apparatus including the Arduino, accelerometers, ballistics gelatin, and pendulum simulator. Include a brief discussion about potential and kinetic energy and how a pendulum demonstrates this phenomenon. Perform sample tests to show the display on the computer interface. (See Appendix C).
4. As a whole class, complete the baseline testing (with steel plate). The accelerometer should be attached to the side of the sledge hammer to prevent damage. (This test is designed to measure the impact force od the pendulum. Accelerometers will be moved to the ballistics gel in the next phase to measure force absorbed by the tissue.) Peak accelerations from the data readout should be recorded on each data table. The use of a document camera or projection screen is highly encouraged. Additionally, teams of students should rotate through for usage of the entire apparatus, and any misconceptions regarding use of equipment should be addressed.
5. Remaining as a whole class, the instructor should walk students through the regression analysis of the data. Using Microsoft Excel, a data table should be created (X-coordinate: Angle reading from goniometer, Y-coordinate: Acceleration from Arduino readout). A scatter plot should be generated, and a linear regression line should be used. The regression equation, slope, correlation coefficient, y-intercept, and function type should be recorded from the use of Microsoft Excel.
6. Strike force of the pendulum should be calculated using F=ma at each of the angle measurements where pendulum was released. (The mass should refer to the mass of the hammer).

7. After performing a model of these calculations, allow student teams time to complete calculations for the impact force of the pendulum apparatus.

Differentiation

Student teams can be structured in either heterogeneous or homogeneous nature with consideration of student readiness.
Additional modeling of calculations and use of the apparatus can be provided.

Assessments

Engineering Design Challenge & Rubric
Protection Gear Analysis Data Recording Log

Section II: STEM Lesson Plan

Title of Lesson

Day 3 & 4: Protection Gear Construction & Initial Testing

Time Required

50 minutes

Materials

Per Team:
Student Design Plan (Appendix J)
Mid-Construction Review Homework (Appendix K)

Testing Materials for Class
Force Impact Testing Apparatus (Building Instructions Appendix B)
Ballistics Gel (one per student team)
Arduino (1-2 per class)
Accelerometers (2-4 per class)
Laptop computer (1-2 per class)
AB - USB cord (1-2 per class)
Assorted Wires (1-2 per class)
Bread Board (1-2 per class)
Resistors (1-2 per class)
Steel Plate (1-2 per class)
Wooden Spacers for Apparatus (1-2 per class)
Microsoft Excel
Calculators
Goniometer (1-2 per class)

Suggested Supplies for Protection Gear Design:
Paper Plates
Styrofoam Cups
Cotton Balls
Cardboard
Bubble Wrap
Craft Foam
Q-Tips
Popsicle Sticks
Duct Tape
Rubber Bands
Velcro Strips
Pipe Insulation

Objectives

Students will design a shin guard from available materials that will reduce the impact force upon a simulated human tissue.
Students will employ proper usage of simulation technologies including use of the Arduino, pendulum apparatus and ballistics gel.
Students will generate linear regression analyses of acquired data for comparison between iterations.

Instructional Process

1. Introduce the Engineering Design Process as an iterative method for solving problems. Lead a discussion about its role in the assignment.
2. Distribute Student Design Plan handouts and provide students 15-25 minutes for team ideation of a protective gear design.
3. Remind students of available materials and location of supplies, apparatus and computers.
4. Prompt student usage of the Engineering Design Challenge Rubric for use of self-assessment during construction and testing.

5. Students should have access to building supplies and the entire testing apparatus for use during construction. If only using one apparatus per class, consider a testing schedule sign-up sheet to prevent delay in teams' progress.
6. Allow the student teams to work on construction of design, initial testing and analysis during the end of Day 3 and Day 4.
7. At the end of Day 4, assign the Mid-Construction Review Homework assignment.

Differentiation

Consider providing more time to brainstorm using large poster paper based on individual student needs. Provide small group instruction to further explore the concepts of force prior to brainstorming based on student needs.

Assessments

Engineering Design Challenge Rubric
Student Design Plan
Protection Gear Analysis Data Recording Log

Section II: STEM Lesson Plan

Title of Lesson

Day 5 & 6: Prototype Testing, Analysis & Redesign

Time Required

50 minutes

Materials

Student Design Summary (Appendix L) - one per student team

Testing Materials for Class:
Force Impact Testing Apparatus (Building Instructions Appendix B)
Ballistics Gel (one per student team)
Arduino (1-2 per class)
Accelerometers (2-4 per class)
Laptop computer (1-2 per class)
AB - USB cord (1-2 per class)
Assorted Wires (1-2 per class)
Bread Board (1-2 per class)
Resistors (1-2 per class)
Steel Plate (1-2 per class)
Wooden Spacers for Apparatus (1-2 per class)
Microsoft Excel
Calculators
Goniometer (1-2 per class)

Suggested Supplies for Protection Gear Design:
Paper Plates
Styrofoam Cups
Cotton Balls
Cardboard
Bubble Wrap
Craft Foam
Q-Tips
Popsicle Sticks
Duct Tape
Rubber Bands
Velcro Strips
Pipe Insulation

Objectives

Students will redesign their protective gear following analysis of the previous iteration(s).
Students will analyze the effectiveness of the team-designed protective gear using the pendulum apparatus and Arduino software.
Students will generate linear regressions for use in comparison between iterations of the protective gear.

Instructional Process

1. Allow student teams time to continue testing with the Arduino and pendulum apparatus.
2. Distribute Student Design Summary handouts to each team to facilitate conversations between teammates regarding the effectiveness of the student designs.
3. Allow access to Microsoft Excel for student teams to complete regression analyses of the design iterations.
4. If time allows, student teams can complete an additional iteration of their protective gear in attempt to further reduce the force experienced by the simulated tissue.

Differentiation

Consider providing more time to construct shin guard based on individual student needs. Provide small group instruction to further explain the calculations of force using the equation F=ma based on student needs.

Assessments

Protection Gear Analysis Data Recording Log
Student Design Summary Worksheet

Section II: STEM Lesson Plan

Title of Lesson	**Day 7: Protection Gear Showcase & Hemophilia Foundation Proposal**
Time Required	50 minutes
Materials	National Hemophilia Foundation Proposal (Appendix M) Testing Materials for Class: Force Impact Testing Apparatus (Building Instructions Appendix B) Ballistics Gel (one per student team) Arduino (1-2 per class) Accelerometers (2-4 per class) Laptop computer (1-2 per class) AB - USB cord (1-2 per class) Assorted Wires (1-2 per class) Bread Board (1-2 per class) Resistors (1-2 per class) Steel Plate (1-2 per class) Wooden Spacers for Apparatus (1-2 per class) Microsoft Excel Microsoft Office Calculators Goniometer (1-2 per class)

Objectives	Students will demonstrate and describe the effectiveness of their improved design in a brief presentation (live test) with the pendulum apparatus. Students will compose a proposal for the National Hemophilia Foundation regarding the use and benefits of their protection gear.
Instructional Process	1. Each team should give a brief, informal presentation while performing a live test using the apparatus. Students should place their protection gear in the apparatus, and run the pendulum at several angles, indicating success (or failure) of the design. 2. Distribute National Hemophilia Foundation Proposal sheet to each student. Discuss and review requirements of the proposal. 3. Allow time for students to work on the development of the final written assignment. Completion of the proposal should be assigned as homework. Provide access to computers with Microsoft Word and Microsoft Excel.
Differentiation	Consider providing more time in class to begin editing and typing proposal.
Assessments	Student Team Presentations National Hemophilia Foundation Proposal

Section II: STEM Lesson Plan

Title of Lesson

Day 8: Hemophilia Foundation Proposal Submission & Post-Test

Time Required

20 minutes

Materials

Student-generated Proposal Submissions
Post-Test (Appendix D) - one per student

Objectives

Students will demonstrate their knowledge of unit content in a summative written assessment that addresses standards-based content.

Instructional Process

1. Collect Proposal Submissions.
2. Administer Post-Test

Differentiation

The Post-Test should be accommodated and/or modified in accordance with documentation regarding participating students.

Assessments

Students will participate in a culminating assessment to communicate their findings regarding their prototypes. A checklist is provided to allow for student self-assessment and transparency in grading. Additionally, students will complete a written summative assessment to measure growth from the beginning of the instructional unit in standards-based objectives.

Section III: Unit Resources

Materials and Resource Master List

Printable Resources:
Appendix D: Pre/Post Test (two per student)
Appendix E: Muscle Contusions Worksheet (one per student)
Appendix F: Pedigree Practice Worksheet (one per student)
Appendix G: Hemophilia Investigation Homework (one per student)
Appendix H: Engineering Design Challenge & Rubric (one per student)
Appendix I: Protection Gear Analysis Data Recording Log (one per student)
Appendix J: Student Design Plan (one per student team)
Appendix K: Mid-Construction Review Homework (one per student)
Appendix L: Student Design Summary (one per student team)
Appendix M: National Hemophilia Foundation Proposal (one per student)

Supplies for Protection Gear Design:
Ballistics Gel - Air Rifle Block - (one per student team) - (http://store.clearballistics.com/10-Percent-Ballistic-Gelatin-Air-Rifle-Block-p/608729261452.htm)
Paper Plates
Styrofoam Cups
Cotton Balls
Cardboard
Bubble Wrap
Craft Foam
Q-Tips
Popsicle Sticks
Duct Tape
Rubber Bands
Velcro Strips
Pipe Insulation

Force Impact Testing Apparatus Materials: (1-2 per class)
(1) 2"x6"x10' piece of lumber
(1) 2"x10"x10' piece of lumber
(25) 3 inch drywall screws
(1) ½ x 10 inch bolt
(1) ½ in x 2 in washer
(1) ½ in Hex Nut
Hand Saw or Table Saw
Drill with Philips head screw bit and 5/8 drill bit.
(1) 4lb sledge hammer
Sand Paper - any grit
Several Wooden Spacers
(1) Goniometer (or similar smart phone app)
(1) 9"x4" Steel Plate
(1) Simulated Blood Packet (http://www.ehow.com/how_2118601_squibs-film-television-stage-production.html)

Arduino Setup Materials: (1-2 per class): See Wishlist here: https://www.sparkfun.com/wish_lists/122150
NOTE: If Vernier technology is available, Dual-range force sensors and associated technology is an alternative to the Arduino software and setup
Arduino Uno (w/Atmega 328 Microcontroller)
(2) ADXL345 Accelerometer “breakout board”
Be sure to purchase header pins, if not included
(1)USB Type AB cord
(1)Breadboard (small to medium in size)
(11)2-3ft, 22-26 gauge (AWG) wire (Consider cat5(e) Ethernet cable)
(11)Female-Female pin connectors (jumper wires)
(2)1KΩ resistor
Assortment of “Jumper” wires

Optional Items to aid setup:

(1)Multimeter
(1)Wire strippers
Assortment of resistors (in case 1KΩ resistor doesn't work properly for the accelerometers used
(1) Soldering Iron (in case header pins need to be installed) - Required for some accelerometers
Solder

Optional: Items needed for LCD
(1)Hitachi HD44780 compatible chipset LCD
(1)10 KΩ potentiometer
Assortment of "Jumper" wires

Optional: Items needed for external power
(1)4-slot AA battery case
(1)2.1mm x 5.5mm male power plug
Any necessary linking components (see Implementing optional LCD and/or external power supply)

Key Vocabulary

AB cable- a USB cable which supports the transfer of high-speed data

Acceleration- the rate of change of velocity with respect to time

Accelerometer- an instrument for measuring acceleration

Arduino- a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible.

Ballistics- the science of the motion of projectiles in flight

Breadboard- a board on which mounted components are placed

C++ general-purpose programming language

Carrier- an individual (as one heterozygous for a recessive trait) having a specified gene that is not expressed or only weakly expressed in its phenotype

Contusion- injury to tissue usually without laceration: bruise

Correlation coefficient- a number or function that indicates the degree of correlation between two sets of data or between two random variables and that is equal to their covariance divided by the product of their standard deviations

Domain- input values of a series or function

Dominant- An allele which is commanding, controlling, or prevailing over all others

Elastic collision- an encounter between two bodies in which the total kinetic energy of the two bodies after the encounter is equal to their total kinetic energy before the encounter. Elastic collisions occur only if there is no net conversion of kinetic energy into other forms.

Force- cause of motion or change

Force of impact- In mechanics, an impact is a high force or shock applied over a short time period when two or more bodies collide.

Gelatin- a colloidal protein used as a food, in photography, and in medicine

Goniometer- an instrument for measuring angles

Hemophilia- a sex-linked hereditary blood defect that occurs almost exclusively in males and is characterized by delayed clotting of the blood and consequent difficulty in controlling hemorrhage even after minor injuries

Heterozygous- having the two alleles at corresponding loci on homologous chromosomes different for one or more loci

Homozygous- having the two genes at corresponding loci on homologous chromosomes identical for one or more loci

Inelastic collision- a collision in which kinetic energy is not conserved

Kinetic energy- the energy an object possesses due to its motion

Laceration- a torn and ragged wound

Mechanical energy- the sum of potential energy and kinetic energy

Pedigree- a register recording a line of ancestors: lineage

Pendulum- a body suspended from a fixed point so as to swing freely to and fro under the action of gravity and commonly used to regulate movements

Potential energy- the energy of an object or a system due to the position of the body or the arrangement of the particles of the system

Range- a series of things in a line

Recessive- expressed only when the determining gene is in the homozygous condition

Regression line- an approach to modeling the relationship between a scalar dependent variable y and one or more explanatory variables denoted X

Resistor- a device that has electrical resistance and that is used in an electric circuit for protection, operation, or current control

Sex-linked trait- the phenotypic expression of an allele related to the chromosomal sex of the individual

Slope- steepness, incline, or grade the higher slope value indicates a steeper incline

USB- a standardized serial computer interface that allows simplified attachment of peripherals especially in a daisy chain

y-intercept- a point where the graph of a function or relation intersects with the y-axis of the coordinate system

Technical Brief

See Appendix A.

Safety and Disposal

1. Safety goggles should be worn at all times during testing around the force impact testing apparatus. Pieces of protective gear or ballistics gel can come loose and damage a student's eye.
2. Scissors and scalpels should be handled with great care as to not cut or damage a student.
3. Proper handling of the pendulum is critical for classroom safety. The pendulum has enough force to damage even break fingers or appendages if caught between the strike plate and the hammer. The pendulum also needs to rest up against a sturdy flat surface when tests are being conducted so that it does not scoot back when in motion. If a student were to hold the entire pendulum device in place to keep it from moving, they can damage

arms and other limbs in the process.

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Curriculum Developers

Ellen Fifarek: Contributing Author
Carly Monfort: Contributing Author, Editor
Dianna Outten: Contributing Author
Leanne Petry, Ph.D.: Contributing Author
Capt. Eric Powell: Contributing Author
Sandra Preiss: Editor
Martha Rutan: Contributing Author
Richard Warren, Ph.D.: Contributing Author
Capt. Mark Weems: Contributing Author

Section IV: Appendices

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