Storybook STEM:
A Chair for Goldilocks

Grade Level	Early Elementary
Lesson/Unit Category	1 Time Engineering Design Process Lesson
Timeline	2 – 3 hours
Curriculum Connections	Engineering Design Process Literacy (Reading and Writing) Physical Science Materials Science
Essential Questions	How can materials be combined to make a chair that holds Goldilocks? How can I improve a design?
Summary	In this lesson students will first identify the "problem" in the fairytale "Goldilocks and the Three Bears", then employ the Engineering Design Process to develop and test a possible solution to the problem (build Goldilocks a chair of her own).
Materials/Tools	• Book: Goldilocks and the Three Bears • Various recycled materials (paper towel tubes, cardboard, pipe cleaners, etc.) • Tape, scissors
Lesson Components	• Students will develop a working definition of the word "engineer" and the function of engineers ○ engineers solve problems. • Students will identify problems that occur in the story "Goldilocks and the Three Bears" • Students will utilize the Engineering Design Process to develop a solution to a specific problem • Students will use given materials to develop a prototype • Students will test the prototype and redesign as necessary • Students will share designs and process with whole class, with a focus on design and materials properties (strong, flexible, rigid) and process (trying again, improving balance)
Extension Activities	• Discuss/write alternate ending to story given Goldilocks' new chair. • Create chairs for Papa, Mama and Baby Bear
Related Lessons	Bridge for Billy Goats Gruff Zipline for Rapunzel

Measuring Wind:
Designing Anemometers

Grade Level	Upper Elementary
Lesson/Unit Category	1 Time Engineering Design Process Lesson
Timeline	2 – 3 hours
Curriculum Connections	Engineering Design Process Earth Science: Weather Materials Science
Essential Questions	How can materials be combined to make something that measures wind speed? How can I improve a design?
Summary	In this lesson students will first identify situations in which knowing wind speed would be helpful. Students then design, build, test and redesign prototypes.
Materials/Tools	• Various recycled materials (paper towel tubes, cardboard, pipe cleaners, etc.) • Various craft materials (paper cups, straws, etc) • Tape, scissors • Box and/or table fans
Lesson Components	• Students will utilize the Engineering Design Process to create a working anemometer • Students will use a fan to test anemometer and redesign as necessary • Students will measure wind speed using their anemometers (revolutions per minute) • Students will identify situations in which is it helpful to know the wind speed
Extension Activities	• Predict and test the wind speed when holding the anemometers at several distances from the fan.

Match that Pitch:
Creating Musical Instruments

Grade Level	Middle School General Music or Band
Lesson/Unit Category	1 Time Engineering Design Process Lesson
Timeline	2 – 3 hours
Curriculum Connections	Engineering Design Process Music Theory Physical Science Materials Science
Essential Questions	How can materials be combined to make sound? How can materials make different pitches? How can I improve a design?
Summary	In this lesson students will use various recycled and reusable materials to create musical instruments. Students will strive to make instruments that play specific pitches.
Materials/Tools	• Various recycled materials (paper towel tubes, cardboard, pipe cleaners, etc.) • Various reusable materials (mason jars, • Tape, scissors • Tuners (we use PanoTuner App on phones/tablets)
Lesson Components	• Students will identify definition of "pitch". • Students will utilize the Engineering Design Process to develop prototypes that produce three given pitches. • Students will use given materials to develop a prototypes. • Students will test the prototypes and redesign as necessary. • Students will share designs and process with whole class, with a focus on design and materials properties (strong, flexible, rigid), tone qualities (resonant, overtones) and process (trying again, adjusting pitch)
Extension Activities	• Notate songs that are played on the instruments. • Create additional instruments that can produce additional pitches.

Heat Transfer
Insulate that House

Grade Level	Middle School Science
Lesson/Unit Category	1 Time Engineering Design Process Lesson/ PBL Introduction
Timeline	2 – 3 hours
Curriculum Connections	Engineering Design Process Physical Science Materials Science
Essential Questions	How does heat energy move? How do material properties affect heat transfer?
Summary	In this activity, students make a model house that meets given requirements and constraints. They place the model over a heat source and measure the ambient temperature at various points outside the house. Students then choose between various materials and use them to insulate their houses. Temperature readings are recorded again and compared to the pre-insulated temperatures. Students analyze the data and make conjectures about heat transfer.
Materials/Tools	• File folders • Various recycled materials (cotton balls, Styrofoam, newspaper) • Tape, scissors • Thermometers • Heat sources (We use shop lights set in foam "table")
Lesson Objectives	• Students will make a prototype house that meets given requirements and constraints • Students will demonstrate accurate measurement techniques using a thermometer • Students will apply the engineering design process • Students will analyze data collected during the activity • Students will justify answers to the essential questions using evidence from the activity
Extension Activities	• Assign monetary values to the insulating materials; include cost-benefit analysis to the project. • Extend to a full Project Based Learning unit by returning to prototypes during a unit on energy. As students gain understanding, they can redesign their houses' insulation and measure its effectiveness.
Note	This activity is an adaptation of The Heat Loss Project, by Lawrence Parretto. Details can be found at https://www.teachingchannel.org/videos/stem-lesson-ideas-heat-loss-project

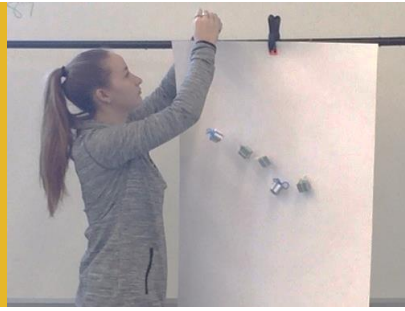
Scientific Inquiry:
Does Air take up Space?

Grade Level	Upper Elementary
Lesson/Unit Category	Scientific Inquiry
Timeline	1-2 hours
Curriculum Connections	Engineering Design Process Physical Science Materials Science
Essential Questions	Does air take up space? How can I test a hypothesis?
Summary	In this lesson students will first form a hypothesis to the question "Does air take up space?", then develop and execute a method to test their hypothesis. Students will also make adjustments to methods and prototypes as a result of peer and teacher input.
Materials/Tools	• Planning sheet, pencils • Various recycled materials (paper towel tubes, plastic shopping bags, cardboard, pipe cleaners, etc.) • Tape, scissors
Lesson Objectives	• Students will develop a hypothesis • Students will brainstorm methods to test their hypothesis • Students will utilize the Engineering Design Process to develop a prototype to test their hypothesis • Students will test the prototype and redesign as necessary • Students will explain what information their prototype collects • Students will explain if their data supports their hypothesis • Students will share designs, process and findings with the whole class
Extension Activities	• Write detailed directions for making and testing prototype

Linear Art:
Defining Lines

Grade Level	Algebra 1
Lesson/Unit Category	Studio Supported Lesson
Timeline	2 – 3 hours
Curriculum Connections	Mathematics Art
Essential Questions	How are lines defined?
Summary	In this lesson students identify various lines within a piece of artwork (original or found). Students define an origin, graph and find the equation for each line.
Materials/Tools	• Art supplies (paper, pencils, markers, etc) • Overhead transparencies with coordinate grid • Tape • Sharpies
Lesson Objectives	• Students will choose or create a piece of art that contains straight lines. • Students will choose an origin point. • Students will identify lines that satisfy given requirements (positive slope, negative slope, zero slope, no slope, various y-intercepts and quadrants) • Students will graph these lines on an overhead transparency. • Students will find the equations for each line
Extension Activities	• Include nonlinear functions • Create art that includes given lines, find equations

Advanced Photography:
Inspired by Catherine MacBride



Grade Level	Photo 2
Lesson/Unit Category	Studio Supported Project
Timeline	4-5 hours
Curriculum Connections	Photography
Essential Questions	How can materials be used to create original subjects in photography?
Summary	In this unit, students create original objects to use as subjects of their photographs. Special attention is given to shadows and composition. Students use similar professional photography as inspiration.
Materials/Tools	• Cameras • Various recycled materials (paper towel tubes, cardboard, pipe cleaners, etc.) • 3D Printers, Laser Cutter
Project Objectives	• Students will incorporate light and shadow in their photographs. • Students will demonstrate the importance of different perspective viewpoints and incorporates changing the angle of view. • Students will demonstrate photo editing skills using Photoshop.
Major Project Components	• Students study the art of Catherine MacBride • Students use found objects as well as objects created with the 3D printer and laser cutter to develop scenes to photograph • Students set scenes and light for photo session • Students use Photoshop to create final photos as well utilize photographs on cards and other products
Extension Activities	• Share photographs with professional artist who inspired them to solicit feedback.

Soup Can Calculus:
Optimization in Action

Grade Level	High School Calculus
Lesson/Unit Category	Studio Supported Project
Timeline	2-3 hours (plus printing time)
Curriculum Connections	Mathematics
Essential Questions	What does optimization mean?
Summary	In this unit, students choose a cylindrical container (soup can, etc.). Students then apply optimization formulas to determine the dimensions of a can that can hold the same volume while having the least surface area. Students then design a cylinder with these dimensions in CAD software for 3D Printing. Finally, students test their dimensions by pouring a full can of water from the original cylinder into the newly printed cylinder.
Materials/Tools	• Various open cylinders (soup cans, drink bottles) • CAD software (We use Tinkercad) • 3D Printer
Project Objectives	• Students will use optimization formulas to correctly find a cylinder of equal volume but least surface area. • Students will design a cylinder of specified dimensions using CAD software. • Students will operate a 3D printer.
Major Project Components	• Students select the can they want to optimize • Students utilize optimization formulas to determine the optimal cylinder size to hold the specified volume • Students design a cylinder to the specifications using Tinkercad • Student prints new container • Students will test their design by filling the original container with water, then pouring the water into the new container
Extension Activities	• Apply optimization formulas to additional situations (cost, production)

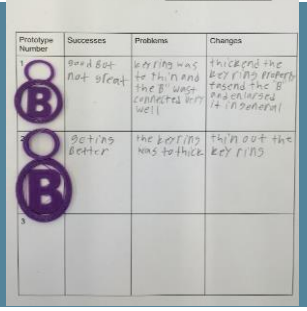
National Parks Project:
Geology and Geography

Grade Level	Middle School Science
Lesson/Unit Category	Project Based Learning Unit
Timeline	Full Unit – ongoing for duration of unit
Curriculum Connections	Earth Science: Geology Geography Digital Literacy Materials Science
Essential Questions	How are locations decided for National Parks? How can I share information about a National Park?
Summary	In this PBL unit, students will demonstrate their understanding of geology by creating a model and digital presentation. Students choose a park at the start of the unit, then plan and create their products at regular intervals during the geology unit. Finally, projects are shared with peers, staff and parents.
Materials/Tools	• Craft materials • Internet access • Tablets/Laptops/Desktops
Project Objectives	• Students will apply understandings of geologic concepts to specific locations (National Parks) • Students will demonstrate understanding of geographic features of National Parks • Students will
Major Project Components *Project components are in addition to ongoing instruction about geological formations	• Students select National Park by participating in a "Yankee Swap" • Students research basic information about their park and brainstorm project format. • At periodic intervals, students apply understanding of geology and geography as it applies to their specific park. • At the conclusion of content learning, students finalize their physical models and digital presentations. • Students share models and presentations to peers, staff and parents at a showcase event.
Extension Activities	• Hold a contest to see which group can attract the most "visitors" to their park. Have project showcase attendees identify which parks they are most likely to visit based on the projects.

Muckraker Magazine:
Progressive Era History

Grade Level	High School Social Studies
Lesson/Unit Category	Project Based Learning Unit
Timeline	Full Unit – ongoing for duration of unit
Curriculum Connections	History: Progressive Era Literacy (Reading and Writing) Digital Literacy
Essential Questions	How do societal issues in the Progressive and Modern eras compare? How do we communicate facts and opinions?
Summary	In this unit, students create a modern "Muckraker" magazine. Throughout their study of Progressive Era U.S. History, students work on the layout and content of their magazines. Contents include articles, editorials, and political cartoons.
Materials/Tools	• Internet access, tablets/laptops/desktops • Art supplies
Project Objectives	• Students will demonstrate understanding of Progressive Era History, with emphasis on social issues and political corruption. • Students will compare social issues and political corruption in modern times to those of the Progressive Era. • Students will demonstrate understanding of how factual information is portrayed differently than opinion in news media.
Major Project Components *Project components are in addition to ongoing study of the Progressive Era in class	• Kick off lesson includes viewing of news reports and examination of modern news magazines. • Students are assigned groups and decide on group roles. • As knowledge of Progressive Era history is gained, students apply to original Muckraker Magazine. • Magazine contains two news articles comparing modern and Progressive Era social issues, one political cartoon and two letters to the editor. • Students have choice of making a digital or print magazine. • Students present final magazines to peers, teachers and community.
Extension Activities	• Solicit letters to the editor from community members • Create additional editions of magazine

Product Development:
School Store



Grade Level	High School Work Transition
Lesson/Unit Category	Project Based Learning Unit
Timeline	Full Unit – ongoing for duration of unit
Curriculum Connections	Engineering Design Process Materials Science Life Skills/Work Transition
Essential Questions	What products will sell well at the school store? How can I improve a design?
Summary	In this unit, students develop products to sell at the school store. Students survey peers to determine what products might be popular and what price points would be appropriate. Students use the design process to create products, such as key chains and jewelry.
Materials/Tools	• Various craft supplies • 3-D Printers • Laser Cutter
Project Objectives	• Students will determine what products will be popular sellers in the school store • Students will determine what price points are appropriate for the products • Students will use the design process to create products
Major Project Components	• Based on their experience of running the school store, students brainstorm possible items that they can make and sell in addition to the current offerings of snacks and drinks. • Students poll peers to determine which ideas are popular. • Students poll peers to determine price points. • Students utilize the engineering design process to create prototypes of their products. • Students solicit additional feedback from potential customers. • Students produce and add these products to the stock at the school store
Extension Activities	• Gather feedback from buyers about product experiences to make further improvements in products

Brave New World:
Dystopian Literature

Grade Level	High School English
Lesson/Unit Category	Project Based Learning Unit
Timeline	Full Unit – ongoing for duration of unit
Curriculum Connections	Engineering Design Process Literacy (Reading, Writing, Speaking) Materials Science
Essential Questions	How can new products support the society of A Brave New World? How can I attract investors to support my product?
Summary	In this unit, students develop an original product inspired by A Brave New World. Students brainstorm and plan their products at regular intervals while reading the novel. Physical prototypes, marketing materials and "Shark Tank" style presentations are then developed. Finally, students pitch their products to a panel of guest sharks.
Materials/Tools	• Books: A Brave New World • Various materials for physical prototypes (crafts, woodworking, 3D Printing) • Internet access, tablets, laptops
Project Objectives	• Students will demonstrate understanding of the World State in the novel Brave New World (community, identity, society) • Students will present and promote their products through marketing materials and a live presentation
Major Project Components *Project components are in addition to ongoing reading, discussion, and learning activities in the ELA class	• Kick-off unit with viewing of Shark Tank clips • During study of Brave New World, students brainstorm potential products at regular intervals • At conclusion of literature study, students decide on a product, and apply for a manufacturing license. • When teacher(s) approve the manufacturing license application, students develop a physical prototype of their product, along with marketing materials and a presentation. • Students pitch their products to a panel of "Sharks" (peers, teachers, administration, parents, etc)
Extension Activities	• Solicit letters to the editor from community members • Create additional editions of magazine