The PLTW Launch program is designed for flexible implementation that allows schools to make decisions about which modules to implement and who will facilitate modules. As you plan for your implementation of PLTW Launch, use this quick reference guide for an overview of the activities, project, and problem for each module.

Modules Aligned to Kindergarten Standards

Structure and Function: Exploring Design

***Big Idea**: Students discover the design process and how engineers influence their lives. Then, in small groups, the students design, build, and test a structure made out of available materials to withstand a force. The students also use the design process to sketch, build, test, and reflect on a new paintbrush design.*

Activity 1. In this activity, students begin to explore role of engineers. The teacher guides students in identifying products around them that were designed by an engineer and prompts students to ask questions about a product that an engineer might have asked when he or she designed the item. The design challenge of creating a paintbrush from available supplies is introduced to the students. (40 minutes)

Activity 2. Students listen to the familiar story of *Jack and the Beanstalk* and retell key parts of the story as a group. The teacher documents the retelling of the story with chart paper and markers. As part of an introduction to the design process, the students model a beanstalk using pipe cleaners with a goal of creating the tallest model possible. Students compare the height of the beanstalk models and then test the strength of the model by adding a mass in the form of a golden egg to the top. The teacher guides the students in a discussion to identify the model they created as an improvement (innovation) rather than a new object (invention). (120 minutes)

Activity 3. The activity begins as the teacher reads the fable *The Three Little Pigs* and then prompts and supports the students to retell the story including key details. The students answer questions about the characters, major events in the story, and identify the materials used by each of the pigs in constructing their houses. The students relate the steps in the story to the design process. (90 minutes)

Project. Students model a house for one of the three little pigs. The students are assigned a specific material to use that represents either straw, wood, or bricks. The teacher guides and supports the students as they use the design process to create and test their models. The students compare data from two models and identify strengths and weaknesses of how each performed. Students also relate the structure to the intended function. At the conclusion of the project, the teacher leads a discussion about the “wolves” in their region, including earthquakes, hurricanes, and blizzards. (150 minutes)

Problem. In this design challenge, students address the problem presented at the opening of the module. The students follow the design process to sketch, build, test, and reflect on a new paintbrush design. With teacher support, students compare physical models of paintbrush tool designs and describe the differences in material choice, shape, and size. The students use technology to document their final design solutions and suggest improvements. (200 minutes)

Pushes and Pulls

***Big Idea**: Students explore and identify forces as pushes and pulls through books, a scavenger hunt, learning centers, and observation of daily activities. Students identify the effects of different strengths or different directions of pushes and pulls on the motion of an object. Students use the design process to design, build, test, and reflect on a model that can move a heavy object up a ramp using pushes and/or pulls.*

Activity 1. Students identify pushes and pulls on objects they interact with on a regular basis. Students also identify how these pushes and pulls affect their everyday lives. The teacher reads aloud a book on forces to define the concept of force. The teacher leads a discussion on pushes and pulls. After students have a solid understanding of pushes and pulls, the teacher leads the students on a scavenger hunt to identify examples. (80 minutes)

Activity 2. In this hands-on activity, students manipulate objects with a variety of pushes and pulls. Students investigate pushes and pulls in three stations. In the GoldieBlox™ and the Spinning Machine station, students work through the activity in the story to try to pull objects in two different ways. In the blocks station, students compare pushing a block on a smooth surface versus pushing a block on a rough surface. In the ball and string station, students explore how to push and pull a ball over a distance. (120 minutes)

Activity 3. Students demonstrate a change in motion when two objects collide. Students apply a push or a pull to the objects and record the result of the collisions. The teacher reads aloud a story to reinforce the concepts of pushes and pulls. Students explore different collisions with blocks as demonstrated in the story. (80 minutes)

Project. In this project, students experiment and document results comparing different strengths and directions of pushes and pulls in three stations. In the GoldieBlox™ and the Spinning Machine station, students create a design and test the direction and strength needed to pull the ribbon. In the blocks station, students compare the strength of pushes or pulls needed to move an empty shoe box and a shoe box filled with varying numbers of blocks across a distance. In the books station, students test the strength of the force needed when pushing and pulling different size books across a surface. (120 minutes)

Problem. In this problem, students modify the strength of a push or pull to solve a design problem. Students use the engineering design process to design a model of a structure that uses pushes and/or pulls to move “rocks” up a ramp. (200 minutes)

Structure and Function: Human Body

***Big Idea**: In this module students are introduced to a story where a character, Angelina, falls off the monkey bars and breaks her arm. Students follow Angelina’s case as they progress through the module, learning about both the diagnosis and treatment of her injury. As students follow Angelina’s story, they explore the basic relationship between structure and function in the human body. They look at major structures, or organs, within the body and investigate how the structure of each organ is related to its function. Once students establish an understanding of basic structure and function in the body, they then take a deeper look at the functions of bone. They assemble a skeleton and create a model X-ray of a hand. They then act as scientists to perform an inquiry investigation to understand why each of our fingers is made up of more than one bone. Finally, students work through an engineering design process to design and build a cast for Angelina.*

Activity 1. Students are introduced to the terms “structure” and “function” in relationship to living organisms. They investigate some of the major structures inside the human body and begin to identify that each body part performs a specific function. Students explore the difference between their inner body and outer body. (60 minutes)

Activity 2. In this activity students explore models of bone, muscle, the lungs, and the stomach. They make observations as they interact with each model and describe the structure of each part. Through discussion, students begin to connect how the structure of each organ is related to its overall function in the human body. (120 minutes)

Activity 3. Students take a deeper look at the functions of bone. They explore how medical professionals view our bones using X-rays and complete an X-ray puzzle to assemble the bones of the skeleton. They then zoom in closer to explore the bones of the human hand and create their own model X-ray. Students return to the story of Angelina’s injury and begin to see how doctors diagnose and treat injury or illness. (120 minutes)

Project. Students begin thinking about how scientists work systematically to find answers to questions. They follow the steps that scientists use to perform an inquiry investigation to understand why each of our fingers is made up of more than one bone. (100 minutes)

Problem. In this design challenge, students read the final section of the Human Body Introduction story and learn that Angelina needs a cast. Students use the design criteria presented in the story to design, build, and test a cast for Angelina. (200 minutes)

Animals and Algorithms

Big Idea: *In this module students develop the ability to design simple algorithms and implement them digitally on a tablet. Students consider why people make things with technology as well as how people control computers. Students explore the sequential nature of computer programs through hands-on activities both with and without a computer. Applying skills and knowledge learned from activities in this module, students work in small groups to design and program a simple digital animation about an animal in its habitat.*

Activity 1. Students participate in board game designed to introduce the step-by-step logic of programming. Students work in groups to build a program by drawing arrows on the board to direct a predator to its prey and ultimately to its shelter. Each group uses a whiteboard and a unique set of predator, prey, and shelter. Students work together to brainstorm ways to solve the puzzle. (120 minutes)

Activity 2. In this activity, students build their first project in ScratchJr, exploring instructions and sequencing as the basis for a computer program. Students become familiar with the Motion and Looks blocks and the Green Flag action starter and how to change the background graphics of their projects. Students learn by mirroring the teacher's demonstration. (90 minutes)

Activity 3. Students learn how to program multiple characters in an animation and how to use the “bump” trigger. Students use skills they learned in activities 1 and 2 to solve puzzle challenges presented to them in ScratchJr. This lesson includes puzzles that scaffold the students’ skills and reinforces their understanding of giving instructions in a sequence to animate characters in a computer program. Teachers need to project the stage setup for each of the challenges on a big screen, so students can mirror the stage on their tablets. Students then write programs to solve each puzzle and then complete the corresponding section in their Launch Logs. (120 minutes)

Project. Students apply skills learned in activities 1, 2, and 3 to create an animated matching game using ScratchJr. The game matches different animals to the letters that they begin with. Students demonstrate their understanding that people can use technology to illustrate interdisciplinary concepts. This project also reinforces the importance of giving program commands in the correct sequence. (120 minutes)

Problem. Working on this problem, students get a chance to use their imagination and creativity to create an animation about an animal in its habitat. Students transfer and apply all the skills and knowledge acquired so far to complete this task. Students use a provided worksheet to plan and sketch out their program using shapes, pictures, and/or words. To create an animation about their animal, students build a ScratchJr project with at least three characters and the appropriate habitat as a screen background. (150 minutes)

Modules Aligned to First Grade Standards

Light and Sound

***Big Idea**: All products created by designers and engineers were created to meet a human need or want. One of the most basic of human needs is to communicate over a distance. In this module students investigate light and sound, including vibration from sound waves and the effect of different materials on the path of a beam of light. The students use a design process to sketch, build, test, and reflect on a device that uses light or sound to communicate over a distance.*

A similar design problem is faced by three fictional characters the students read about. Angelina, Mylo, and Suzi are lost and need to use only the materials in their backpack to communicate using light or sound.

Activity 1. Students learn about the design process and are introduced to the design problem they face at the conclusion of the module. (40 minutes)

Activity 2. Students learn how sound travels over distances and is heard by people. To discover the relationship between sound and vibration, students explore a variety of ways to generate sound. Students explore how sound is generated at three stations. After the stations, students continue to learn about sound and vibration using a tuning fork, a metal coil, and cup phones. (120 minutes)

Activity 3. Students learn how light travels over distances and how people see objects. Students view a presentation on light and record responses or draw sketches in their PLTW Launch Logs. Students also investigate how objects can be seen only if they reflect available light or if they give off their own light. (120 minutes)

Project. This project is an inquiry experience. The teacher guides the students to an understanding of the effect that different materials have on a beam of light, including reflection, refraction, the creation of shadows, and color. (120 minutes)

Problem. In this design challenge, students use available materials to create a device to communicate over a distance using light or sound. (200 minutes)

Light: Observing the Sun, Moon, and Stars

***Big Idea**: In the previous Light and Sound module, students explored how light and sound travel over distances. The primary source of light on Earth is the Sun. The Sun is the star at the center of our solar system. Students learn that stars, including the Sun, generate their own light, while objects such as the moon reflect that light.*

Throughout the module students document patterns as they observe the Sun, moon, and stars. The ability to recognize patterns is an important scientific skill that researchers use to develop explanations of observations in nature.

Finally, students are challenged with the task of designing, building, and testing a device to protect students from ultraviolet (UV) radiation. Students analyze media to determine the peak times during the day for UV radiation and then design a cover for a playground structure.

Activity 1. In this activity students learn about the design process and are introduced to the design problem they face at the conclusion of the module. Students also observe and document patterns of the sun, including how the sun rises, moves across the sky, and sets. Students use a sun tracker to gather data on the sun. (120 minutes)

Activity 2. Students explore the surface of the moon with either Moon Globe for iPad or Moon Atlas 3D for Android. Students create a diagram to learn how we see the moon even though it does not produce its own light. Students also observe and document patterns of the moon, including the apparent movement of the moon through the night sky and phases of the moon. (120 minutes)

Activity 3. In this activity students learn how we see stars as the light the stars generate travels through space. Students also observe patterns of stars, including the fact that stars are able to be observed only at night. (120 minutes)

Project. This project is an inquiry experience in which students learn about UV rays. The teacher guides the students as they experiment and document results of exposing UV-sensitive “mystery” beads to sunlight. (80 minutes)

Problem. In this design problem, students design a covering for a playground to protect students from UV exposure. They use the UV-sensitive beads and a UV flashlight to determine the effectiveness of their design to protect students playing on the playground at midday. (200 minutes)

Animal Adaptations

***Big Idea**: In this module students are presented with the problem of preparing an ideal traveler for a visit to an extreme environment and designing the ideal shoe for this traveler to wear in this environment. Students look to plant and animal adaptations to guide them as they make choices about how to prepare their traveler. Students learn what it means for an organism to be adapted to its environment and how different adaptations can be categorized. Through various investigations, students explore examples of adaptations for protection, camouflage, food, and locomotion. They complete an inquiry investigation to explore how different beak shapes are best adapted for gathering different foods. They then investigate organisms that live in an extreme environment and document the variety of adaptations that each of these organisms display. Students combine all of their knowledge of plant and animal adaptations with their understanding of the extreme environment to prepare their traveler and design their shoe.*

Activity 1. Students read a story that describes why different animals have different outer coverings, or coats, specially adapted to help them live in their environment. Students learn what it means for an organism to be adapted to its environment and begin to learn how different adaptations are categorized. Students investigate how different adaptations help animals survive in the environment in which they live. Through various investigations, students explore examples of adaptations related to locomotion, protection, and camouflage. (120 minutes)

Activity 2. Students complete a scientific inquiry investigation to explore how different beak structures are related to gathering food. Students act as birds searching for food and use different utensils (a spoon, a clothespin, and tweezers) to represent the beaks of different birds. Marbles, toothpicks, and straw represent the different foods these birds consume. Students perform various trials to determine which beak is best adapted to pick up each type of food. (80 minutes)

Activity 3. In this activity the students explore five different environments: the Arctic, the African Savanna, the Sahara Desert, the Pacific Ocean, and the Amazon Rainforest. All students explore the Pacific Ocean, and then each group explore one of the other four environments. They then investigate organisms that live in each of these environments and explore the variety of adaptations that each of these organisms possess. Students pretend they are preparing a traveler for a trip to this exotic new land. They consider clues provided by the animals and plants that are successfully adapted to this environment. (80 minutes)

Project. Students are challenged to "design" an ideal traveler to survive in the assigned environment. They think about how they need to prepare their traveler to endure the challenges of the environment. They design four innovative adaptations: one to help their traveler gather food, one to help the traveler move around in the environment, one to protect the traveler in the environment, and one to camouflage the traveler in the environment. The designs should mimic how plants and/or animals use their parts to help them survive, grow, and meet their needs. Examples might include a special waterproof coat that protects against the rain by mimicking fish scales or a coat that keep the traveler warm in the air and water by mimicking a polar bear's fat and thick fur. Students also justify how each adaptation helps the traveler in the given area. (160 minutes)

Problem. In this problem students design a shoe for their traveler to wear in the assigned environment. Students follow the engineering design process to modify a canvas shoe to prepare it for the environment. Students use what they learned throughout the module about their environment, as well as about animal adaptations, to determine how to modify their shoe. They modify the shoe to help the traveler with three of the categories of adaptions—camouflage, protection, and locomotion. (160 minutes)

Animated Storytelling

***Big Idea**: In this module students develop the ability to create digital animated stories on a tablet. Students explore the sequential nature of computer programs through hands-on activities both with and without a computer. Applying skills and knowledge learned from activities in this module, students work in pairs to design and program a simple digital animated story that interacts with the reader.*

Activity 1. Students play a life-size board game called Rosie's Runtime. The teacher plays the role of a robotic dog. In small groups, students create a sequence of instructions out of playing cards that "program" program the dog to move through a maze. This activity helps students build programming skills such as putting steps in the correct order and giving complete instructions. (120 minutes)

Activity 2. Students are introduced to programming on tablets using an age-appropriate tool called ScratchJr. Students learn about Movement and Looks blocks and also how to record sounds. Students explore what happens when they snap blocks together into a sequence. (90 minutes)

Activity 3. Students learn how to program more than one character in ScratchJr. They learn about triggering blocks that can activate a character's program to begin. Students play Scratch Skits where they act out programs, triggering each other to begin acting by passing a high five, a light envelope, or a dark envelope. Students learn how to make backgrounds and characters with drawing tools built into the ScratchJr development environment. (120 minutes)

Project. Students learn about adding new pages to a project in ScratchJr and how to switch between pages. Then, after hearing a storybook read aloud, they choose one scene from the story to illustrate in a ScratchJr project. Students plan the project in their PLTW Launch Logs and then make the scene come to life on the tablet. (120 minutes)

Problem. As they work in pairs, students apply the skills and knowledge learned from the activities and project in the module to design and program a simple digital animated story that interacts with the reader. This animated story must have at least two characters and two different pages. (150 minutes)

Modules Aligned to Second Grade Standards

Materials Science: Properties of Matter

Big Idea: *Students investigate and classify different kinds of materials by their observable properties, including color, texture, and heat conduction. After analyzing data from materials testing, the students design an insulating cover for an ice pop to prevent melting.*

All materials have a melting point, or a temperature at which a solid becomes a liquid. The melting point for water is 32 degrees Fahrenheit. Ice pops have a slightly lower melting point, but both water and ice pops are liquid at room temperature because room temperature is above the melting point of the substance.

Every material has unique properties of insulation. The better a material is at insulating, the more it keeps an object at its starting temperature. This means a cup made from a good insulator, such as polystyrene foam, keeps hot liquids hot and cold liquids cold better than a cup made from a poor insulator such as paper.

Engineers and designers select materials that have properties that are best suited for an intended purpose. Properties such as color, texture, and heat conduction may influence design choices.

Activity 1. The module begins with an introduction of the challenge faced by the fictional characters which involves keeping a frozen dessert solid in a warm environment. Students work in small groups researching and documenting the products created by young inventors and innovators including the ice pop, ear muffs, and the trampoline. (120 minutes)

Activity 2. In this activity students are introduced to the concepts of matter and the physical properties of color and texture by exploring features and materials of toy monster trucks. The students also classify the trucks in a variety of ways, including color. (80 minutes)

Activity 3. Students observe and describe reversible and non-reversible changes in matter as a result of temperature change. Students observe and sketch the physical properties of a leaf, a frozen leaf, and a thawed leaf. Students discuss this type of change. (80 minutes)

Project. In this project students investigate the material property of heat conduction. Students test a variety of materials and classify the material either as good or poor at conducting heat. This project is an inquiry experience. The teacher guides the students to an understanding of heat conduction and insulation at the conclusion of the assignment. (120 minutes)

Problem. Students work through the engineering design process to design, build, and test a product to insulate an ice pop. Using technology, the students document and describe the process they used to design and test their ice pop cover. (200 minutes)

Materials Science: Form and Function

***Big Idea**: Engineers and designers select materials that have properties that are best suited for an intended purpose. Students continue their investigation of materials science by exploring properties of matter, including flexibility, hardness, strength, and absorbency. Students apply this knowledge to a design problem involving the dispersal of seeds across a large area.*

As students prepare for the design problem, they learn about pollination, seed dispersal by animals, and seed germination. Students also learn how nature has inspired product design, including the invention of Velcro® *brand fasteners. This popular hook-and-loop fastener was developed by a Swiss engineer after observing how burrs, or tiny seeds covered in hooks, became attached to his dog while on a walk.*

Students are introduced to the design problem through the three fictional characters who are planting a wildflower garden at their school. The students are faced with the problem of how plants are already growing in the cleared area and how to quickly and efficiently disperse wildflower seeds once the area is cleared again.

Activity 1. In this activity students review properties of matter, including color and texture. Students observe and describe a natural object and a human-made object. Students are introduced to the concepts of form and function and how each informs design. Students learn that engineers and designers often look to nature when designing or improving objects to meet a human need or want. (80 minutes)

Activity 2. Students explore the variety of ways that animals disperse pollen. Students begin their exploration learning about the form and function of pollen as well as the role pollen plays in the development of a seed and plant. (80 minutes)

Activity 3. In this activity students explore the variety of ways animals disperse seeds. Students begin their exploration learning about the form and function of seeds as well as seed germination and plant growth**.** (120 minutes)

Project. Students work in small groups to identify observable properties of common materials, such as wood, stainless steel, nylon, marble, silicon, and cloth. The students explore and document observable properties of these materials. (120 minutes)

Problem. In this problem students design, build, and test a device that mimics one of the ways animals either disperse seeds or pollinate plants. Students reflect on the efficiency of their design and how it was informed by nature. (200 minutes)

The Changing Earth

***Big Idea**: In this module students explore how the surface of the Earth is always changing. They are introduced to different kind of maps and explore how these maps convey different kinds of information about the world we live in, including where water is found on Earth. Students investigate the different forces that shape the surface of the Earth and design solutions to limit the impact of erosion on a fictional community.*

Activity 1. Students read a fictional story that follows five friends as they go on an adventure to find a missing cat and dog. Using maps as their guide, the friends make their way through the neighborhood, into the city, across the country, and around the world. Through this story, students explore different types of maps used to present different information, and learn key components of maps, including legends, symbols, scale, landmarks, and the compass rose. Students use what they learn to analyze a map and then make a map of their own. (120 minutes)

Activity 2. Students discover where water is found on Earth and whether it exists as solid ice or as a liquid. They apply what they learned about maps in the previous activity and use the Google Earth application on their tablet to explore the continents and the major oceans, lakes, and rivers on Earth. They add all of this information to a world map in their Launch Logs. (80 minutes)

Activity 3. Students explore how erosion changes the shape of the Earth's surface. They learn how moving water, freezing ice, blowing wind, and moving glaciers all work to create different landscapes over long periods. They also investigate events that cause changes to the landscape in very short periods, such as hurricanes, earthquakes, and floods. They use this knowledge to analyze various photographs of different areas from around the world, determine what forces of erosion caused the landscapes they see, and predict whether the change occurred quickly or slowly. (80 minutes)

Project. Students model erosion caused by wind, earthquakes, glaciers, and moving water. They build a model landscape using an erosion tray and complete different trials to determine whether wind, earthquakes, ice, or water causes more sand to be eroded from the tray. (160 minutes)

Problem. In this design challenge, students design, build, and test a solution to prevent water from changing the shape of the land. Students work to save a city from a possible landslide created by an impending rain storm. They choose materials that are best suited for the purpose of preventing erosion and explain why they believe they have made the best choice in material and design. (160 minutes)

Grids and Games

***Big Idea**: In this module students build knowledge and skills that enable them to program a game on a tablet. Through the activities and project in the module, students explore how mathematics is used in animation, using addition and subtraction to move characters on a numbered grid. Students discover that computer science is important to many parts of our lives, and that computer scientists do more than just program computers*.

Activity 1. In this activity students play a life-size board game called Rosie's Runtime. The teacher plays the role of a robotic dog. In small groups, students create a sequence of instructions out of playing cards to "program" the dog to move through a maze. A special Repeat command can be used to enclose a set of cards in a loop that repeats a number of times as designated by the programmer. This activity helps students build programming skills such as putting steps in the correct order and giving complete instructions. (120 minutes)

Activity 2. Students program characters in ScratchJr to move back and forth on the number line to solve math challenges. Student teams create program challenges for each other and then trade tablets to solve the challenge problems. (80 minutes)

Activity 3. Students brainstorm to identify different parts of our lives that are enhanced by technology. Students discover that computers are not just laptops and tablets and that computing touches nearly every aspect of our lives. Students read a story to learn about different roles computer scientists have in the world, from obvious ones like video game programmers, to less obvious ones like scientists. Students create a scorekeeping project in ScratchJr. Students use this scorekeeper project for a math game with number cards and a 20-sided die. (80 minutes)

Project. Students use programming skills to animate a character to sweep across every row and column of the ScratchJr grid such that every single square in the grid of the screen is traversed by the Sweeper character. Students are required to use a Repeat block to solve the problem. (160 minutes)

Problem. Students create a game with a main character, a moving target, and a moving obstacle (Repeat Forever block will be helpful). The player must use game controls such as tapping directional arrows or tapping the character itself to navigate the main character past the moving obstacle to get to the target. If the character gets hit by the obstacle then the game moves to Screen 2 where the player is asked whether they want to play again. If the player gets to the target safely, then the game switches to a celebration screen. (160 minutes)

Modules Aligned to Third Grade Standards

Stability and Motion: Science of Flight

Big Idea: *Air is all around us. We know that air can hold up heavier-than-air objects such as kites, gliders, and airplanes, but how does it do that? What forces act on an airplane or glider? Students use aerodynamic concepts to explain how the motion of air and other forces act on gliders and other aircraft.*

Gliders and other aircraft use wings to develop the lift needed to fly. Wing shapes, sometimes called airfoils, provide lift. Wings must have the proper angle of attack, which is the angle at which a wing meets the flow of air. The airfoils, because of their design, can overcome the gravity acting on the aircraft. Research has shown that a wing with a streamlined shape and a body or fuselage that is streamlined can help overcome drag.

In this module students learn about the forces involved in flight as well as Newton's Laws of Motion. Then they design, build, and test an experimental model glider to find out how air and other forces affect its flight. In addition, they apply a design process to the problem of delivering aid to an area where supplies must be airlifted in and dropped to the ground from an aircraft.

Activity 1. Students learn about forces and describe the motion of an object with balanced or unbalanced forces. Students also ask questions engineers may ask when gathering information about a situation involving balanced and unbalanced forces. (60–80 minutes)

Activity 2. Students learn about forces working on an airplane in flight. Students research the forces involved in flight and Newton's Laws of Motion. Students also explore forces with hands-on activities designed to introduce the forces of lift, drag, thrust, and weight. (60–80 minutes)

Activity 3. Students identify and classify aircraft as well as identify the differences between the invention of aircraft and innovations that have improved aircraft. Students also describe how the major parts of a glider affect the overall balance of an airplane during flight. (120 minutes)

Project. In this inquiry-based project, students learn how Newton's laws apply to flight. Students investigate how the center of gravity affects a glider and analyze the features and benefits of different types of wings. Students conduct several test flights with their glider and document the effect of modifications including wing type and additional weight. Through these investigations students make observations and measurements of a glider's motion to provide evidence that a pattern can be used to predict future motion. (160 minutes)

Problem. In this problem students analyze flight data from the previous project and suggest improvements to the glider to maximize the amount of relief supplies the glider can transport a set distance. As part of a design challenge, students design a unique wing configuration and weight distribution and then evaluate their design through a controlled test. Students share their findings and conclusions with the class through a multimedia presentation. (200 minutes)

Stability and Motion: Forces and Interactions

Big Idea: *Forces and interactions are at work all around us. We experience pushes and pulls, resistance forces, gravity, and friction in our daily routines. In this module students gain understanding of forces and interactions using multiple modalities. They explore, design, sketch, and build both simple and compound machines that demonstrate the use of forces. Students also test the forces of magnets as they build skills and knowledge that can be applied in solving an open-ended, real-world-situated problem. From the scaffolded learning that comes from the activities, project, and problem of this module, students are able to predict the effects of a force on an object.*

The design problem for this module is presented to students through a fictional story. The problem involves rescuing a trapped zoo animal. Solving this problem requires that students plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

As students work through this module on Stability and Motion: Forces and Interactions, they are also engaged in hands-on experiences with how engineers use a step-by-step process to solve problems related to our wants and needs. Students evaluate a problem in a novel situation—rescuing a zoo animal—and apply the design process as they develop a solution.

Activity 1. Students learn about forces, including effort and resistance forces. Students review related concepts from the previous module including: balanced and unbalanced forces, opposing forces, and Newton's Laws of Motion. They view presentations on forces and simple machines. Students continue to learn about simple machines through a teacher read-aloud. Finally, students build a wheel and axle system to move a load. (60–80 minutes)

Activity 2. Students build and explore three simple machines including a lever, inclined plane, and pulley. Students identify effort force and resistance force on each simple machine and identify balanced and unbalanced forces in relation to the stability and motion of the machine. (140 minutes)

Activity 3. Students expand their understanding of simple machines to learn about compound machines. Students create compound machines by combining two or more of the simple machines they explored in the previous activity to solve a simple design problem. (120 minutes)

Project. In this inquiry-based project, students explore the cause and effect relationship of magnetic interaction. Understanding of the use of magnets is useful for developing a solution to the animal rescue design problem. In part 1 of this project, students predict and test a variety of objects to determine whether or not they are magnetic. In part 2, students test magnetic interactions between the magnetic poles and a magnet and a paperclip. (60 minutes)

Problem. Students design and build a prototype of a mechanism that can rescue a trapped zoo animal. Students follow the engineering design process to create their animal rescue device. They use a decision matrix to determine which design is the best to build. (200 minutes)

Variation of Traits

Big Idea: *In this module students investigate the differences between genetic traits that are inherited and traits that are learned or influenced by the environment. As they learn about dominant and recessive genes, students explore the phenomenon that offspring may express different traits than parents. As a culminating problem, students identify a question they would like to investigate regarding population genetics. Once they have determined their question, students perform a study to gather data to answer their question. Students draw conclusions about what their data indicates and present their findings*.

Activity 1. Students investigate some of the features, or traits, that make us who we are and investigate how common these traits are among their peers. Classroom data help students answer a question about the distribution of traits among their classmates. Students learn about and follow the scientific inquiry process as they complete their investigation. (80 minutes)

Activity 2. To learn basic principles of genetics and inheritance, students explore how family traits are passed down. The teacher reminds students throughout the module that the environment and a person's experiences also shape traits and abilities. (80 minutes)

Activity 3. Students observe traits and inheritance in pea plants. They then complete a variety of practice problems to test their knowledge. (80 minutes)

Project. Students work with Simple Plants, a fictional plant that only has a few genes. Students explore how genes from the mother and father plants pass down to the baby plants. They use what they learned from the previous activities to determine what the baby plants look like based on the genotype for each trait. Students then build these plants and observe the variation they see in their final products. (160 minutes)

Problem. Students apply what they have learned about variation and inheritance of traits to solve the problem presented in the Introduction story. Students use the design process to model and test a solution that explains genotypes and phenotypes of three generations of plants. Students have the chance to grow their own plants and analyze traits in their plant samples. (200 minutes)

Programming Patterns

Big Idea: *This module introduces important computer science concepts such as abstraction and modularization. These are computer science terms that mean breaking big problems down into smaller ones. One way to break down programming problems is to use functions to handle processes that are easy to separate from the larger program. Students also uncover the power of putting information into containers called variables*.

These new understandings help students appreciate how computer programs can handle different versions of a problem even though the details of the problem may change. Through building their own unique programs, students learn that technology makes it possible for people to accomplish things that would be impossible, or at least very time consuming, without the help of computers.

Activity 1. In this activity students break into groups. Each group has a function to perform. One group assembles the main story. When prompted by the main group, the other groups produce their assigned part of speech (verb, adjective, etc.). This serves as an embodied example of how a computer program uses functions to modularize tasks. (60–80 minutes)

Activity 2. Students play a life-size board game where they program Rosie, a robotic dog played by the teacher. Students arrange code cards to guide Rosie along a path, picking up bones and avoiding puddles. Students take on additional challenges where they program functions for Rosie to follow, such as a set of movements. Rosie follows these steps when someone plays a card that calls that function.

Students are also introduced to conditionals in the form of "if-then." New cards allow Rosie to evaluate the next spot in front of her before she steps on it. Students write conditional statements such as, "If the next spot has a mud puddle, jump over it," or "If the next spot is blue, step on it and do a dance." (60-80 minutes)

Activity 3. Students are introduced to Hopscotch with a step-by-step tutorial that guides them through making a character move around the screen to create shapes. Students explore different movements, angles, colors, and widths to see how that affects the design. Part 2 challenges students to build symmetrical shapes by looping through the same drawing procedure several times, rotating by some number of degrees each time the loop is called. Students learn to use loops and create their own functions as they work on their designs. (120 minutes)

Project. In this project students create an interactive game as they are guided through some new programming concepts. Students use the x-y grid and manipulate character positions on the screen. Students build on the previous activity by making the character slide around the screen when the iPad is tilted, shaken, or tapped. Students learn about using variables in a program to track values like game score, time, and character health. (120 minutes)

Problem. Students design their own game or animation. After choosing from a selection of project types, students build a game or animation that fits the design criteria. Students prepare a graphical representation of the algorithm they have designed. (180 minutes)

Modules Aligned to Fourth Grade Standards

Energy Collisions

***Big Idea**: This module begins with three fictional characters at an amusement park observing bumper cars. Through the example of the bumper cars, students are introduced to energy transfer and conversion in collisions. The students apply new skills and knowledge to solve a design problem where they are asked to design and build a restraint system to protect a passenger in a vehicle collision. The passenger is represented by an egg. The vehicle rolls down an inclined plane and collides with a solid object such as a wall.*

Students explore how mechanisms change energy by transferring direction, speed, type of movement, and force. Students discover a variety of ways that potential energy can be stored and released as kinetic energy. Citing evidence, students explain the relationship between the speed of an object and the energy of that object. They also predict the transfer of energy as a result of a collision between two objects. As students solve the problem for this module, they apply their knowledge and skills related to energy transfer in collisions to develop a vehicle restraint system.

Activity 1. Students read an article on seatbelt safety and discuss the reading with a classmate. (120 minutes)

Activity 2. Students observe real-world applications of potential and kinetic energy and classify energy in a system as either potential or kinetic. Students discover additional properties of power, work, and forces while working through activities in a mobile application. (80 minutes)

Activity 3. Students explore the relationship between the speed and energy of an object. They assemble a simple model of a pendulum and vehicle and document the changes to the system that can increase or decrease the speed of the objects. Changes to the system include varying the amount of potential energy by altering the mass or initial height of the objects. (100 minutes)

Project. In this project students describe elastic and inelastic collisions in systems they construct using VEX® IQ equipment. Students also describe how energy is conserved and transferred in a collision, including changes in motion and the production of heat and sound. (100 minutes)

Problem. In this design challenge, students design a restraint system or alter the vehicle design to protect a passenger in a car during a collision. Students prototype their design using the VEX IQ vehicle they constructed in Activity 3 and an egg as a passenger. Students test the solution by rolling the vehicle down an inclined plane at varying slopes to evaluate the effectiveness of the design. Students use technology to present their design solution, test outcomes, and provide suggestions for improvement. (200 minutes)

Energy: Conversion

Big Idea: *Energy, and the conversion of energy to different forms, is all around you. Many of the devices we use every day convert electricity to usable forms of energy such as light and heat. Students learn about this conversion of energy as well as the conversion of a variety of fuel sources from stored energy to usable electrical energy.*

First, students review concepts of potential and kinetic energy. Next, students learn about forms of energy, including thermal, light, nuclear, chemical, electrical, and mechanical. Students then learn about the conversion of energy between forms and the energy transfer required to move energy from place to place.

Then, students are presented with a design problem involving moving large amounts of donated food from a truck to a food pantry.

Activity 1. Students review potential and kinetic energy and create a model to demonstrate the conversion between kinetic energy to potential energy and back. Finally, students reflect on human energy sources and how energy from food is converted to usable energy. (120 minutes)

Activity 2. Students experience several types of energy conversion. As they work through the activity, they are exposed to vocabulary that can be used in the final part of the activity, in which the students create a digital presentation detailing one example of energy conversion. (120 minutes)

Activity 3. This activity is designed to provide context for students learning about the sources of energy, its conversion into electrical energy, transporting energy to our homes and industry, and ultimately its conversion into forms of energy that benefit us, including light, thermal, and mechanical energy. (80 minutes)

Project. Students use two devices built with VEX IQ equipment to work toward a solution to a fictional problem of lifting objects into a tree house. (80 minutes)

Problem. Students design, build, and test a system to unload boxes of food at a community food pantry. (200 minutes)

Input/Output: Computer Systems

Big Idea: *This module introduces students to computer systems infrastructure including basic computer hardware and digital data representation. Students start by comparing the computer system to a human brain, focusing on input, processing, and output. Students move on to learning about how data is stored in a computer.*

Students learn about collecting data and representing it visually using programming. Students also create a reaction timer concussion diagnosis tool. The module culminates in a problem that challenges students to create a program that measures baseline brain fitness. Along the way, students practice breaking problems into smaller tasks and using variables, events, and control flow structures.

With these new understandings, students come to appreciate how computer programs can help people solve real-life problems. This module ties well with the Biomedical Science Launch module, Input/Output: Human Brain. Students discover how similar a computer system and the human brain can be.

Activity 1. Students learn about the anatomy of a computer system and its similarities to a human body, including input, processing, and output. Students learn the roles of basic computer hardware components and how they compare to the functions of human organs. Students map the similar functions of parts of the human body to those of the computer: eyes/ears, sense/nerves (input); brain (processor); nerves/muscles, mouth (output). Students play a game where they measure reaction time by passing a signal around a circle—first from hand to shoulder and then from hand to ankle. This allows them to see the difference in reaction time when the pathway from shoulder to brain to hand is shorter than the pathway from ankle to brain to hand. (60 minutes)

Activity 2. The concept of abstraction and data representation in a computer system is introduced in this activity. Students learn that all electronic information must be translated to bits of data to be understood by the computer. Basic information about the Internet is addressed, including privacy, safety, and appropriate behavior. (90 minutes)

Activity 3. Students begin by looking at data sets and considering how the data can be represented in different ways. Students are introduced to programming using Tynker™. Students learn basic programming concepts, including sequencing, repetitions, conditionals, events, functions, and variables. Students program an interactive game that collects data and then displays the collected data in a visual representation. Students learn to break a problem down into subproblems and understand what data needs to be stored so it can be used later. (180 minutes)

Project. Students create an interactive app to test the user's alertness, which can help diagnose a concussion. The app specifications are explicitly defined for the students. Students use knowledge and skills learned in the previous activities to process events and use variables, functions, repetitions, and conditionals. (90 minutes)

Problem. In this problem students create an interactive app to assess the user's brain function, which can serve as a baseline for concussion testing. Students choose whether to use any of the suggested ideas or create their own idea for the game. (180 minutes)

Input/Output: Human Brain

Big Idea: *In this module students are introduced to the analogy of the brain as a computer. They explore the various inputs and outputs of the human body. Students discover how signals passing from cell to cell allow us to receive stimuli from the outside world, get this information to the brain for processing, and then send out a signal to generate a response. Students investigate how we take in information through the senses and where the information is processed in the brain.*

Additionally, students explore how the brain and body react to stimuli. Students work as part of a team to design, plan, and create a video or podcast to raise awareness about concussions and educate children as to how concussions can be either identified early or prevented all together. Students follow a design process—a step-by-step way to solve problems—to help develop their video or podcast.

Activity 1. Students begin to explore the structure and function of the nervous system and learn about the brain and spinal cord, which together make up the central nervous system. Students build a model brain out of clay and identify what each region of the brain does. (80 minutes)

Activity 2. Students explore how the brain takes in information from the outside world. They investigate each of the five senses and complete an activity to test each sense and learn how the organs responsible for each sense communicate with the brain. (80 minutes)

Activity 3. The focus of this activity is investigation of how the brain processes information it takes in through the senses and how it stores the information as memories. Students complete a scientific inquiry investigation to explore reaction time. (120 minutes)

Project. This project calls for students to apply everything their learning as they explore how our bodies sense information from the outside world, process this information, and cause an appropriate response or reaction in the body. Students outline what happens in the body when they take in information from the world around them and showcase this flow of information on their Body Outline models. (120 minutes)

Problem. In this design challenge, students work as part of a team to design, plan, and create a video or podcast to raise awareness about concussions and educate their peers as to how concussions can be either identified early or prevented completely. Students follow a design process—a step-by-step way to solve problems—to help them develop their video or podcast. (200 minutes)

Modules Aligned to Fifth Grade Standards

Robotics and Automation

Big Idea: *This module begins with an exploration of the world of robotics through research using the IEEE Robots for iPad app on an* iPad® *tablet. Students explore robotic history and learn more about a particular type of robot. The activities and projects in this module develop skills and knowledge associated with robotics and the use of* VEX® IQ *equipment.*

The problem for this module is introduced through a fictional story in which the three characters (Angelina, Mylo, and Suzi) are also learning about robotics. The characters learn about the use of robots in the clean up after a natural disaster at a nuclear plant. In this design problem, students work with a group to design, model, and test a robot that can remove hazardous materials from a disaster site. They also design the layout of the site to include a water site and a hazardous materials collection zone.

Activity 1. Students learn about the history of robotics and research a variety of classes of robots including those developed to complete tasks that would be dangerous to people. After completing their research, students present their findings to the class. (120 minutes)

Activity 2. Students construct a testbed using VEX IQ equipment to explore a variety of input and output devices including a motor, bumper switch, touch LED, color sensor, and controller. (100 minutes)

Activity 3. Students work collaboratively with a partner using engineering skills to design, sketch, and build a model of a toy using VEX IQ components. Students create a presentation to share their toy with the class. (80 minutes)

Project. In this project students build a remotely operated robot with a variety of input and output devices. Students build a robot chassis according to a given plan. After they have built and tested the vehicle, they have the opportunity to modify the vehicle to complete the task of collecting blocks and moving them across the floor. (120 minutes)

Problem. In this design problem, students are challenged to design, model, and test a mobile robot that can remove hazardous materials (represented by blocks) from a disaster site. Students also design the layout of a disaster site using criteria and constraints presented in the problem. The robot chassis students built in the Project serves as the basic robot design for the group to modify. (180 minutes)

Robotics and Automation: Challenge

Big Idea: *This module begins with an exploration of the world of autonomous robots through research using the IEEE Robots for iPad application on an* iPad® *tablet. Students explore the application of autonomous robots in a variety of situations and learn more about a particular type of robot. The activities and project in this module develop skills and knowledge associated with using computer software to program robots.*

The problem for this module is introduced through a fictional story in which the characters are designing an automatic guided vehicle that can deliver supplies to a specific area in a hospital without being remotely controlled by a person. In this design problem, students work with a group to apply their knowledge of mechanisms, robotics, and programming to design, build, test, and refine a mobile robot that meets a set of design constraints.

Activity 1. In this activity students explore the need for automated robotics systems and cite specific applications currently in use. Students research and compare autonomous robots to identify characteristics that the robots share and characteristics that are unique to each robot. (40 minutes)

Activity 2. This activity introduces programming and how it relates to robotics and automation. Students work with a partner to write specific directions for safely moving from one point in the classroom to another. (120 minutes)

Activity 3. Students build a mobile robot with sensors and motors and create a variety of programs to change the default functionalities of the sensors. Students also describe the programming necessary for the inputs and outputs to function in the default setting. (200 minutes)

Project. In this project students modify a mobile robot with a variety of input and output devices and then create a computer program to direct the robot to follow a set of instructions. (120 minutes)

Problem. Students are challenged to use their knowledge of the VEX IQ platform and Modkit™ programming to build a fully autonomous robot. Students work together to program their Automated Guided Vehicle (AGV) to transport blocks representing hospital materials to the specific area for the material. (200 minutes)

Infection: Detection

Big Idea: *In this module students are presented with a problem where a large number of students at a school are sick. Students learn about transmission of disease through a simulation and compare communicable and non-communicable diseases. Students design, run, and analyze data from an experiment related to preventing the spread of germs.*

Student groups present ways to prevent the spread of infection using evidence from their experiments. Students investigate how the body protects us from these germs to keep us healthy. Bacteria and viruses are introduced as agents of disease, and students use information learned and patient symptoms to identify the disease agent causing a simulated disease outbreak. Using epidemiology practices, students deduce a likely source of an infection that is spreading through a fictional school.

Activity 1. Students trace the path of a mysterious classroom infection to observe how germs can spread. Students play a version of the classic game Seven Up. Unknown to them, one of the students in the game has been exposed to a glowing simulated germ. As the game progresses, this germ spreads. It is up to the class to determine patient zero, the initial patient in this outbreak. (80 minutes)

Activity 2. In this activity students work with a partner to design and perform an experiment to test the effectiveness of different hand-washing methods. They follow the scientific inquiry process to collect and analyze data and to draw conclusions. Students are guided through two example experiments. Students analyze the two alternatives to determine best practice with experimental design and use what they've learned to design and complete an investigation. (160 minutes)

Activity 3. Students explore the body's defenses and diagram how the body fights invasion from germs. Students will explore nonspecific defenses—defenses that are not targeted against a specific invader, such as the skin, cilia, and mucus in the nose and respiratory tract. These nonspecific defenses act as a barrier to keep foreign bodies from entering our system. Students will also begin to look at specific defenses, particularly the white blood cells, which target specific germs that enter the body. (80 minutes)

Project. Students investigate germs in depth and explore the two types of germs that are responsible for a majority of the communicable illnesses that infect humans—bacteria and viruses. They explore different diseases and apply their knowledge to identify the mystery illness spreading around Angelina, Mylo, and Suzi's school. (160 minutes)

Problem. In this design challenge, students determine the patient zero in a school outbreak of strep throat. Students deduce a path of transmission among the students in the class who are sick. Students work through the design process to solve the problem. (120 minutes)

Infection: Modeling and Simulation

Big Idea: *This module invites students to discover how modeling and simulation provide powerful insight into complex systems. As they engage in building their own simple computer models, they come to understand the indispensable role computers play in helping scientists study systems through modeling and simulation.*

The module begins with a game in which students act as agents in an illness transmission simulation. Students then observe a computer model in action when they run a susceptible-infected-susceptible (SIS) simulation on tablets. Running multiple simulations with different parameters helps students build understanding about how different conditions affect the system.

Students dive into computer programming while building a game on a tablet. They extend these new skills by building a predator-prey ecosystem model and simulation. The final problem challenges students to create their own SIS model to investigate how hand washing affects the spread of an illness in a classroom.

Students learn that technology makes it possible for humans to accomplish things that would be impossible, or very time consuming, without the help of computers.

Activity 1. In this activity students act out a simulation that mimics an ecosystem on a very simple scale. They act out the simulation several times and record data from each simulation. Students make observations about cause-effect and the dynamic interdependence of the agents in the system. (60 minutes)

Activity 2. Students use simulation software to see how powerful it is to be able to run many simulations on a model, and to see how one can gain understanding of system dynamics by running simulations with different parameters. In addition, students use a preprogrammed SIS model to make predictions and then answer questions about the behavior of the model under certain circumstances. (60–80 minutes)

Activity 3. In this activity students build a model with three agents and then turn it into a tablet tilting game where the main actor, a dinosaur, chases its prey and tries to avoid being hit by meteors. (80 minutes)

Project. Students extend the dinosaur system from Activity 3 by cloning the actors to create a dinosaur ecosystem simulation with predators, prey, and food source. Students discover what it means to program a computer to simulate a model. (160 minutes)

Problem. Students are challenged to develop a model of an infectious disease and then build an original computer program to simulate it. Students build a simple model in Tynker™ based on that disease's characteristics. With guidance, students develop an algorithm for running simulations on the model and then program the simulation. Students use their original program to run simulations and record data. (120 minutes)