Turtle Tech:
From Scales to Solutions

Adapted from	https://petsintheclassroom.org/wp-content/uploads/lesson-plans/PreK%20to%202nd%20Grade,%20Turtle%20Lesson%20Plan.pdf
Pet: turtle	**Class:** PK - 2

Brief Overview: This lesson explores the adaptations of turtle shells and challenges students to use their observations to invent solutions to human problems. Through hands-on design and building, they'll understand how inspiration from nature can lead to innovative solutions. This lesson can be adapted for other grades.	**Lesson Breakdown** **Lesson 1:** Turtle Observations **Lesson 2:**Build and Share
Essential Question How can we use the designs found in nature, like a turtle shell, to solve problems we face in our own lives?	

Subjects ☑ **Science** ☑ **ELA** ☑ **Math** ☑ **STEM** ☑ **Art** ☐ **Other**	**Stem Connections** **Science**: adaptations **Technology:** 3D modeling (optional) **Engineering**: inventions based on turtle aspects **Math:** measuring, enlarging

Performance Expectations/ Standards
NGSS
K-LS1-1 Use observations to describe patterns of what plants and animals (including humans) need to survive
K-ESS3-3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants vand/or animals use their external parts to help them survive, grow, and meet their needs.
K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

CCSS
Math and English Standards:

Math K.MD.7 Geometry and Measurement: Describe and compare measurable attributes of objects.
K.SL.1 Communication: Participate in collaborative conversations with peers, expressing ideas clearly and concisely.
K.W.8 Writing: With guidance and support, describe familiar objects in detail

I CAN statements: I can...

- identify different parts of a turtle shell and describe their functions.
- use various materials to build a model inspired by a turtle shell.
- explain how my model relates to a human problem I've identified.
- work collaboratively with my classmates to share ideas and build together.

Materials

- Turtle Tech: From Scales to Solutions Student Worksheet
- Turtle - if you do not have a turtle, show the students pictures of different types of turtles.
- cardboard, straws, tape, fabric, and recycled objects
- Markers, crayons, and paper for sketching
- 3D modeling (optional)
- Ruler, scale

Teacher Background

The turtle shell is more than just a passive shield. It's a biocomposite masterpiece, seamlessly integrating protection with functionality through a complex mosaic of keratinized plates. Understanding its structure and properties reveals an interplay of materials science, biomechanics, and evolutionary optimization.

At its core, the shell comprises two primary layers: the carapace, a dorsal dome, and the plastron, a ventral plate. These layers are composed of individual scutes, interconnected by fibrous collagenous joints. This modular design provides exceptional strength and rigidity, effectively dispersing impact forces across the entire shell. The scutes themselves are composed of keratin, a protein also found in claws and hair, offering additional abrasion resistance.

Beyond brute force, the shell exhibits remarkable adaptability. Growth rings on the scutes reveal continuous deposition of keratin throughout life, allowing for ongoing reinforcement and repair. Hinged shells found in species like snapping turtles introduce another layer of complexity, enabling active defense mechanisms through rapid closure. Notably, the shell isn't just a passive barrier; it's also a dynamic interface with the environment. Its textured surface facilitates rainwater harvesting, while its pigmented patterns can function in camouflage or thermoregulation.

The turtle shell, therefore, is a microcosm of evolution's ingenuity. It embodies a perfect balance of protection, flexibility, and functionality, all within a lightweight and energy-efficient design. Studying its composition and mechanics inspires biomimetic approaches in material science, promising advancements in impact-resistant composites and self-repairing polymers. In essence, the turtle shell offers a blueprint for future innovations, demonstrating how nature can achieve remarkable feats through elegant biological engineering.

Lesson 1:Turtle Observations

Lesson Summary:

Learning Outcomes:
After completing this lesson, students will:

Total Time:	**Guiding Questions:**

Time	**Materials**	**Activity**
15 mins	turtle	Have the turtle(s) on display for the students. Have them make written/drawn observations about the structures they see on the turtle: top and bottom shell, camouflage coloring, claws, beaked mouth, eyes, tail, ability to hide in shell (if box turtle),webbed feet (if water turtle). Note: if you do not have a turtle, show the students pictures of different types of turtles.
10 mins	Turtle Tech: From Scales to Solutions Student Worksheet	Problem Brainstorming: Ask students to identify everyday problems they encounter (carrying books, protecting belongings, staying dry). Guide them to think how turtle shells might offer solutions.
5 mins	Markers, crayons, cardboard, straws, tape, fabric, and recycled objects	Share the rubric with the students. Show them the materials.
15 mins	Ruler, scale	Together, measure the turtle. So their creations don't get too big, you can have the design confined to the size of the turtle or challenge them to make the model twice as large as the actual turtle. In small groups, have them brainstorm a list of things that could be designed based off of one aspect of the turtle. After 10 minutes have them share their ideas.

Lesson 2: Build and Share

Lesson Summary:

Learning Outcomes:

Total Time: 45 minutes		**Guiding Questions:**
Time	**Materials**	**Activity**
30 mins	Markers, crayons, cardboard, straws, tape, fabric, and recycled objects Turtle Tech: From Scales to Solutions Student Worksheet	Build:Allow the students time to build their models.
15 mins		Model Showcase & Sharing: Each group presents their model, explaining the problem they addressed, the turtle shell features they incorporated, and how their design works

Differentiation

For students who need additional support:

- Provide pre-cut shapes or templates for students who need support with construction.
- Offer alternative materials like pipe cleaners or beads for students with tactile needs.
- Allow individual or smaller group work for students who prefer independent creativity.

For students who need additional challenges:

- **Independent Research:** Encourage advanced students to delve deeper into specific turtle species and their unique shell adaptations. They can present their findings to the class with visuals and diagrams, comparing and contrasting different designs.
- **Challenge Building:** Provide them with more complex materials like wood, fabric

with different textures, or even 3D printing materials to create advanced model prototypes. They can explore mechanisms like hinges or flaps inspired by turtle shell movement.

Problem-Solving Depth: Encourage them to tackle multi-faceted problems or consider sustainability elements in their designs. They can present their model as a potential solution for real-world environmental or social challenges.

Team Leadership: Let them take on leadership roles within their groups, facilitating discussions, assigning tasks, and guiding their peers through the building process. This enhances their communication and collaboration skills.

Assessment				
	4	**3**	**2**	**1**
MODEL	The model is age appropriate and carefully constructed	The model is age appropriate and fairly carefully constructed	The model is age appropriate and somewhat carefully constructed	The model is not age appropriate and/or is poorly constructed
PROTOTYPE	Students can accurately explain what part of the turtle inspired the prototype	Students can fairly accurately explain what part of the turtle inspired the prototype	Students aren't sure what part of the turtle inspired their design	Students built something that does not relate to any part of the turtle
PROBLEM	Students can explain with confidence what human problem this prototype is solving	Students can explain with some confidence what human problem this prototype is solving	Students aren't sure what problem their design is solving	Students have made a prototype that does not solve a human problem
COOPERATION	The group required less than 1 teacher interventions	The group required less than 2 teacher interventions	The group required less than 3 teacher interventions	The group could not cooperate

Extension

- Visit a local zoo or nature center to see different turtle species and observe their adaptations in real life.
- Read books about turtles and other animals with unique adaptations for further inspiration.
- Organize a class "Inventor Fair" where students can showcase their model solutions and receive feedback from others.
- Encourage students to continue brainstorming and sketching potential solutions to everyday problems, inspired by the power of nature.