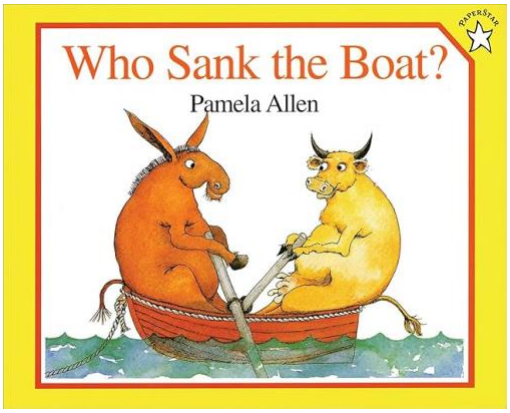
PORT ABLE LAB
Education That Moves

Floating Zoo (Grades K-2)

+ OVERVIEW



In this design challenge, students will receive a problem from the story *Who Sank the Boat?* by Pamela Allen. Beside the sea, there once lived a cow, a donkey, a sheep, a pig, and a tiny little mouse. They were good friends, and one warm, sunny morning, they decided to go for a row in the bay. Students will put on their engineering hats to build a boat that can hold a cow, donkey, sheep, pig, and mouse without sinking. Students will engage in a STEM challenge to build a boat in 25 minutes that can float while holding the animal figures for a set amount of time without sinking. Teams will receive bonus points if their boat can hold a horse in addition to all the other animals for an additional 10 seconds.

+ 2021 Science TEKS covered in this design challenge

Kinder TEKS: K.1.A, K.1.E, K.1.G, K.6.A,

Grade 1 TEKS: 1.1.B, 1.1.E, 1.1.G, 1.6.A, 1.6.C

Grade 2 TEKS: 2.1.B, 2.1.E, 2.1.G, 2.6.A, 2.6.B, 2.6.C

+ Math TEKS covered in this design challenge

Kinder TEKS: K.1.A, K.2.A, K.2.C, K.5.A

Grade 1 TEKS: 1.1.A, 1.3.D, 1.3.E, 1.5.A

Grade 2 TEKS: 2.1.A, 2.4.A

+ Technology Applications TEKS covered in this design challenge

Grade 1 TEKS: 1.5.A

Grade 2 TEKS: 2.3.A, 2.5.A

+ ELAR TEKS covered in this design challenge

Kinder TEKS: K.1.D, K.8.E

Grade 1 TEKS: 1.1.D, 1.8.C, 1.9.C, 1.9.E

Grade 2 TEKS: 2.1.D, 2.9.D, 2.9.E

+ The students will be able to:

- Read *Who Sank the Boat?*
- Observe the properties of objects used to build a boat.
- Classify objects by the materials from which they are made.
- Solve a problem using the engineering design process.
- Explore and collect many types of data such as preferences or daily routines of people, events, or objects.
- Identify and collect non-numerical data, such as weather patterns, preferred reading genres, and holidays.
- Identify and communicate a problem or task and break down (decompose) multiple solutions into sequential steps.
- Demonstrate personal skills and behaviors, including effective communication, following directions, and mental agility, needed to implement a design process successfully.
- Recognize characteristics of persuasive text with adult assistance and state what the author is trying to persuade the reader to think or do.
- Describe ploy elements, including the main events, the problem, and the resolution, for texts read aloud with adult assistance or independently.
- Work collaboratively as a team by following agreed-upon rules for discussion, including listening to others, speaking when recognized, making appropriate contributions, and building on the ideas of others.

+ Students will use the following STEM fluency skills:

- Communication
- Collaboration
- Creativity
- Critical Thinking
- Resilience
- Time/Resource Management
- Innovation
- Adaptability

+ Materials needed for this design challenge

> Popsicle Sticks	1 counter per 5 sticks
> Straws	1 counter per 5 straws
> Thick Foam Sheet	4 counter per sheet
> Aluminum Foil	2 counters per sheet
> Cardboard Sheet	2 counters per sheet
> Paperclips	1 counter per clip
> Scissors	2 counters per pair
> Duct Tape	5 counters per roll
> Scotch Tape	3 counters per roll

Teacher's Note: For Kindergarten, we recommend providing students with notched popsicle sticks and straw connectors if available. Students will have some trouble using adhesives and scissors. As a result, extra care and monitoring will be needed to assist students. Higher achieving students can be offered fewer sticks and straws per counter.

+ Materials needed by the facilitator:

- *Who Sank the Boat* by Pamela Allen
- Projector
- Computer
- Slide deck for the lesson
- Copies of the scorecard for each group
- Timing device
- Container to hold water for testing
- Water
- Cow, donkey, sheep, pig, mouse, and horse figurines (one set per group)
- Paper towels for any spills
- Rubber bands (Used to pre-bundle popsicle sticks and straws into sets of 5)

* After the competition of this activity, water can be dumped down a drain. Make sure to get any materials that may have fallen into the container out before disposing of the water.

+ FACILITATION GUIDE

SECTION	PROCEDURE
INTRODUCTION	**Slide 1: Floating Zoo** **Slide 2: Read Aloud** > *Read Who Sank the Boat?* By Pamela Allen > Summarize what happens on each page. > Ask students if they thought it would be the mouse who sank the boat? What materials would they use to build a boat? > Explain to students that there are jobs that specialize in working with boats, although not in the same way as in the book. The people who do these jobs are called engineers. They help design and build the things people see and use every day. **Slide 3: Engineering Design** > Ask students the question: what is engineering? ▪ Explain to students that engineering is when engineers take what they know and apply it to solve problems by designing a product or process. ▪ For example, phones could only be used at home or in specific locations. Why is this a problem? (Needing to make a call outside the home). What solution did engineers design to fix that problem? (Cell phones). • *Teacher's Note: Any example can be used here but focus on examples that students are familiar with.* **Slide 4: Engineering Design** > Ask students the question: What do you think engineers build or create? ▪ *Teacher's Note: If students have trouble giving examples, ask students who makes the things they use. Ask them to observe the classroom space, what are some items in the space that people have created or built? Who makes refrigerators? Cars? Helmets? Cell phones? Sneakers?* **Slides 5-7: Engineering Jobs** > Show students pictures related to engineering jobs connected to the story. > Civil Engineering ▪ Ask students what they see in the pictures. ▪ Explain to students what they are seeing in the pictures is called civil engineering. Civil engineers use math and a type of science called physics to build buildings that help people. Civil engineers will build

many structures like bridges, highways, towers, and water systems!
    - Ask students which they have ever seen a bridge, or thought about how it was made. Civil engineers design bridges that are safe for us to use every day, along with the highways or roads we travel on. When designing bridges do you think that civil engineers have to think about vessels?
- Marine Engineer
    - Ask students what they see in the pictures.
    - Explain to students the students that marine engineers help to design, build, and maintain ships of all kinds from aircraft carriers to sail boats.
    - They work with teams of other engineers and people to be able to do their jobs. Do you think that you can work in a team to complete a job?
- Environmental Engineering
    - Ask students what they see in the pictures.
    - Explain to students that engineers who study the environment are called environmental engineers. They use science to help the Earth! Some of the work they do can help make plants grow bigger and healthier or check our water to make sure it is safe for us and animals that live in the water.
    - Ask students what would happen if we didn't' have environmental engineers?

Slide 8: Engineering Design

- Ask students the question. Who can be an engineer?
    - Anyone!

Slide 9: Engineering Design Process

- Ask students if they think all engineers solve their problems in one try. Explain to students that it takes many tries to get something correct in engineering. In engineering, there is no such thing as a mistake; there are only opportunities to learn. It is okay to fail. Just find the mistake and correct it. In engineering, there is never one correct solution. There are always many solutions to a problem and always improvements that can be made. The steps that engineers take to find these solutions are called the *engineering design process*.
- Ask students to read the first big step (Identify).
- What does identify mean? (To point out or find). Engineers design solutions: what do they need to know first before they can find the answer? (The problem)
- How do people know when they have found the correct answer? In engineering, there are no correct answers, just better ones. Explain to students that there are expectations that engineers

must meet called *criteria*. For example, when engineering a football, what does a football need to do? (Bounce, look a certain way, have laces, have air inside, etc.). Those things are all called criteria. By comparing the design to the criteria, an engineer knows a solution will work. Is a child-sized football the same as an adult football? The criteria for both footballs include leather, the white laces for fingers, and the shape. However, the two footballs would have different criteria for the size. The footballs are similar but different because of different criteria.

- Once the criteria are understood for the design challenge, what could make it difficult for an engineer to design their solution? (Money, time, materials, etc.) Explain to students that these rules are called *constraints* or rules that engineers must follow. Engineers are given constraints they must follow when finding the solution to a problem. Think about football again. What are college and professional footballs made from? (Leather). What if instead, the rule (or constraint) was not to use leather, could another type of football be made instead? Many of the footballs for sale are made of rubber because the engineer had different constraints.
- Ask students to read the next step (Imagine)
- Ask students what imagine, or imagination, means. Are these things real or tangible? They may not be real, but they help give us ideas about what things could be. In this step, see what materials are available, then brainstorm or think about possible ideas/solutions to the problems.
- Explain to students that there are no right answers in engineering. Start with as many ideas as possible.
- Ask students to read the next step (Plan)
- The third big step of the engineering design process is to plan out the idea. Make sure that what is designed can be repeated. A plan will help an engineer identify where mistakes happen so they can be fixed.
- When planning, begin with the brainstorming phase. Each team member will contribute their ideas, and then the team combines the different ideas!
- Once ideas are combined into a single group idea, determine what materials will be used for the solution and make sure the design has met the criteria and constraints of the project.
- Ask students to read the next step (Create).
- The fourth step is to create! Since this is the very first creation, it is called a *prototype*. A prototype is a first or preliminary model of something from which other forms are developed or copied. A

	prototype is created to test the engineer's idea or concept. Engineers ask themselves, "Did the idea work the way we wanted it to?" After testing the idea, the engineer will make improvements to the prototype. > Ask students to read the last step (Improve). ▪ Finally, the last step is to improve. How does an engineer know if the prototype did well on the test? It must meet certain expectations and follow some rules. But how do engineers determine how well it met the expectations and how well it followed the rules? In school, how do you know if you mastered something? (Grades). The prototypes made today will be scored using a scorecard or rubric. By looking at the score, each team will determine if the design could be better. If improvements should be made, then the team will revisit the plan and decide what to do to improve the score. Remember, there are no correct answers in engineering, just better solutions.
IDENTIFY	**Slides 10-11: Identify** - Problem > Teacher will read the bolded scenario to students. ▪ Ask students what problem do the cow, donkey, sheep, pig, and mouse have? Their boat sunk when everyone got on. ▪ Explain to students that they will put on their engineering hats to assist the cow, donkey, sheep, pig, and mouse in building a boat that is large enough to hold them without sinking. **Slides 12-13: Identify** - Criteria (Desired Outcomes) **DELETE OTHER GRADE SLIDE** > Explain to students that criteria is what engineers use to determine if they have successfully solved the engineering problem. > Ask students how we will know if we are successful engineers today. ▪ A successfully designed boat will do the following: • Be large enough to hold a cow, donkey, sheep, pig, and mouse • Float with all 5 animals onboard for at least 30 seconds Bonus points will be awarded if the boat can also hold a horse (along with the other animals) without sinking for an additional 15 seconds. • *Teacher's Note: For Grades 1-2, the criteria require the vessel to float with the five animals for at least one minute.* **Slides 14-15: Identify** - Constraints (Limitations)

	> Explain that constraints are the rules that engineers must follow. > Explain the following constraints for this engineering design activity: ▪ Time Limit: Students will have 25 minutes to build their boats. • *Teacher's Note: The teacher will time the design challenge and give the students time checks periodically to assist the teams with their time management.* ▪ Materials: Students can only use 20 items to build their boats. ▪ Counters: Students will have 20 counters to complete this challenge. • *Teacher's Note: 20 counters will be given to each group. Pre-bag the counters for easy distribution to each group. When students go to the supply table, they will hand the teacher one counter for each item they "buy". They can buy up to 20 items to build their prototype.* ▪ Collaboration: One design element from each team member must be used in the final design. Explain to students that a design element is taking one part of someone's idea and adding it to another. ▪ Redesign: Each team can test their prototype as many times as needed during the 25-minute design phase. Remind students what a prototype is. It is the first creation of our design. • *Teacher's Note: When a team is ready to test their design, they should raise their hand and the teacher should assist the team with their score. If the team receives a low score on any part of the design, the team should redesign if they still have time.*
IMAGINE	**Slide 16: Imagine** - Explore Materials > Introduce materials to students by showing each item as you go through the materials list. Explain to students that when engineers describe items, they talk about properties like color, size, and flexibility. Ask students to identify the properties of each material. After each material, ask students if it is similar to any of the other materials we have shown, and what the similarities and differences are. > Ask students to reclassify their objects based on what they are made of or how they can be used. > After students have practiced classifying the materials, they will be allowed to combine the materials however they wish to build their boat that meets the criteria. **Slide 17: Imagine** - Brainstorm

	> Give students one minute to individually design and draw a plan of what they think the home should look like. Emphasize that students should not talk during this minute or share ideas with each other. Remind students their ideas will be used as design elements for the final design. > After a minute, give students five minutes to present and share their ideas with their group. Let students know that they should focus on key aspects of their idea that they like and want to be used as design elements for the final design when sharing. ▪ *Teacher's Note: If students are struggling with an idea for their design, provide ideas without giving the solution. For example, "This is a design that I tried earlier, but it failed. What could I do to improve it?" Emphasize that the design failed to reinforce that it is okay to fail and to let students know they cannot copy the design and expect success.*
PLAN	**Slides 18-19: Plan** – Gather Materials **DELETE OTHER GRADE SLIDE** ○ Hand out the scorecard that will be used during the design challenge. Review the testing criteria with the class and answer questions. The testing criteria will inform their design decisions. ○ Have students collaborate to come up with a final design. Let students know they must include at least one element from each team member for their final design. ○ Ask students again what the design criteria are: ▪ A successfully designed boat will do the following: • Be large enough to hold a cow, donkey, sheep, pig, and mouse • Float with all 5 animals for at least 30 seconds Bonus points will be awarded if the boat can also hold a horse (along with the other animals) without sinking for an additional 15 seconds. • *Teacher's Note: For Grades 1-2, the criteria require the vessel to float with the five animals for at least one minute.* • *Teacher's Note: Students will not be expected to rank themselves or calculate their scores, but the teacher should explain how they will earn points. The testing criteria will inform their design decisions.* ○ They will need to select the materials to be used for the design. Students will have 20 counters to "purchase" materials for their build at the classroom supply table. The prices used in this challenge can be found in the materials list. Students will raise their hands when they are ready to purchase materials and will be guided by the teacher. Students can go over the counter limit if they want but remind them that they will lose points on their score card.

	Slide 20: Plan – Team Member Responsibilities ○ Each team member must be given a responsibility, such as materials manager, banker, head engineer, and quality control manager.
CREATE	**Slide 21: Create** - Design Your Boat ○ Let students know to have fun, be creative with their designs, and work together. ○ Remind students that being an engineer is not about getting the solution on the first try. There is no right answer, just better solutions. **Slides 22-23: Identify** - Criteria (Desired Outcomes) **DELETE OTHER GRADE SLIDE** > Reminder slide for students to look at while working. **Slides 24-27: Create** – Test **DELETE OTHER GRADE SLIDE** ○ Teacher will have a bin with water. Students will bring their boats to the test station and the teacher will place all the boats in the bin and start the timer to see which boats sink and which boat float for 30 seconds. Then the teacher will add a horse to the boats that lasted the time and add another 15 seconds to the timer. ○ They will go through each of the categories on the scorecard with the students as testing is done by the teacher. > Teacher will then recap the point total with the students and how many points the team received for each category.
IMPROVE	**Slide 28: Improve** - Redesign: Discussion > Students will reflect on their scores and discuss: ▪ What worked? • *Teacher's Note: Focus on the materials being used and ask what properties of those materials might have helped. Check and see if any students combined materials to make their vessel stronger. Check and see if any students cut or folded the materials to make their vessel float better.* ▪ What did not work? • *Teacher's Note: Focus on the materials being used and ask what properties of those materials made it not work well. Check and see if any students cut or folded their materials, and if that made the vessel float less or sink.* ▪ What do you want to improve? • *Teacher's Note: Focus on engineering aspects with students. Ask students if they found a solution or just part of one. Reinforce that it is*

	okay to not succeed on the first try and that engineering is about making improvements over time. Ask students if they would design their boat differently if they had no rules, how? Ask students if working together was difficult. Learning to work together is very important and it is easier to find a solution with many ideas rather than just one idea.