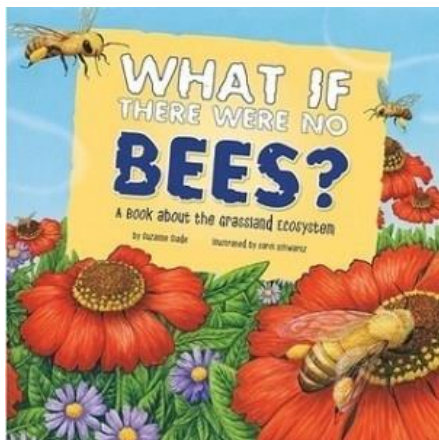


LESSON: What If There Were No Bees (Grades 2-4)

+ OVERVIEW



In this design challenge, students will receive a problem derived from the story *What If There Were No Bees?* by Suzanne Slade. In the story, Suzanne talks about how bees help the ecosystem and the ramifications if bees were to disappear from the ecosystem. The students will be presented with the following problem: “The Lee, Martinez, and Smith families have noticed that there are fewer bees around their farm. They are worried that over time there may be no bees left to pollinate their crops. What can they do to make sure their crops and surrounding lands get pollinated?” Students will engage in a STEM challenge to build an artificial pollinator in 25 minutes. Teams will receive bonus points if their pollinator can transfer enough pollen in different-sized flowers.

+ 2021 Science TEKS covered in this design challenge

Grade 2 TEKS: 2.1.B, 2.1.E, 2.1.G, 2.12.B, 2.12.C

Grade 3 TEKS: 3.1.B, 3.1.E, 3.1.G, 3.12.B

+ Math TEKS covered in this design challenge

Grade 2 TEKS: 2.2.B, 2.4.A

Grade 3 TEKS: 3.4.A, 3.4.C, 3.7.E

+ ELAR TEKS covered in this design challenge

Grade 2 TEKS: 2.1.D, 2.6.B, 2.8.C

Grade 3 TEKS: 3.1.A, 3.1.D, 3.6.B

Grade 4 TEKS: 4.1.A, 4.1.D, 4.6.B

+ 2022 Technology Applications TEKS covered in this design challenge

Grade 2 TEKS: 2.3.A, 2.3.B

Grade 3 TEKS: 3.3.A, 3.3.B

Grade 4 TEKS: 4.3.A, 4.3.B

+ The students will be able to:

- > Read *What If There Were No Bees*
- > Compare the ways living organisms depend on each other and on their environments through food chains
- > Solve a problem using the engineering design process
- > Build a device by applying an understanding of the physical properties of objects, and smaller units can be combined to make new objects
- > Classify building materials by their physical properties
- > Count forward and backward to at least 20 with and without objects
- > Describe the elements of plot development, including the main events, the problem, and the resolution, for texts read aloud with adult assistance or independently
- > Work collaboratively with others 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:

	Grade 2	Grades 3-4
> Chenille Sticks	4 counters per stick	\$4 per stick
> Pompoms	2 counters per pompom	\$2 per pompom
> Popsicle Sticks	5 counters per stick	\$5 per stick
> Clothespin	5 counters per pin	\$5 per pin
> Drinking Straws	2 counters per straw	\$2 per straw
> Tape	3 counters per roll	\$3 per roll
> Glue Stick	4 counters per stick	\$4 per stick
> Scissors	3 counters per pair	\$3 per pair
> Construction Paper	3 counters per sheet	\$3 per sheet
> Cotton Swabs	1 counter per swab	\$1 per swab

Teacher's Note: 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:

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| <ul style="list-style-type: none"> > <i>What If There Were No Bees?</i> By Suzanne Slade > Projector and computer > Slide deck for the lesson > Copies of the scorecard for each group | <ul style="list-style-type: none"> > Timing device > Digital scale > Square weigh boat (100 mL) > Weigh boat with medium opening > Weigh boat with a small opening > Baking powder |
|--|--|

+ FACILITATION GUIDE

SECTION	PROCEDURE
INTRODUCTION	Slide 1: What If There Were No Bees? Slide 2: Read Aloud > Read <i>What If There Were No Bees?</i> ▪ Summarize what happened on each page. ▪ Ask students what they think can be done to bring back bees. ▪ Explain to students that there are jobs that specialize in finding solutions to problems like losing bees. 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 1 > 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 once 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). • <i>Teacher's Note: Any example can be used here, but focus on examples that students are familiar with.</i> Slide 4: Engineering Design 2 > Ask students the question: What are some examples of engineering jobs? ▪ <i>Teacher's Note: If students have trouble giving examples, ask students who makes the things they use. Who makes refrigerators, cars, helmets, cell phones, and sneakers?</i> Slides 5-7: STEM Careers > Show students pictures related to careers connected to the story. > Environmental Engineering ▪ Ask students what they see in the pictures. ▪ Explain to students that engineers who study the planet and natural materials 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 help explain why there are population imbalances in the ecosystem. ▪ Ask students if they remember any of the environmental reasons why bees would go away. Explain to students that changes in

their home environment could cause the bees to leave because it's now too cold or too hot to live there.

> Chemical Engineering

- Ask students what they see in the pictures.
- Explain to students that this is called chemical engineering. This is when engineers specialize in working with things called chemicals. Chemicals are things that cannot be broken down without changing what they are. Examples of chemicals include oxygen and gold.
- Ask students what kind of chemicals would make bees go away. Explain that engineers are always working on protecting crops and plants by spraying them with chemicals. Sometimes chemicals can harm bees, too, so chemical engineers want to develop safer ones to help them.

> Agricultural Engineering

- Ask students what they see in the pictures.
- Explain to students that engineers who focus on farming are called agricultural engineers. They use science to understand farming better and to build tools that make it easier for farmers to care for their farms.
- Ask students if they remember why bees are important for farming. Explain to students that agricultural engineers want to know how bees impact the growing of crops and plants on farms and what they can do to solve pollination problems on the farm.

Slide 8: Try the Trade

> Agricultural Technician

- Ask students what they see in the pictures.
- Explain to students that these are farms, gardens, greenhouses, or crops that agricultural technicians help care for. Ask students what they think an agricultural technician does. Explain that agricultural technicians help farmers and scientists grow healthy plants, care for animals, collect information, and solve problems related to food production.
- Ask students why it is important for crops and animals to stay healthy. Explain that agricultural technicians observe plants and animals, measure growth, test soil and water, and help identify problems. If crops do not grow well or animals become unhealthy, there may be less food available for people and communities. Agricultural technicians help ensure farms are productive, safe, and sustainable.

Slide 9: Engineering Design 3

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

Slide 10: 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, 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*.
- > The teacher reads the first step to the students. (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 can determine if their solution will work. Is a child-sized football the same as an adult football? The criteria for both footballs include leather, white laces for the fingers, and shape. However, the two footballs would have different size criteria. The footballs are similar but differ in certain criteria.
 - Once the criteria are understood for the design challenge, what are some potential challenges that 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 solving 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.
- > The teacher reads 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 us imagine what things could be. In this step, see what materials are available, then brainstorm possible ideas/solutions to the problems.
 - Explain to students that there are no right answers in engineering. Start with as many ideas as possible.

	> The teacher reads 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 will combine 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 meets the criteria and constraints of the project. > The teacher reads the next step. (Create) ▪ The fourth step is to create! Since this is the very first creation, it is called a <i>prototype</i>. 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. > The teacher reads 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 expectations and 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 are needed, the team will revisit the plan and decide how to improve the score. Remember, there are no correct answers in engineering, just better solutions.
IDENTIFY	Slide 11-12: Identify – Problem > The teacher will read the bolded scenario to students. ▪ Ask students what problem the Lee, Martinez, and Smith families are having right now. > Explain to students that they will put on their engineering hats today to help the Lee, Martinez, and Smith families overcome their bee population problem by building an artificial pollinator. Explain to students that artificial means something humans make to imitate what happens in nature. In this case, the students are going to copy bees pollinating. Slide 13: Identify – Criteria (Desired Outcomes) > Explain to students that criteria are what engineers use to determine if they have successfully solved the engineering problem. > A successful pollinator design should include the following:

- A handle that can fit in the palm of an adult's hand
 - Ability to transfer 0.2 g of pollen over three attempts
 - *Teacher's Note: Students in 2nd grade will not be familiar with a digital scale or with reading a decimal. Assistance should be provided to the student at this step of the scoring process. The baking powder will represent pollen.*
 - Look like a natural pollinator (bee, hummingbird, butterfly, etc.)
- Bonus points will be awarded if the pollinators can transfer 0.2 g of pollen over three attempts in medium and small openings.
- *Teacher's Note: Display the medium and small openings to students so they understand that there is a difference in size for accessing the pollen.*

Slide 14-17: Identify – Constraints (Limitations)

DELETE OTHER GRADE SLIDES

- > 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 the pollinator.
 - *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 will only be able to use the materials available.
 - Budget: Students will have \$25 to complete this challenge.
 - *Teacher's Note: Fake money can be given to each group to represent their budget. Students would then go to the supply table and hand the teacher the money to "buy" their materials.*
 - *Teacher's Note: For grade 2, 25 counters will be given to each group instead of money. Pre-bag the counters for easy distribution to each group. When students go to the supply table, they will hand the teacher the appropriate number of counters to "purchase" the material.*
 - 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 18-19: Imagine – Explore Materials <i>*DELETE OTHER GRADE SLIDE*</i> > Introduce materials to students by showing each item as it is read out loud on 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 they have seen and what the similarities and differences are. ▪ Ask students to reclassify the objects based on what they are made of or how they can be used. Slide 20: Imagine – Brainstorm > Give students one minute to individually design and draw a plan of what they think their pollinator should look like. Emphasize that students should not talk during this minute or share ideas with each other. Remind students that 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, when sharing, they should focus on the key aspects of their idea they like and want to use as design elements in the final design. ▪ <i>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. In particular, students may struggle with the idea of a "pollinator." Presenting pictures of pollinators may be enough, rather than a prototype.</i>
PLAN	Slide 21: Plan – Gather Materials > 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. > Review the design criteria: A successful pollinator design should include the following: ▪ A handle that can fit in the palm of an adult's hand ▪ Ability to transfer 0.2 g of pollen over three attempts ▪ Look like a natural pollinator (bee, hummingbird, butterfly, etc.) Bonus points will be awarded if the pollinators can transfer 0.2 g of pollen over three attempts in medium and small openings.

	• <i>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.</i> > They will need to select the materials for the design. Students will have 25 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 scorecard. Slide 22: Plan – Team Member Responsibilities (Career Role-Playing) > Assign each student a career role within their team. As students complete the challenge, they should make decisions and contribute from the perspective of their assigned career. This activity models how STEM and skilled trade professionals collaborate in the real world to design, build, test, and improve their prototype. ▪ <u>Agricultural Engineer</u>: Builds the hand pollinator with assistance from the group ▪ <u>Agricultural Technician</u>: Draws the group plan and ensures the plan matches the prototype ▪ <u>Chemical Engineer</u>: Keeps track of the materials and manages the budget ▪ <u>Environmental Engineer</u>: Tests the hand pollinator's ability to carry pollen
CREATE	Slide 23: Create – Design Your Pollinator > 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. Slide 24: Identify – Criteria > Display the reminder slide for students to look at while working Slide 25-28: Create – Test *DELETE OTHER GRADE SLIDES* > The base test will have an open weigh boat, while two additional tests for bonus points will require transferring from weigh boats that have “lids” on them with narrowed openings. Testing will be conducted using a digital scale to determine whether sufficient pollen is transferred across three attempts. Testing will be done at the testing station, where students will get three attempts to transfer at least 0.2 g of pollen (baking powder) from the flower (weigh boat) to another flower (empty weigh boat). A digital scale will

be used to measure the amount of pollen transferred. After three attempts are completed, the teacher will read the digital scale output to the students and let them know their score on the scorecard. The teacher will further explain to the students whether they need to transfer more pollen to get a better score.

- *Teacher's Note: The digital scale will need to be zeroed with the weigh boat on it. To do this, place an empty weigh boat on the scale and press the calibration button (also called the zero or tare button on the digital scale). This step must be completed before the testing step for accurate measurements.*
- > If students wish to pursue the bonus points, they will try to transfer 0.2 g from the medium-hole lid and record their score. If successful, they may attempt the small hole lid for additional bonus points. Sample weigh boats will be at each team station.
- > The teacher will recap the point total with the students and how many points the team received for each category to make sure it matches what the students recorded.

IMPROVE

Slide 29: Improve – Redesign/Discussion

- > Students will reflect on their score and discuss:
 - What worked?
 - *Teacher's Note: Focus on the materials being used and ask why they think those materials were helpful. Check whether any students combined materials to improve their pollinator. Check whether any students cut or folded the materials to make their pollinator sturdier.*
 - What did not work?
 - *Teacher's Note: Focus on the materials being used and ask why they think those materials did not work as well.*
 - What do you want to improve?
 - *Teacher's Note: Focus on engineering aspects with students. Ask students why they were designing artificial pollinators. 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 how they would design their pollinator differently if they had no rules. 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 than with just one.*