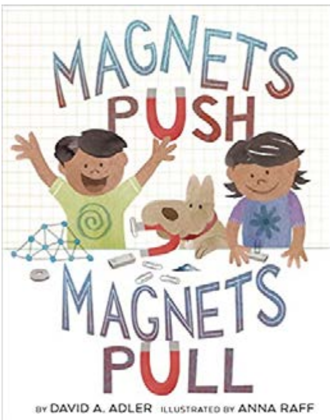
LESSON: Magnets Push, Magnets Pull (Kindergarten)

+ OVERVIEW



In this design challenge, students will read the storybook *Magnets Push, Magnets Pull* to learn about how magnets work. The students will receive the following problem; "Jose loves to entertain his community by designing hay mazes every year. He needs some help this year in thinking of a new maze design. Today, you will be putting on your engineering hat to build a maze!" Students will engage in a STEM challenge to design a solvable maze with one entrance and exit that utilizes only a magnet to solve.

+ 2021 Science TEKS covered in this design challenge

Kinder TEKS: K.1.B, K.1.E, K.1.G, K.7.A

+ Math TEKS covered in this design challenge

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

+ ELAR TEKS covered in this design challenge

Kinder TEKS: K.8.D.i

+ 2022 Technology Applications TEKS covered in this design challenge

Kinder TEKS: K.3.A, K.3.B

+ The students will be able to:

> Read *Magnets Push, Magnets Pull*
> Explore interactions between magnets and various materials
> Predict and describe how a magnet can be used to push or pull an object
> Count forward and backward to at least 20 with and without objects
> Solve a problem using the engineering design process
> Recognize the central idea and supporting evidence of informational text with adult assistance

+ 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 and student cost:

> Thick Foam Sheet (6mm)	No cost
> Magnets	No cost
> Magnetic Wand	No cost
> Chopsticks	1 counter per stick
> Marker	1 counter per marker
> Colored Pencils	1 counter per pencil
> Glue Stick	4 counters per stick
> Scissors	1 counter per pair
> Construction Paper	1 counter per sheet
> Toilet Paper Rolls	1 counter per roll
> Chenille Stick	1 counter per stick

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.

+ Materials needed by the facilitator:

- > *Magnets Push, Magnets Pull* by David A. Adler
- > Projector and computer
- > Slide deck for the lesson
- > Copies of the scorecard for each group
- > Timing device
- > Foam Sheet
- > Magnet
- > Magnetic Wand

+ FACILITATION GUIDE

SECTION	PROCEDURE
INTRODUCTION	**Slide 1: Magnets Push, Magnets Pull** **Slide 2: Read Aloud** > Read *Magnets Push, Magnets Pull* ▪ Ask students what they thought was the most interesting thing they learned about magnets. Ask who they think works with magnets for a living. ▪ Ask students what jobs they think work with magnets. • Explain to students that there are jobs that specialize in the use of magnets to help make our lives better. For example, there are trains that use the idea of magnets to make them go very fast and shorten how long it takes to go from one place to another. These are called maglev trains, and currently, there are only six in the world. **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). • *Teacher's Note: Any example can be used here, but focus on examples that students are familiar with.* **Slide 4: Engineering Design 2** > Ask students the question: What are some examples of engineering jobs? ▪ *Teacher's Note: If students have trouble giving examples, ask who makes the things they use. Who makes refrigerators, cars, helmets, cell phones, and sneakers?* **Slides 5-6: Engineering Jobs 1-2** > Show students pictures related to engineering jobs that connect to the story.

	> Materials Engineering ▪ Ask students what they see in the pictures. ▪ Explain to students that learning about and using different materials is called materials engineering. ▪ Ask students if all the magnets in the book looked the same. ▪ Ask students if the materials that were attracted to the magnets were the same. Explain to students that not all objects have the same strength of attraction to magnets. > 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 a type of science called physics and math to build structures that help people. Civil engineers will build many different things like bridges, highways, towers, and water systems! ▪ Ask students if they think we use magnets in our buildings. Explain to students that civil engineers have started to use magnetic materials to improve our buildings and streets! • *Teacher's Note:* More information on magnets and civil engineering. **Slide 7: Engineering Design 3** > Ask students the question: who can be an engineer? ▪ Anyone! **Slide 8: 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, 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 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 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 to not 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 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. > 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 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. > The teacher reads 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. > 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 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	**Slide 9-10: Identify** - Problem > Teacher will read the bolded scenario to students. ▪ Ask students what problem Jose is having right now. > Explain to students that they will put on their engineering hat today to help Jose design a maze. **Slide 11: 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 maze design should include the following: ▪ One path connecting one entrance and one exit ▪ Paths wide enough for a magnet to fit ▪ All key elements drawn (connected walls, entrance, exit) Bonus points will be awarded if the maze takes at least 20 seconds to solve. • *Teacher's Note: The teacher will time how long it takes to solve the maze. If appropriate, the teacher can have students count with them.* • Students may also design a maze runner for their maze if they like. It will require them to cut out their design and tape it onto the magnet. Bonus points will be awarded if the maze has barriers that stay up on their own.

	Slide 12-13: Identify - Constraints (Limitations) > Explain to students 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 maze. • *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 be able to use no more than 20 items to build the maze. ▪ 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 14: Imagine** - Explore Materials > 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.

	> Explain to students that the foam sheet will be the floor of the maze. Demonstrate placement of the magnet on top of the foam sheet and the magnetic wand underneath to make the magnet move. > Ask students why the magnet is moving. Explain that the bottom of the magnet's polarity is the opposite of the wand's, so they are attracted to each other. **Slide 15: Imagine** – Brainstorm Ideas > Give students one minute to individually design and draw a plan of how they think Jose's maze could look and what materials would be used in the design. 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	**Slide 16: 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 maze design should include the following: ▪ One path connecting one entrance and one exit ▪ Paths wide enough for a magnet to fit ▪ All key elements drawn (connected walls, entrance, exit) Bonus points will be awarded if the maze takes at least 20 seconds to solve. Bonus points will be awarded if the maze has barriers that stay up on their own. ▪ *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.*

	Slide 17: 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 18: Create** - Design Your Maze > Let students know to have fun, be creative with their designs, and to 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 19: Identify** – Criteria > Display the reminder slide for students to look at while working. **Slide 20-21: Create** – Test > The teacher will bring their magnetic wand to each team when they are ready to test. They will go through each of the categories on the scorecard with the students. Prior to starting the maze, the students will point to the entrance and exit of their maze and set their magnet or maze runner at the entrance. The teacher will make sure to time how long the maze takes to solve. If appropriate, the students will count along with the teacher. > The teacher will then recap the point total with the students and how many points the team received for each category.
IMPROVE	**Slide 22: Improve** - Redesign: Discussion > Students will reflect on their score and discuss: ▪ What worked? • *Teacher's Note: Focus on the magnets being used and ask if the magnets were able to move through the maze. Check and see if any student made a maze that met the bonus criteria. Ask how they designed the maze.* ▪ What did not work? • *Teacher's Note: Focus on the magnets having difficulty moving through the maze. Check and see if any students had difficulty with their maze barriers.* ▪ 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 not to succeed on the first try and that engineering is about making improvements over time. Ask students if they would design their*

		maze 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.