Windmill Project Timeline: 3 Day Plan

The windmill project is designed to span three days, with the flexibility to extend to five days depending on whether all key learning areas are fully addressed. The activities that are optional are able to make this project a longer plan and have been listed as optional. These can be skipped if the educators feel that they have covered all the key learning areas before the 3-day plan.

Prior To Day 1:

Introduction to 3D Printing, Engineering Jobs, and the

Engineering Design Process

Time: 45 minutes - 1 hour

3D Printing Activities- This activity is going to be used to introduce the 3D printing concept to students not familiar with 3D printing.

This lesson on 3D printing will cover its principles by exploring the basics of 3D printing through an activity called 3D Print with sand, which is brought to you by Science Buddies. This activity will help students understand the process of 3D printing.

Engineering Design Process Slides And Activity

This lesson will introduce students to the engineering design process, emphasizing the importance of problem-solving, prototyping, and testing in engineering. The hands-on activity is

modifying a matchbox car to catch the wind to propel it as far as possible. A worksheet is provided to guide students through the design process. This worksheet is provided by teacherspayteachers created by Vivify STEM.

Day 1: Field Trip To Engineering Location.

Time: 5-7 hours

Engineering Concepts At the Engineering Field Trip.

During this trip, they will be accompanied by a UDRI mentor through a tour of the building and their role in the success of this system. As the tour comes to an end, they will be introduced to the Macgyver Challenge, where they will be given a story that requires them to use recyclable resources to restore power to Windyville. On Day 1, they have a UDRI mentor with their team - everyone comes, all 80 kids go to UDRI, and they split into groups of 3. They will make a windmill out of recycled materials collected by the school.

MacGyver Challenge: Building Windmill Prototypes

Next Generation Standards: ES-PS2A ,MS-PS2A , ES-PS2B, MS-PS2B, ES-PS3A, MS-PS3A, ES-PS3B, MS-PS3,ES-PS3C, MS-PS3C, ES-ETS1A, MS-ETS1A, ES-ETS1.B, MS-ETS1.B, ES-ETS1.C, MS-ETS1.C

In this challenge, students will work in teams to design and build a windmill using everyday materials. They will be given a set of recyclable materials and will need to use their creativity and problem-solving skills to construct a functional windmill that can generate electricity. This hands-on activity will help students understand the principles of wind energy and the importance of renewable resources.

The MacGyver Challenge will require a list of different materials, which are:

- Blades (Cardboard, index cards, paper, recycled materials)

- The hub (foam cylinder)
- The drive shaft (straws and skewers)
- Weighting: The spool, string, cup, and washers
- Additional materials: box fan, ruler, tape, scissors, hot glue gun

If you would like to see the full list of materials needed for this project, click here. If the materials are purchased this way then the class will also be agreeing to not participate in the Day 1 fieldtrip to UDRI.

If you would like these materials to be provided by UDRI, contact us and we will provide the materials needed for this project.

Day 2: Brainstorm and Blade Designing.

Time: 45 minutes - 1 hour

Step 1: Read Aloud: "The Boy Who Harnessed the Wind"

NGSS (Next Generation Science Standards): 3-5 ETS 1-1, 2,3 , Ohio Learning Standards: RL 3.3, W.3.2(a-d) and SL.3.1

- "The Boy Who Harnessed the Wind" tells the true story of William Kamkwamba, a young boy from Malawi who builds a windmill to bring electricity and water to his village during a time of famine. Using resourcefulness and creativity, William gathers materials from scraps and studies how windmills work, eventually designing and constructing a functioning wind turbine. This story highlights the importance of perseverance, problem-solving, and innovation in engineering.
- The book directly relates to windmill blade design as William experiments with different blade shapes and materials to maximize the windmill's efficiency. His journey demonstrates how understanding aerodynamics and renewable energy principles can lead to practical solutions for real-world problems. By reading this story, students can see the impact of renewable energy and be inspired to apply similar engineering concepts in their own windmill projects. For a YouTube video read-aloud of this story, click here.
- Once this story has been read, it is easy to engage students in a discussion about the key themes and concepts

presented in the book. Ask questions to prompt critical thinking and connections to their own experiences with engineering and problem-solving. Once this has been done there is a worksheet that will be given to the students to give them a reflection on the story and its themes.

Step 2: TinkerCAD Lesson On Building Legos (Optional)

(Next Generation Science Standards) Engineering Design-3-5 ETS 1-1,2,3 and ISTE (International Society for Technology in Education) Technology Standards for Students - 1.4a,1.4b,1.4d and 1.6

- This lesson should be reviewed by educators and be used to introduce students to TinkerCAD. If the students have experience with tinkerCAD this step should be skipped.
- This lesson will introduce students to the basics of using TinkerCAD to create 3D models. They will learn how to manipulate shapes, use the workplane, and create their own Lego designs. The lesson will include step-by-step

instructions and a hands-on learning experience to reinforce concepts. This is the tinkerCAD lesson slides.

- This slides provides an overview of the TinkerCAD interface and basic tools.

Step 2: TinkerCAD Lesson On Making Name Plate/Pencil Holder:

(Next Generation Science Standards) Engineering Design-3-5 ETS 1-1,2,3 and ISTE (International Society for Technology in Education) Technology Standards for Students - 1.4a,1.4b,1.4d and 1.6

- This lesson should be reviewed by educators to be used first with students who are familiar with TinkerCAD and are more aware of the tools and materials within TinkerCAD. In this lesson, students will learn how to design and create a personalized name plate or pencil holder using TinkerCAD. This project will help students develop their CAD skills and understand the importance of design in engineering. Within the slides, you create a name

plate, then if you continue, you can make it into a pencil holder by adding the holes needed. This is the TinkerCAD lesson slides.

Step 3: TinkerCAD Lesson On Building Blades:

(Next Generation Science Standards) Engineering Design-3-5 ETS 1-1,2,3 and ISTE (International Society for Technology in Education) Technology Standards for Students - 1.4a,1.4b,1.4d and 1.6

- This lesson will be the next step to building and designing their windmill blades after the previous 3D designing lessons have been selected to give them a refresher on the TinkerCAD software. Students will be tasked with drawing their desired blade shapes. Once they have agreed on a design they want for their windmills, they will begin working alongside the volunteer to finalize the design of their blades within TinkerCAD.

Day 3: 3D Printed Design Testing

Time: 2 hours

Step 1: 3D Printing

- Students will see the exciting process of 3D printing their windmill designs. By using 3D printing technology,

students can experiment with different design elements, such as blade shapes and sizes, to optimize their windmills for maximum efficiency.

Step 2: Test

- Once printed, they will test their components, ensuring that each blade works correctly. This process not only enhances their understanding of engineering principles but also provides them with valuable experience in seeing advanced manufacturing techniques.
- Each windmill will be evaluated on its ability to generate electricity. Students will connect their windmills to a testing device that will measure the electrical output. The performance of each windmill will be compared to a benchmark model provided by the University of Dayton Research Institute (UDRI). This comparison will help students understand the effectiveness of their design and identify areas for improvement.

Step 3: Bracket

- The teams will be evaluated in a bracketed style competition where the top-performing teams, whose windmills generate the most electricity will be recognized as winners. This competitive aspect adds an element of excitement and motivates students to strive for excellence in their windmill projects and aspire to bring back power to Windyville.

Objective Of The Project

The ultimate objective of the project is to light up the testing device's bulb, symbolizing that the windmill has successfully restored power to the fictional town of Windyville. This goal provides a clear and tangible target for students to work towards. By achieving this, students will demonstrate their ability to apply STEM concepts to solve real-world problems. The sense of accomplishment they gain from seeing their windmill power the bulb will reinforce their learning and inspire them to continue exploring the field of renewable energy and STEM innovation.