

**Engineering Design Challenge Notebook:**

**Prototyping a Wind Turbine**

[Engineering Design Challenge Notebook Wakelet](#)

**By: Christin McNeil**



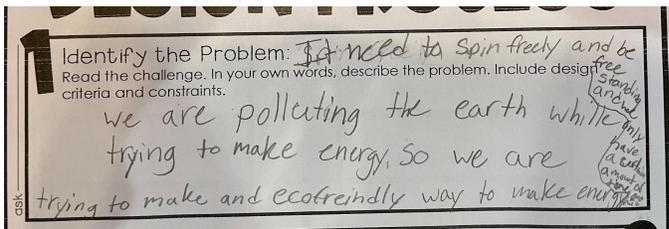
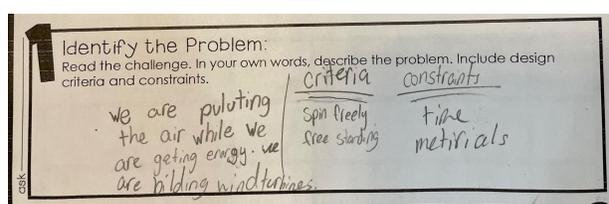
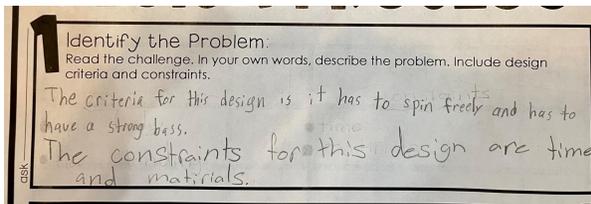
## Step 1: Identifying the Problem

In the weeks leading up to the Engineering Design Challenge, students were learning about climate change and the importance and impact that sustainable energy could have on slowing the rate of global warming. We completed the NASA “Graphing Global Temperature Change” activity and looked for trends in the rising global temperatures. We also reviewed several other resources to learn more about the growing issue of climate change. Students were then presented with the Engineering Design Challenge that is as follows:

**Calling all engineers! You have just been hired by a local committee searching for a location in the region to build a wind farm. They need YOU to help them design a prototype for the farm. Here is your challenge:**

**Design and prototype a free spinning windmill/ wind turbine using available materials**

## Student Samples:



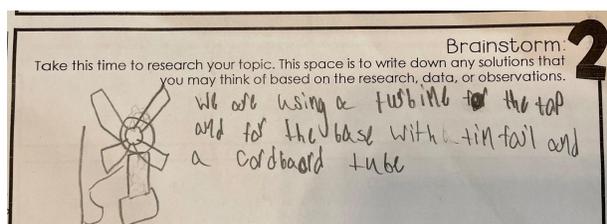
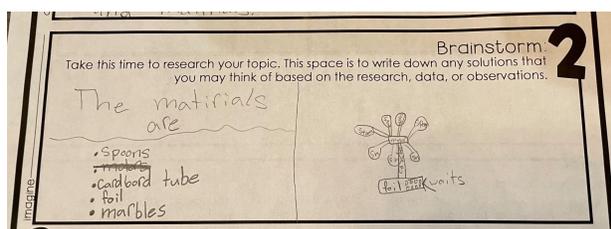
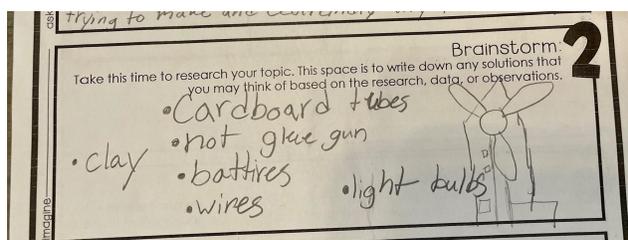
## Step 2: Brainstorm

On the first day of the challenge, students came in and we did some brainstorming about wind turbines. We viewed a picture of a wind farm in the ocean and used a Jamboard as a place to collaborate, share ideas, and ask questions. The link to the Jamboard is as follows:

### [Wind Turbine Jamboard Collaboration](#)

After students did some collaborating, we read “The Boy Who Harnessed the Wind” and watched a video in which William Kwamkamba recounted his experience with creating a wind turbine for his town that provided them with electricity. Students did some research independently prior to completing the brainstorming step on their planning pages.

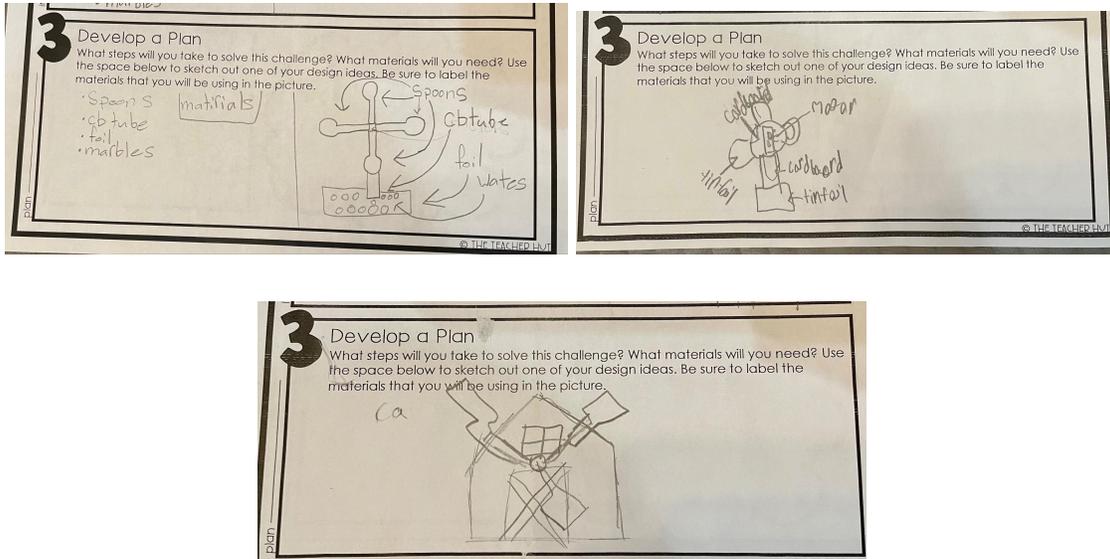
### Student Samples:



### Step 3: Design

After brainstorming several ideas amongst the group members, students settled on a specific design and labeled the materials they would use to build their wind turbine.

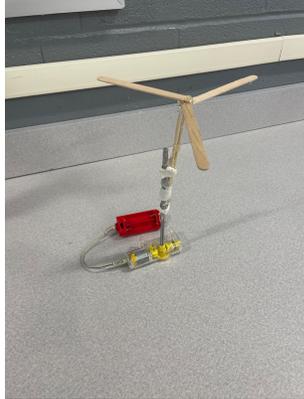
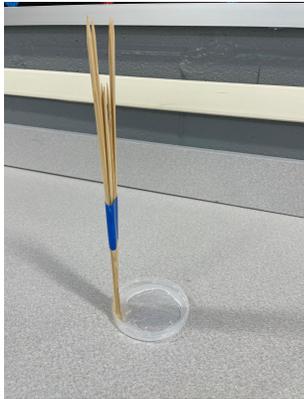
#### Student Samples:



### Step 4: Build

Students used their declarative knowledge and their sketch to begin prototyping their wind turbines. The group started off slow with simple designs.

#### Student Samples:



### Step 5: Test and Evaluate

This was the step in which students started to pick-up steam a bit. Once they were able to test out their initial prototypes, they could analyze the results and make informed decisions on redesigning their wind turbines.

### Student Samples:

Test it Out 5  
Now it's time to test it out! Make observations about what is working on what is not working. Complete the information below.

Trial	Results	Did you Complete the Challenge?	Ideas for Improvement
1	did not spin freely	X	take out one stick
2	It spin freely	✓	stronger base

What is working? The 2 cardboard supports  
What is not working? Three bamboo sticks

Test it Out 5  
Now it's time to test it out! Make observations about what is working on what is not working. Complete the information below.

Trial	Results	Did you Complete the Challenge?	Ideas for Improvement
1	successful	✓	turn propellers
2	successful	✓	spin the right way

What is working? it is spinning  
What is not working? the propellers do not catch much wind

Test it Out 5  
Now it's time to test it out! Make observations about what is working on what is not working. Complete the information below.

Trial	Results	Did you Complete the Challenge?	Ideas for Improvement
1	fail	No	make the hole bigger
2	fail	No	we could make the propellers wider

What is working? a strong base and stronger make it taller  
What is not working? weak base, old bad turbines

Test it Out 5  
Now it's time to test it out! Make observations about what is working on what is not working. Complete the information below.

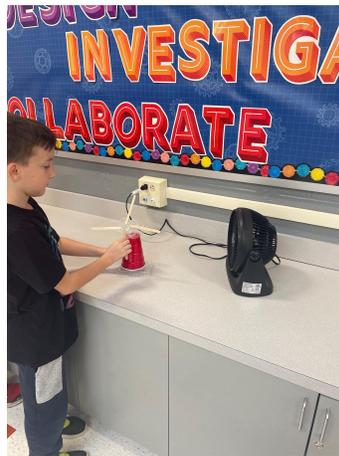
Trial	Results	Did you Complete the Challenge?	Ideas for Improvement
1	did not spin freely	X	take out one stick
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### Step 6: Redesign

The groups used what they learned from their trials to redesign their wind turbines. Some redesigns were drastic while others just made slight changes to their designs.

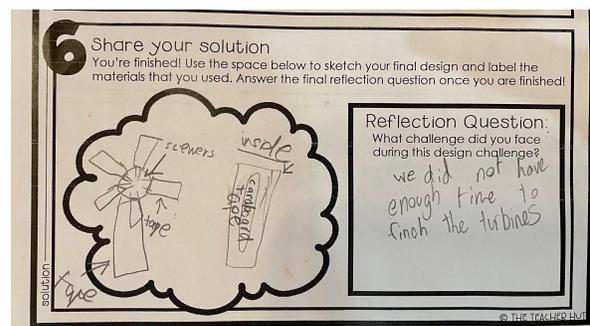
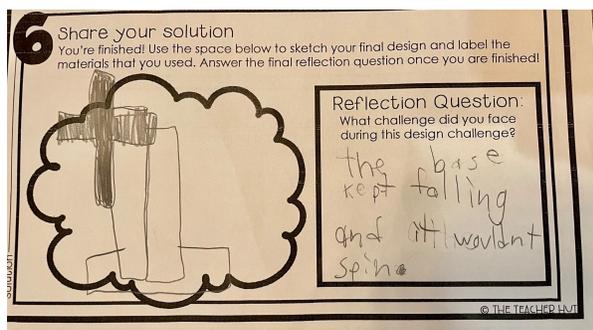
**Student Samples:**



**Step 7: Share the Solution**

Students iterated the Testing, Evaluating, and Redesign steps several times. Most groups recorded 2 trials, but actually worked on their redesign beyond their second trial. As part of their reflection, students shared a sketch of their final designs and the challenges they faced during the prototyping process.

### Student Samples:



### Reflection

I completed this challenge with a small group of high achieving 5th grade students. It was extremely enjoyable to be able to work with a small group and spend more time than typical testing and improving their turbines. **Here are the major takeaways from the implementation of the challenge:**

- We have been discussing climate change and sustainability for much of the first quarter with this small group of students. I think it was beneficial to have enough time to allow for building their background knowledge about the importance of wind energy. Having this knowledge gave them a leg up when it came to

designing their own wind turbine, it also increases the chances that students will transfer their knowledge of the science behind the engineering challenge. In addition, when students complete engineering challenges in larger groups; there is less time for iteration. This group of students was able to test and improve their prototypes several times. This allowed for more success with the challenge and greater takeaways for students.

- Although I was able to work with a smaller group of students, we had small, isolated pockets of time to complete the challenge. This meant that there were days (and sometimes a full week) between sessions. I think this made it more difficult because the flow of their work and their thought processes were interrupted multiple times throughout the course of the project.
- “In design there is never enough time or money. This means that all designs are compromises- no design will be perfect. Students must become comfortable with compromise- not easy for all students.” (Garmire, 22). This quote from Garmire rang true throughout the course of this challenge. Although we did have extended time to spend on each step of the design process, students had to make compromises due to our limitations of time and materials. A great life lesson for these students to be learning now that will assist in strengthening their preparedness for the future.

- The big concepts taught as part of this lesson were about alternative energy, specifically wind energy. The goal was for students to understand the positive impact of alternative energy and to develop a deeper understanding of how climate change is negatively impacting our world. It was an integrated STEM lesson which included the following standards:

**NGSS Performance Expectations**

**3-5-ETS1-1.-**Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

**PA Science, Technology, and Engineering Standards:**

**3.4.5.E3** Explain how tools, machines, products, and systems use energy in order to do work.

**3.4.5.D1** Identify ways to improve a design solution.

**3.4.5.B3** Describe how community concerns support or limit technological developments.

**3.4.3-5.E-** Construct and argument to support whether action is needed on a selected environmental issue and propose possible solutions.

**PA Core ELA Standards:**

**CC.1.2.5.B** Cite textual evidence by quoting accurately from the text to explain what the text says explicitly and make inferences.

**ITEEA Standards**

Apply the technology and engineering design process.

Explain how technologies are developed or adapted when individual or societal needs and wants change.

Evaluate designs based on criteria, constraints, and standards.

Practice successful design skills

- The Engineering Design process required students to consider and apply the science and math concepts to their wind turbine design. In addition to their knowledge of the importance of wind energy and how wind turbines work, they also needed to think about aerodynamics, torque, and

centrifugal force when building and improving their wind turbines to spin freely. When building their turbines to stand upright, they had to consider height, weight, and how to include shapes into their base to ensure that it would be sturdy against the power of the wind. These concepts were revisited through the design process as each step required students to reflect on what they had already completed in order to move forward in a productive way.

- It is interesting, because I would have thought this project would have been simple for this group. With this high achieving group, I provided students with additional building materials and less direction. I think this proved to make it more of a challenge for them. Honestly, I do not think I would change much about it in the future. I really enjoyed watching the productive struggle and I think it is important for a high achieving group to experience that feeling. I felt that the testing, evaluating, and improvements steps were the most powerful because they pushed the students to think critically and analyze flaws in their designs. I also found it fascinating that students became competitive with each other during these phases. When a group would experience success with a trial, it seemed to motivate the other groups to work more diligently on their redesigns. I have done many Engineering Design projects with my students, but this was the first with a small group of enrichment students. I have never seen the amount of growth and change in designs as I did with this group.

- I would improve this challenge by lengthening the last step in the process. The reflection part of this process has the potential to be extremely powerful. I will set aside 1 additional pocket of time for us to have more of a conversation and truly share our ideas. This step always feels rushed because time is our greatest constraint. However, if we could have had a more meaningful discussion about each groups' challenges and ideas for improvement in the future, I believe it would have been a great way to end the challenge.
- My primary goal as the STEAM educator in my school is to facilitate the development of students' habits of mind with regard to engineering and problem solving. I scaffolded this challenge in a way that was different from my general education classes due to the small group size and the fact that these are high achieving students. Providing less parameters and specifications allowed for students to experience productive struggle. It also meant that some groups walked away without successfully completing the challenge. I truly believe that this group of students experiencing both productive struggle and failure will better prepare them for their futures both in and out of the classroom.

## **Resources**

1. "EDP Engineering Design Process Posters and Worksheet: Stem." *TPT*,  
[www.teacherspayteachers.com/Product/EDP-Engineering-Design-Process-Posters-and-Worksheet-STEM-5666000](http://www.teacherspayteachers.com/Product/EDP-Engineering-Design-Process-Posters-and-Worksheet-STEM-5666000). Accessed 5 Nov. 2023.
2. Garmire, Elsa. "The Engineering Design Method." *The Technology Teacher*,  
2003, pp. 22–28.
3. "EDP Engineering Design Process Posters and Worksheet: Stem." *TPT*,  
[www.teacherspayteachers.com/Product/EDP-Engineering-Design-Process-Posters-and-Worksheet-STEM-5666000](http://www.teacherspayteachers.com/Product/EDP-Engineering-Design-Process-Posters-and-Worksheet-STEM-5666000). Accessed 5 Nov. 2023.