

Engineering in the Primary Grades

Brandy A. Bermudez

Adams State University

Concepts and Standards Covered

I used this engineering design challenge to help teach my students about two-dimensional and three-dimensional shapes. We then took it a step further and investigated how three-dimensional shapes are all around us. Below is a list of the mathematics standards that were covered in this challenge.

- **K.G.A.3** Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).
- **K.G.A.2** Correctly names shapes regardless of their orientations or overall size.
- **K.G.B.4** Analyze and compare two- and three- dimensional shapes, in different sizes and orientations, using information language to describe their similarities, differences, parts (e.g., number of sides and vertices/”corners”) and other attributes (e.g., having sides of equal length).
- **K.G.A.3** Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).
- **K.G.A.2** Correctly names shapes regardless of their orientations or overall size.
- **K.G.B.4** Analyze and compare two and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/”corners”) and other attributes (e.g., having sides of equal length).
- **K.G.B.5** Model shapes in the world by building the shapes from components (e.g., sticks and clay balls) and drawing shapes.

Engineering Design Process Used

For this challenge, I used an engineering design process I created by incorporating three design processes. The three design processes included are from the National Atmospheric and Space Administration (NASA), PBS Design Squad, and University Center they would help younger engineers organize their work and thinking in a way that made sense to them. The process steps include: ask, imagine, plan, create, experiment, improve, share, and ask. Figure 1 provides the visual used in my classroom during the design challenge.

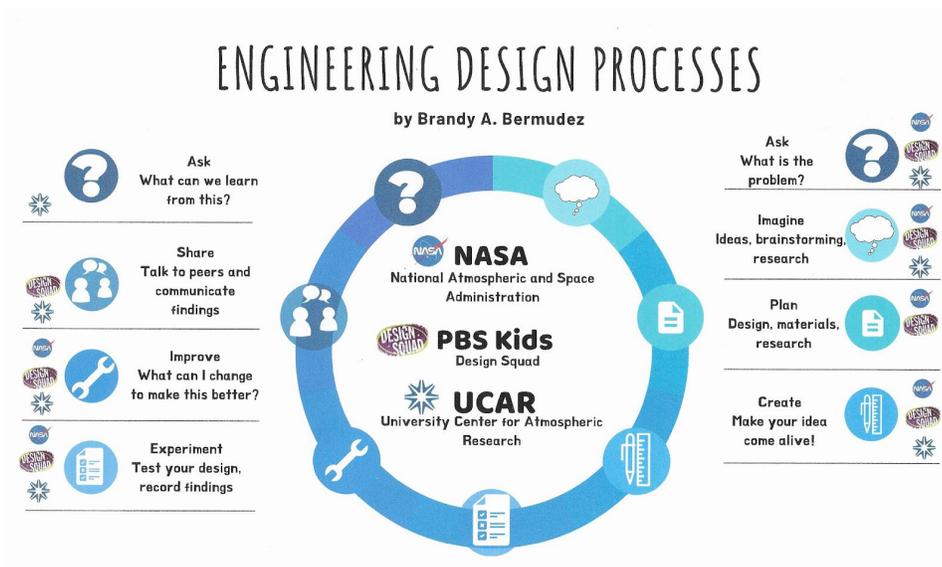


Figure 1.

Implementation Timeline

I decided that one week was plenty of time for my students to be able to implement the design challenge. I believed that any longer might have caused my kindergarteners to lose interest in the “why” and “how” of the process and move into play without meeting the needs of the challenge.

On the first day, we read the story “The Three Little Pigs,” and then received a “letter” from Peggy Pig. She asked the students to help her build a house out of shapes that would keep her and her brother’s safe from the big, bad wolf. I then introduced the engineering notebooks and made our first entry. See Figure 2 below.

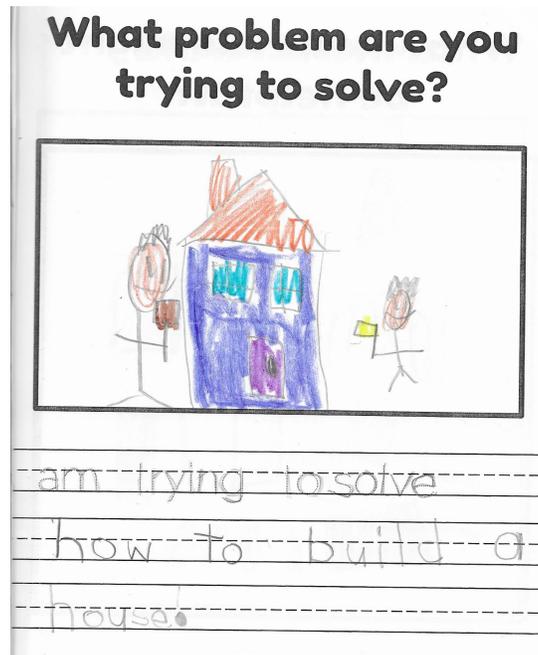


Figure 2.- “I am trying to solve how to build a house.”

On the second day, I set out uncooked spaghetti, marshmallows, modeling clay, and popsicle sticks. The students then drew these materials into their notebooks as options for building material. They then began brainstorming ideas of what their house might look like and drew in their top idea. See figures 3-6 below. I noticed that my students were getting frustrated with the amount of work needed, so we discussed our ideas and what materials we might use orally. See figure 7 below.

What materials might be helpful?

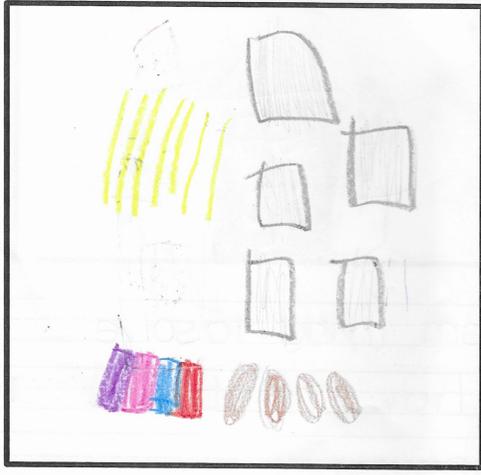


Figure 3.

BRAINSTORM!

Circle realistic ideas.



Figure 4.

BRAINSTORM!

Circle realistic ideas.

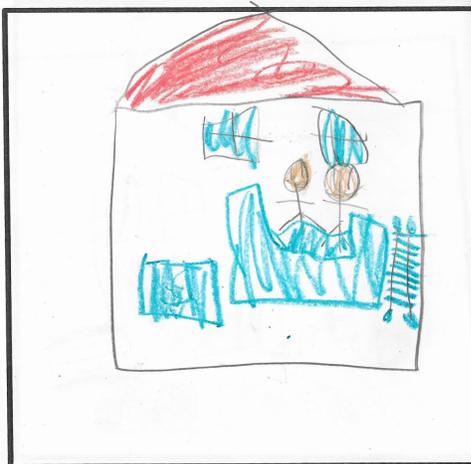


Figure 5.

MY TOP IDEA!

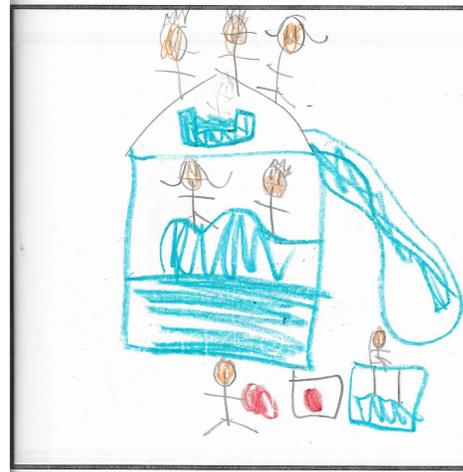


Figure 6.

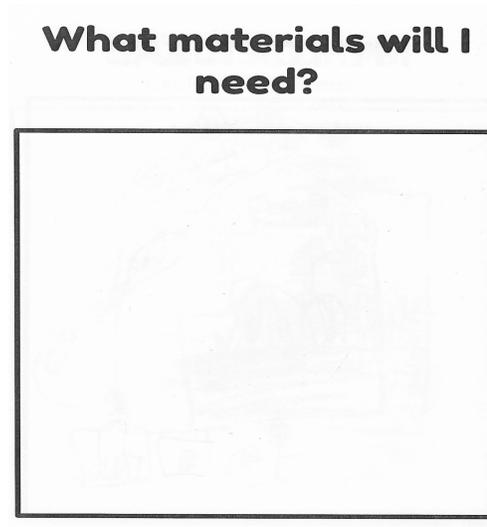


Figure 7.- completed orally

On the third day, the students began building their houses. I asked them to use only the food items first, just to see what might happen. The students were allowed 15 minutes to work on their design before we met on the carpet to discuss our findings. They were then asked to draw what happened in the first test and sketch a redesign. Figures 8-11 depict this phase of the project.

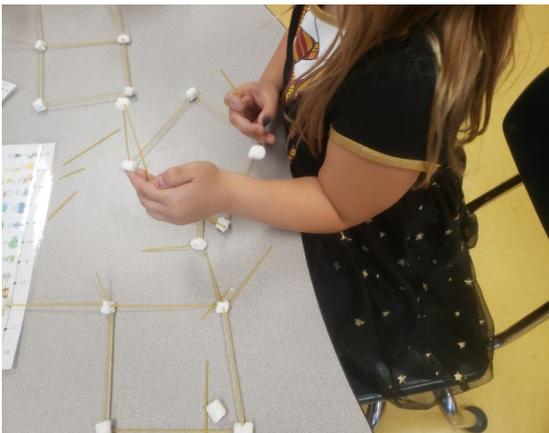


Figure 8.

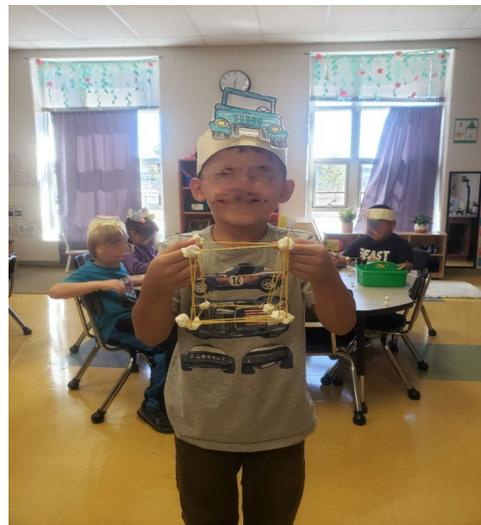


Figure 9.

What happened in the first test?



Figure 10.- "It kept falling."

REDESIGN IDEAS

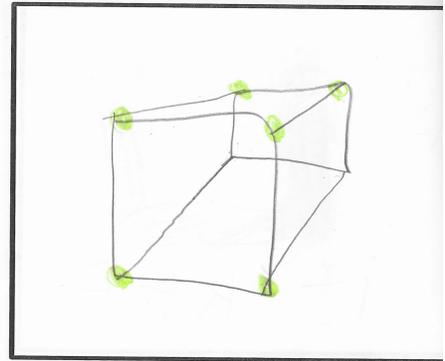


Figure 11.

On the fourth day, students were given the entire class period, one hour, to work on other house designs that might work for Peggy Pig. They were given the option to work alone or as a group. The rules for the challenge were that the house must use three-dimensional shapes that they are able to identify and that it be stacked two shapes tall. Figures 12-17 depict this time in our design process.

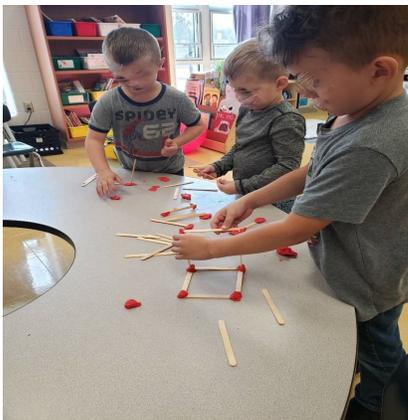


Figure 12.

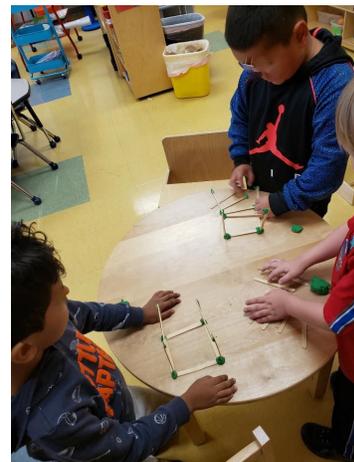


Figure 13.



Figure 14.

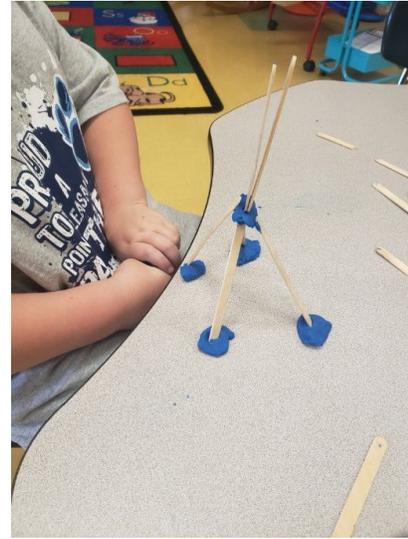


Figure 15.

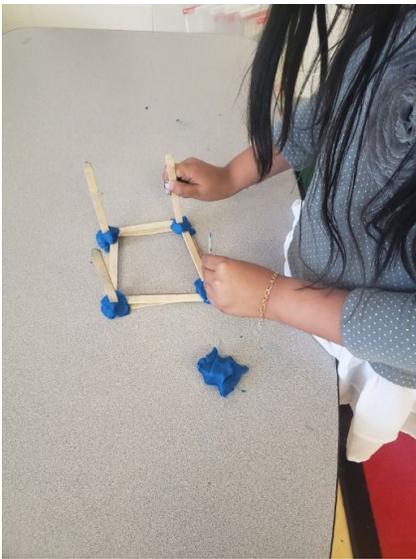


Figure 16.

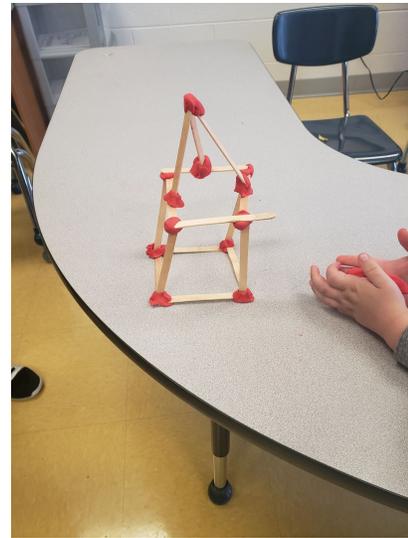


Figure 17.

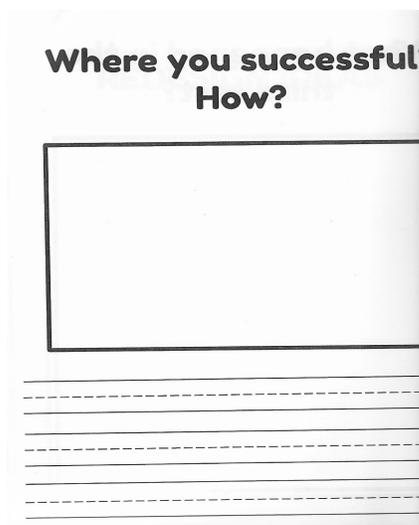
Throughout the hour, I had students pause what they were doing to come and share ideas of things that have worked and things that did not. These pauses were strategic in that I used them to help them refocus when they began to get off task as five-year-olds tend to do.

On the final day of our project, we discussed how we were successful in the challenge, what we liked best about our designs, what we thought needed more work, and the importance of trying again. We then ended our discussion by talking about what we were able to learn from each other and how our designs might help others.

Each of these steps was crucial to the design process I had selected. I wanted my students to not only learn math concepts in an engaging way, I wanted them to learn more about their world, how to help others and be helped, and why it is not only okay, but important to fail.

Engineering Design Notebooks

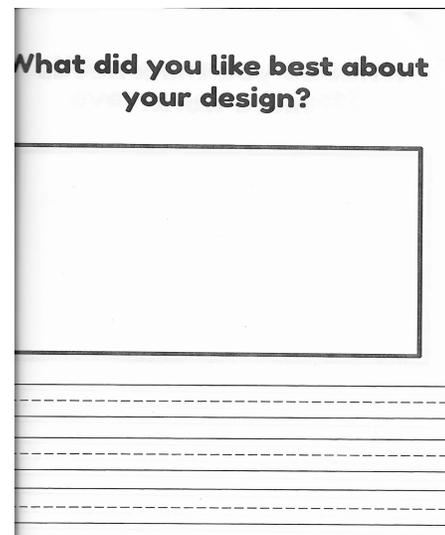
The engineering design notebook I created allowed for my students to take notes on their progress throughout the challenge. After the first test, my students became frustrated with the amount of writing and drawing I was requiring for the challenge. Rather than having my students continue to feel defeated by writing so early in the challenge, we came together as a class to discuss each question listed, so that they would still be completing each step of the engineering design process orally. Below are scans of a student's notebook entries.



**Where you successful
How?**

A large empty rectangular box for drawing or writing, followed by several horizontal lines for text, each with a dashed midline.

Figure 13- completed orally

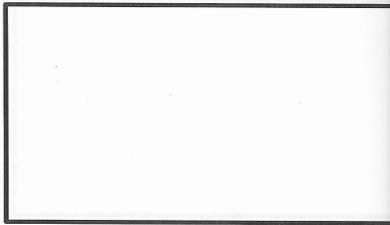


**What did you like best about
your design?**

A large empty rectangular box for drawing or writing, followed by several horizontal lines for text, each with a dashed midline.

Figure 14.- completed orally

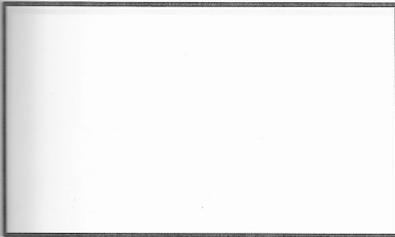
**What do you think needs
your more work?**



Four sets of primary-ruled lines (top solid, middle dashed, bottom solid) for writing.

Figure 15- completed orally

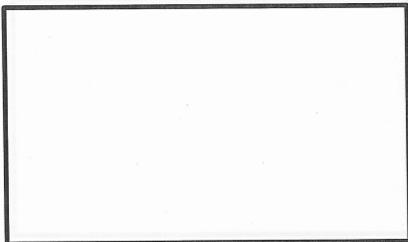
**Why do you have to do
something a few times before it
works the way you want?**



Four sets of primary-ruled lines (top solid, middle dashed, bottom solid) for writing.

Figure 16.- completed orally

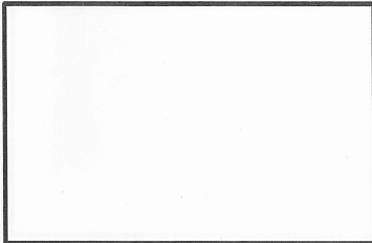
**What can you learn from
your friends' projects?**



Four sets of primary-ruled lines (top solid, middle dashed, bottom solid) for writing.

Figure 17.- completed orally

**How can your work help
other people?**



Four sets of primary-ruled lines (top solid, middle dashed, bottom solid) for writing.

Figure 18.- completed orally

Reflection

Positive Outcomes

My students truly enjoyed and learned so much about two dimensional and three-dimensional shapes using the engineering design process. Prior to beginning the design challenge, I gave a pre-assessment of three-dimensional shapes. The average score in my class was 53%. I gave the exact same assessment a few days after completing our design challenge and the average score jumped to 82%. I credit this huge difference with the fact that not only were my students learning about shapes, but they were having to use mathematical terminology to help them complete the design challenge.

Opportunities for Growth

In the future, if I decide to continue using individual notebooks, I would provide my students with more sentence starters to help them form their ideas, as they are still learning the basics of writing at this point in the school year.

I may, however, encourage more oral discussions and keep a class notebook where I would write down their ideas and thoughts, but allow them to add in their own drawings. This will help ensure that my students are still taking ownership of the project while not becoming frustrated to the point of tears because communicating on paper in standard English is still above their developmental capabilities.

Appropriateness of Engineering Design Process Selected

I believe this process was more than appropriate for my student's levels of understanding of math topics. Young children love to build using anything they can find. Having the

opportunity to do so in the classroom with the freedom to be as creative as they could, allowed my students to become fully engaged throughout the entirety of the design process.