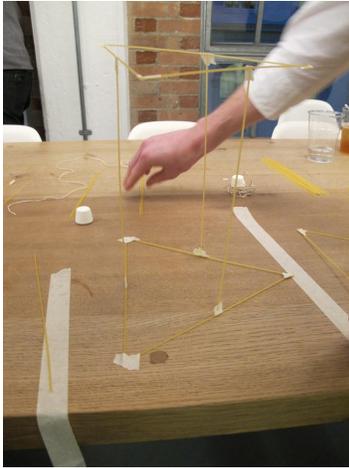


Marissa Paul

Major Project: Engineering Design Challenge Phase 2-Implementation

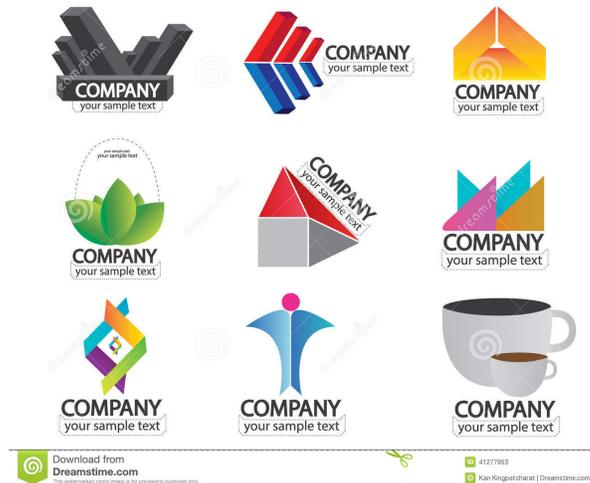
<p>Activity: To wrap up a unit on earthquakes this is an exciting way to incorporate engineering and healthy competition to a middle school Earth Science class.</p>	<h3 style="text-align: center;">Spaghetti Structures</h3>  <p style="text-align: center;">Copyright-Sarah's STEM Stuff on TPT https://drive.google.com/drive/folders/100Y6GmeXiW-07eYKDVAz0xuoP6OwocsX Thank you Sarah!</p>
<p>1. Engineering Design Process: NASA Engineering Design Process flows easily for students in a K-8 classroom setting.</p>	<h3 style="text-align: center;">NASA Engineering Design Process</h3> 
<p>2. Implementation Timeline: Six days for an hour each class. Maybe more</p>	<p>Day 1 - A. Introduce Spaghetti Structures engineering design challenge. Read over the packet 2022 Spaghetti Structures student version with your classmates and teacher and identify the problem. On the project overview page decide group roles so all</p>

depending on the ability level of the class.

participants have an active role in the design challenge and initial contract.

☰ 2022 SPAGHETTI STRUCTURES student version

B. Pick partners and create a logo and company name to compete with other, "engineering companies", students to build the sturdiest structure to withstand a simulated earthquake.



Day 2-A. Watch teacher researched videos and look at images of buildings together and give time for "engineering companies" to do their own research on the internet. Some useful websites:

- ▶ The Future of Earthquake-Proof Buildings
- ▶ Building Earthquake-Resistant Structures
- ▶ How We Design Buildings To Survive Earthquakes
- ▶ Students build, test earthquake-proof buildings
- ▶ Earthquake Building
- ▶ Building Strong Shapes Demo

B. After watching videos and doing their own research on the internet students can start filling out the Spaghetti Structures Planning Sheet. Here, they can write down the needs, constraints, jot down notes from their research and brainstorm ideas.

☰ Planning Sheet Spaghetti Structures

Day 3-A. Students can make a plan and draw a conceptual model and label the parts on the Spaghetti Structures Planning Sheet.

B. Students can plan out their budget of \$3,000 dollars on the budget worksheet found in the 2022 Spaghetti Structures student version document.

 2022 SPAGHETTI STRUCTURES student version

C. Students can also start to analyze materials and write out a check to gather materials from their teacher. Store materials in a labeled, sealable plastic bag.



	DATE _____ 20 ____	00000
PAY TO THE ORDER OF _____		<input type="text"/> \$
_____	DOLLARS	
MEMO _____		
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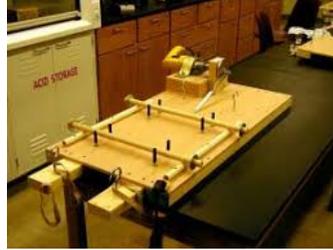


Day 4-A. Needs and constraints formative assessment out of 2 points as a review of the

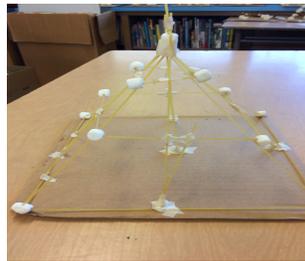
requirements for the design challenge.

☰ Spaghetti Structure Needs and Constraints

- B.** Measure out a one foot by one foot cardboard base for the earthquake shake table.



- C.** Start building on top of the cardboard base.



- Day 5 - A.** Test out earthquake proof science building on the earthquake shake table for 20 seconds. Students hand in Spaghetti Structures Proposal Sheet.

https://web.kamihq.com/web/viewer.html?state=%7B%22ids%22%3A%5B%221YSvcRQZf6kBMTOQdy9Dku9BIk-EdlEG6%22%5D%2C%22action%22%3A%22open%22%2C%22userId%22%3A%22112299215741648036372%22%2C%22resourceKeys%22%3A%7B%7D%7D&kami_user_id=9975196

- B.** Make improvements and use two other checks making sure to stay under budget of \$3,000 dollars. Teacher will keep track on a teacher supply sheet for each group.
- <file:///C:/Users/mpaul/Downloads/Teacher%20Supply%20Sheet.pdf>

	<p>Day 6 - A. Final test date for earthquake proof science building improvement structures on shake table for 20 seconds.</p> <p>Teacher fills out Spaghetti Structures Model Rubric for assessment.</p> <p>https://web.kamihq.com/web/viewer.html?state=%7B%22ids%22%3A%5B%221U68TvuZuOWjQkW5hR1bl_mZUtnuUo_R0%22%5D%2C%22action%22%3A%22open%22%2C%22userId%22%3A%22112299215741648036372%22%2C%22resourceKeys%22%3A%7B%7D%7D&kami_user_id=9975196</p> <p>B. Student reflection on overall engineering design challenge.  Spaghetti Structures Reflection</p> <p>Give students time to reflect on their hard work and write out their thoughts and share their experiences with the rest of the class.</p>
<p>Engineering Design Notebook:</p> <p>1. Identify the problem</p>	<p>1. Identify the problem-Spaghetti Structures</p> <p>Design and build a physical model earthquake proof building to test and determine if it can withstand a simulated earthquake for at least 20 seconds without collapsing and going over a budget of \$3,000 dollars of certain materials.</p> <p>The San Andreas faultline is a major area of study in my Earth Science class. Since it is a tectonic plate boundary between the Pacific Plate and North American Plate and is located here in the United States, California, it is very relevant to my students. Especially since an action-movie was made about it starring Dwayne, "The Rock" Johnson,</p>

a favorite actor among my middle school students.



Since the faultline runs through major cities engineers need to create buildings that can withstand seismic wave activity, including primary and secondary waves that will keep people safe from falling objects or collapsing buildings while working or living in the cities in close



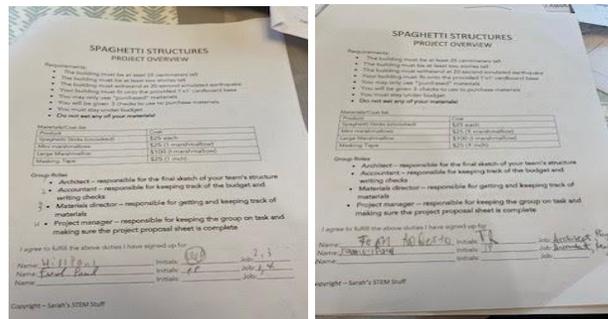
proximity to the faultline.

Since my middle school was already out for summer break I decided to present this challenge to my 11 year-old son, 8 year-old son, and his best friend, another 8 year-old whose father is an engineer. My older son William is going into middle school and my younger son Sam and his best friend Thomas love to play with legos so I thought they would be up for the task. Will originally was going to work with a cousin Fred, but he opted to go down the shore instead so Will worked by himself. Happens in school all the time when one partner is absent. Sam and Thomas

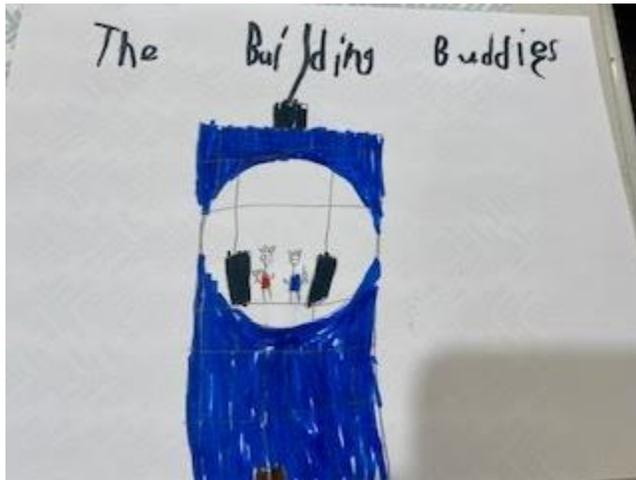
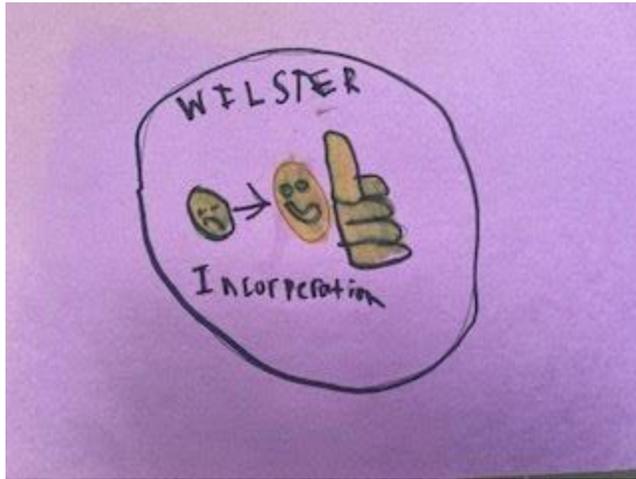


teamed up.

1. To start off the engineering design challenge we read aloud the Spaghetti Structures Task Card and the Project Overview where the boys went over the requirements, constraints and needs, were introduced to the materials and cost list, and were assigned group roles such as architect and accountant to make sure everyone was participating. There definitely was some negotiating on roles. They even had to initial and sign their names on a contract to make sure they would fulfill the duties assigned to them.



2. We then talked about how Will's engineering company would be competing against Thomas and Sam's engineering company and it would be beneficial to come up with a name and logo to make it as real-world as possible. Here is what they came up with: Will



Sam and Thomas

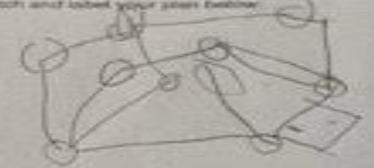


2. Brainstorming

Brainstorming: The Spaghetti Structures Planning Sheet was very organized and brought structure to the design challenge. As the teacher I reinforced the needs and constraints and the boys wrote it down. I always feel that your brain remembers better when you write down the information. We went over the following: The structure needs to be 25 cm tall, fit on a 1 foot by 1 foot cardboard base, and withstand 20 seconds of shaking on

an earthquake shake table. The constraints were the boys could only use certain materials such as mini marshmallows, large marshmallows, uncooked spaghetti, and masking tape, they could only use purchased materials, and had to stay under a budget of \$3,000 dollars. This can be seen under the ASK section here:

SPAGHETTI STRUCTURES
Planning Sheet

Ask	<p>Need: To build 20cm tall structure with a base</p> <p>Constraints:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Only use purchased materials <input type="checkbox"/> Only use 100g of spaghetti <input type="checkbox"/> Only use 100g of marshmallows <input type="checkbox"/> Only use 100g of masking tape
Research	What have others done to solve this problem? (Find out)
Imagine	Brainstorm ideas with your group and decide on the best idea
Make a Plan	Sketch and label your plan below:
	
Build	Purchase materials and start building
Test it out	Test it out! Does it meet the requirements? YES
Improve	What can you do to improve your design? be + the base YES SIMPLY

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The building bridges the
SPAGHETTI STRUCTURES
Planning Sheet

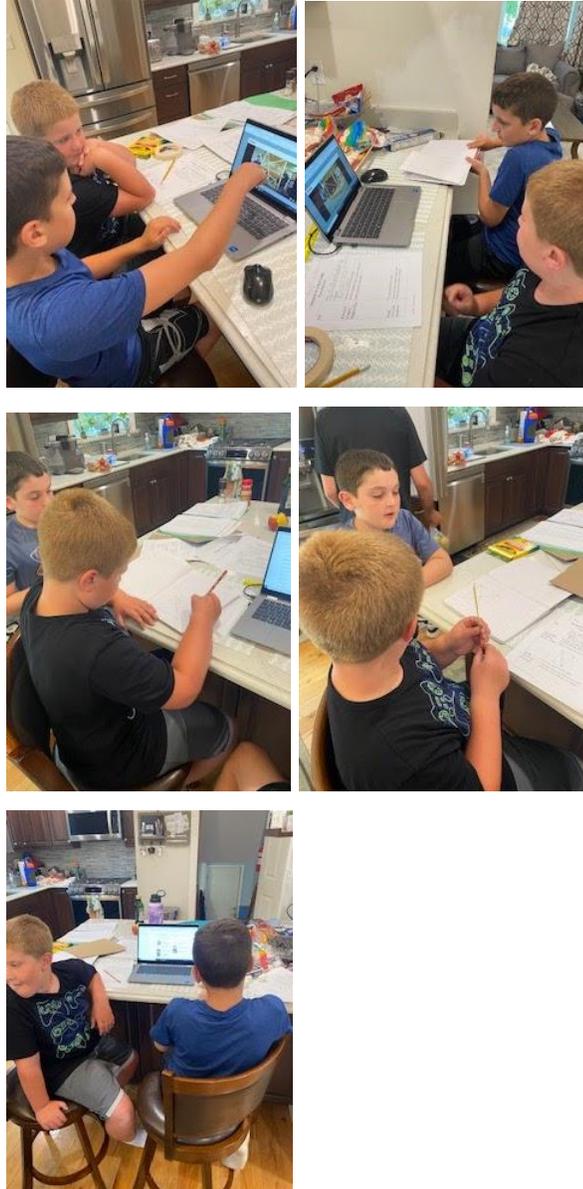
Ask	<p>Need: 25 cm tall structure with a base</p> <p>Constraints:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Only use purchased materials <input type="checkbox"/> Only use 100g of spaghetti <input type="checkbox"/> Only use 100g of marshmallows <input type="checkbox"/> Only use 100g of masking tape
Research	What have others done to solve this problem?
Imagine	Brainstorm ideas with your group and decide on the best idea
Make a Plan	Sketch and label your plan below:
	
Build	Purchase materials and start building
Test it out	Test it out! Does it meet the requirements? yes
Improve	What can you do to improve your design? reinforce the base

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Once I felt the boys understood the needs and constraints of the spaghetti structure challenge we were able to move on to the research section. We watched various videos on earthquake proof structures and searched images on similar spaghetti structure materials.

We also learned about the career of a structural engineer.

ny.pbslearningmedia.org/resource/ee68803e-5116-43b3-b4e5-18ed1e835552/what-is-structural-engineering-quest/?student=true&focus=true



The boys wrote down some notes on the Spaghetti Structures Planning Sheet under Research. They then started brainstorming ideas with each other. I stepped in and spoke to Will since his partner was absent. They all were concerned with the shape of the base and the mass of the structure. Thomas thought about buildings he had seen in New York City while traveling with his father. Will thought about the San Francisco earthquake

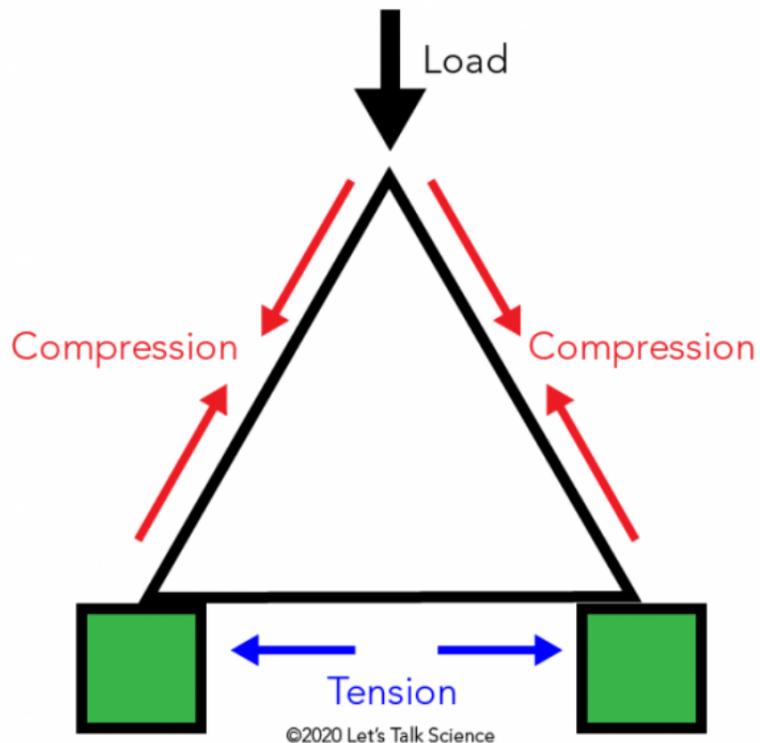
of 1989, during the World Series, and how the building structures have changed over time.



Sam was concerned about the strength of the spaghetti and if it would snap every time.

I showed the kids pictures of various buildings from: [Structures: Statues And Towers | Let's Talk Science](#) of the Statue of Liberty, the Space Needle, the Eiffel Tower, and the Xi'an Bell Tower in China. All to see the different shapes of the bases. We also watched:

[Strong Structures with Triangles | Design Squad](#) to understand that triangles support, stabilize, and stiffen the structures they are creating. At this point I spoke to them about force, load, and compression and how a triangle shape can create trusses. I had visuals to show them which can be seen below:



Why Triangles are a Strong Shape

When engineers build structures, they want to make sure that the structure can bear **weight**. In other words, they do not want the structure to fall down when a **force** is applied to it. For example, bridges must be able to hold up the materials that make the bridge, as well as all of the traffic travelling across it. One of the shapes that can bear weight very well is the triangle. But what makes triangles so good at this?

Let's look at how a triangle transfers a **force**.

When a force (the **load**) is applied to one of the corners of a triangle, it is distributed down each side. The two sides of the triangle are squeezed. Another word for this squeezing is **compression**. The third side of the triangle is pulled, or stretched sideways. Another word for this stretching is **tension**.

Triangles can be used to make trusses. **Trusses** are used in many structures, such as roofs, bridges, and buildings. Trusses combine horizontal beams and diagonal beams to form triangles. Bridges that use trusses are called **truss bridges**.

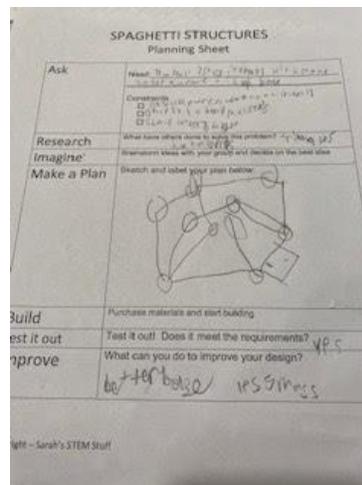


Credit to <https://letstalkscience.ca/> for the amazing visuals and notes on compression, tension, load, and trusses.

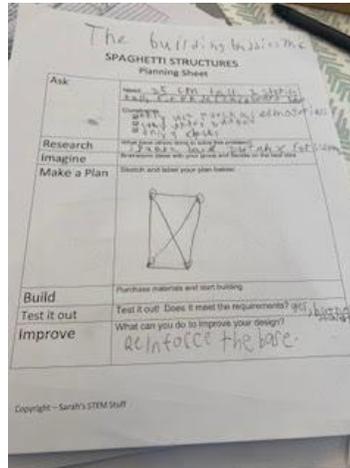
3. Design

Design:

With this new information the boys decided to make a 3-sided triangular base, 4-sided rectangular base, and 5-sided pentagon base for each earthquake proof structure design. Will felt each one of these geometry structures would fit on the cardboard base. All the boys were busy creating a conceptual model. Will chose the pentagon and it can be seen on the Make a Plan section of the Planning Sheet.



Thomas and Sam decided on the rectangular base first and would later try the triangular base.



Thomas was adamant on adding triangular shapes to support the space between the floors of the building from his research and my visuals.

The boys now had to plan how much of each material was needed to fulfill the requirements of 25 cm tall, 2 stories tall, and stay under the budget of \$3,000 dollars. The boys were given the opportunity to analyze the materials and plan out how many spaghetti sticks, mini marshmallows, large marshmallows, and inches of masking tape they would need. They were only given three checks to write out, so they could only obtain materials three times. This was very helpful because the boys couldn't just keep coming up and wasting materials. They were allowed to test out the structure and then buy more materials as long as they didn't go over budget. Will used all of his budget before testing out the building. Thomas and Sam were more cautious and used only two checks before they did a test run. They saved over a thousand dollars to make improvements. Their work can be seen on the Budget Worksheet and fake checks below: Will

SPAGHETTI STRUCTURES
Budget Worksheet

Materials/Code for	Product	Cost
	Spaghetti (25) (1000)	\$25 each
	Mini marshmallows	\$25 (1 marshmallow)
	Large Marshmallows	\$100 (1 marshmallow)
	Masking Tape	\$25 (1 inch)

Check #	Description of Materials purchased	Cost
Check 1	10 spaghetti (\$25) = 250 0 mini marshmallows (x25) = 0 0 large marshmallows (x100) = 0 9 inches tape (x25) = 225 250 $+ 225$ 475	1,150
Check 2	8 spaghetti (\$25) = 200 0 mini marshmallows (x25) = 0 8 large marshmallows (x100) = 800 10 inches tape (x25) = 250 200 $+ 800$ $+ 250$ 1250	950
Check 3	0 spaghetti (\$25) 16 mini marshmallows (x25) = 400 0 large marshmallows (x100) 20 inches tape (x25) = 500 400 $+ 500$ 900	900
Total Spent		3,000

Pay to: Mrs. Paw
the order of: J+K Structure
Memo: Structures by Mrs. Paw
Date: 3/22/22
Amount: 1,150

Pay to: Mrs. Paw
the order of: J+K Structure
Memo: Structures by Mrs. Paw
Date: 3/22/22
Amount: 950

Pay to: Mrs. Paw
the order of: J+K Structure
Memo: Structures by Mrs. Paw
Date: 3/22/22
Amount: 900

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SPAGHETTI STRUCTURES
Budget Worksheet

Materials/Item	Quantity	Unit Price	Total Cost
Spaghetti (25¢)	25	25¢	\$6.25
Mini Marshmallows	250	4¢	\$1.00
Large Marshmallows	100	10¢	\$1.00
Making Tape	10	30¢	\$3.00
Total			\$11.25

Check #	Description of Items Purchased	Cost
Check 1	25 spaghetti (\$25) = 6.25 250 mini marshmallows (x25) = 1.00 100 large marshmallows (x10) = 1.00 10 inches tape (x25) = 3.00	\$11.25
Check 2	10 spaghetti (\$25) = 2.50 250 mini marshmallows (x25) = 6.25 100 large marshmallows (x10) = 1.00 10 inches tape (x25) = 3.00	\$12.75
Check 3	10 spaghetti (\$25) = 2.50 4 mini marshmallows (x25) = 1.00 4 large marshmallows (x10) = 4.00 10 inches tape (x25) = 3.00	\$10.50
	1,000 +	
	Total Spent:	3,000

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Pay to: Mrs. Pawi Date: 7/7/12

the order of: One thousand one hundred Dollars

Memo: Mat. all Job Re # 1 to

Pay to: Mrs. Pawi Date: 7/11/12

the order of: eight hundred sixty Dollars

Memo: MARINE SAM PAWI

Pay to: Mrs. Pawi Date: 7/11/12

the order of: One thousand fifty Dollars

Memo: mat for Mrs SAM PAWI

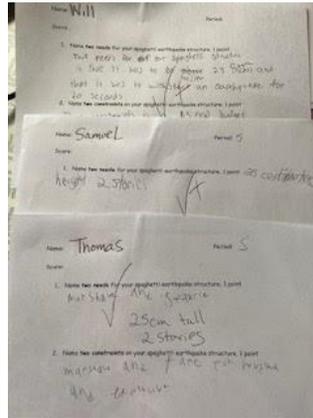
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Sam and Thomas

4. Build

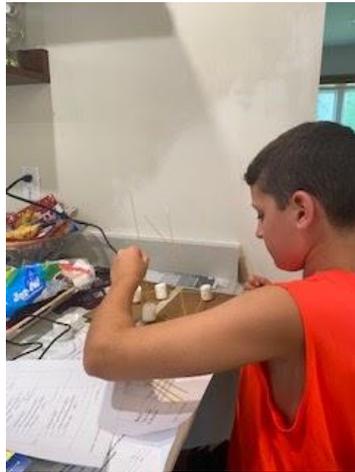
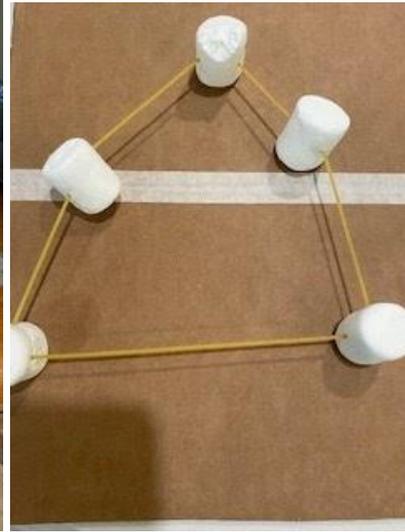
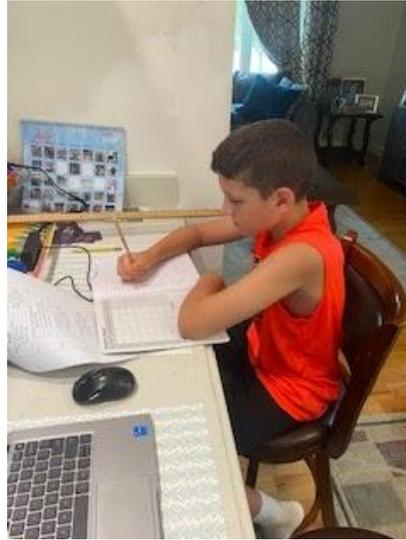
Build:

Before the boys started building I gave them a small assessment on needs and constraints. [Spaghetti Structure Needs and Constraints](#) They all did well on their own ability level and I did do some prompting with the younger boys.



I measured out ahead of time two one foot by one foot cardboard bases for the earthquake shake table for each engineering company to save time. The boys started building and up their structures using the Planning Sheet, purchased materials, cardboard base, and scissors.

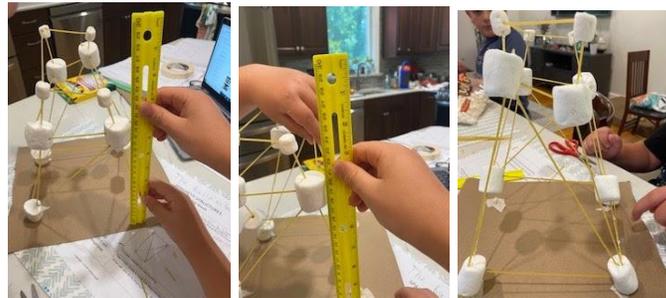
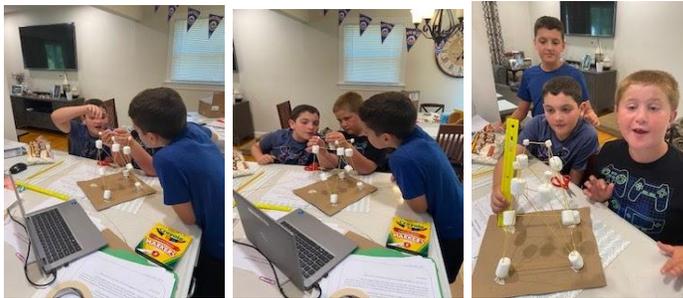
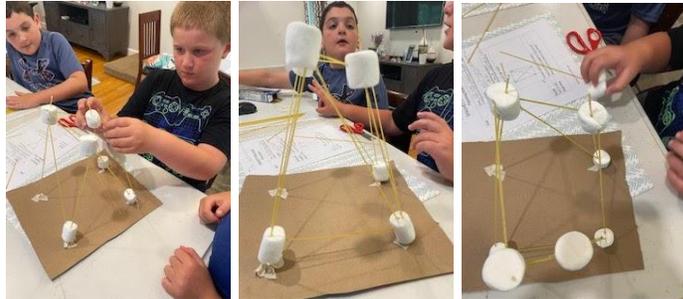
Will's pentagon base:



Will added large marshmallows on the bottom as shock absorbers to the shaking. We saw this in many videos during our research. It took Will a half an hour to build, use up all his materials, and just stay within the budget of \$3,000 dollars to the dollar. I had to assist him in the

holding of materials to get them just right on the cardboard base.

Thomas and Sam's rectangular base:



Sam and Thomas took an hour to build their earthquake structure. They were very cautious as to not break the spaghetti sticks as best they could! They incorporated

triangular supports for their rectangular base which could be seen in the trusses from the visuals and research we did earlier. They stayed under budget significantly only using two checks and a total of \$1,950 combined. They still had \$1,050 dollars to purchase more materials.

All boys checked the height requirement with a ruler and I checked over the budget calculations, materials used, and number of floors.

5. Test and Evaluate

Test and Evaluate

Before the two engineering companies, Wilster Incorporation and Building Buddies, were able to test their structures on the earthquake shake table they had to hand in their Proposal Sheets to the teacher. Here is what they entailed:

The image shows a hand-drawn proposal sheet titled "SPAGHETTI STRUCTURES Proposal Sheet". The form includes the following fields and content:

- Company Name: Building Buddies
- Group Members: Jon Thomas
- Design Details:
 - Height of Model: 26 CM
 - Number of Floors: 4
 - Total Cost: 1,950
- Labeled Diagram of your model: A hand-drawn truss diagram of a rectangular structure with diagonal supports, labeled with letters A through H at the joints.
- Describe what makes your design unique: also spaghetti rectangles base sturdy

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Building Buddies

SPAGHETTI STRUCTURES
Proposal Sheet

Company Name: Wilster Incorporation
 Group Members: Will

Design Details

Height of Model: 15 cm
 Number of Floors: 2
 Total Cost: \$3,000

Labeled Diagram of your model

Describe what makes your design unique.

Pentagon base
pentagon base
for the shock

-Sarah's STEM Stuff

Wilster Incorporation

A timer was set for 20 seconds, the cardboard base was attached to the earthquake shake table.

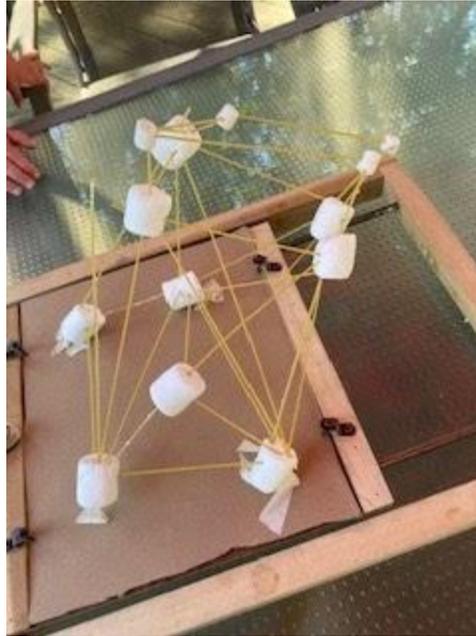
Wilster Incorporation went first. I, the teacher, used a wooden handle to move the table back and forth with all my strength. The science building was down in 8 seconds.



Check out the video below:

 Wilster Inc

Building Buddies was up next. Their structure lasted 15 seconds before it started to topple over. I again used all my strength to move the wooden base back and forth.



Check out this link: [Building Buddies Part 1](#)

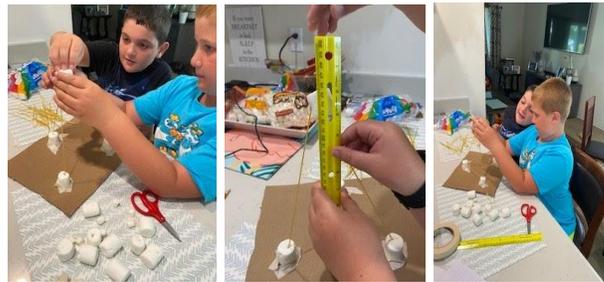
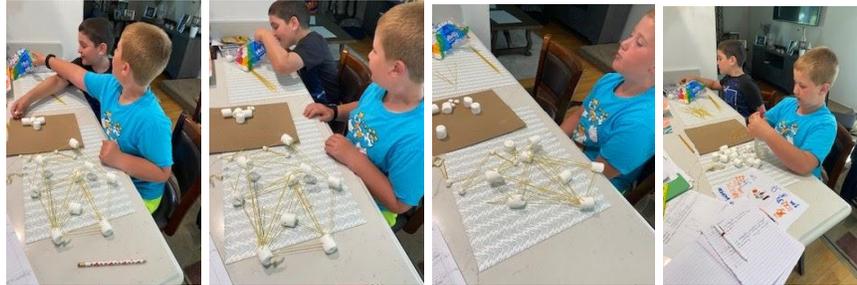
Will was out of money and had no extra materials to make improvements so I had to reject his proposal. Thomas and Sam were eager to change the shape to create a triangular base with less mass. They would regroup and start again the next day with their remaining budget.

6. Redesign

Redesign

Will realized that he should not have spent his entire budget for one test. He joined forces with Building

Buddies and decided to help in their final design of a triangular base. Thomas wanted less mass and more tape. He figured the heavy structure was toppling and less mass would let it sway in the air.



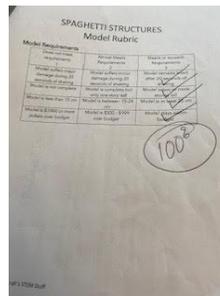
Sam and Thomas were careful to keep the materials they used from the day before and spent the rest of their budget on 10 new spaghetti sticks, 4 new mini marshmallows, 4 new large marshmallows, and 10 inches of tape. I also gave them new "sticky" tape and traded it in for the old tape.

Here is their final test:

Building Buddies Take 2

The boys were over-the-moon happy that their triangular base survived the simulated earthquake. Their excitement and willingness to come back the next day to make improvements made me proud as an educator and as a mother. They really enjoyed the challenge and it kept them away from the television and Ipads for a substantial amount of time.

I filled out a Spaghetti Structures Model Rubric for Building Buddies and they earned their one hundred percent grade. I also accepted their proposal and Building Buddies won the bid for the best structure that met the design requirements.



If we were actually in a school setting I would have added to the rubric for time management, behavior, and clean up.

7. Share the solution

Share the solution

After the excitement wore down I gave each engineering company five reflection questions to answer.

 Spaghetti Structures Reflection Will answered his own and Sam and Thomas answered me verbally, then later Sam wrote out the answers when he calmed down and had a snack. 😊 This can be seen below:

Reflection:

1. Did you spaghetti structure successfully build all the requirements? yes
2. Did your spaghetti structure survive building without 20 seconds of intense shaking? Why or why not? no it didn't because it was too weak to keep going
3. What was your favorite part of the engineering design process?
My favorite part was building
4. If you could make any improvements to this challenge what would they be?
I'll get more spaghetti and use more glue
the glue has sticky on all sides
I'll get more glue

5. If we had more time on this challenge what would you do differently to your spaghetti building? R something?
I would use more spaghetti
or more glue

Reflection:

1. Did your spaghetti structure successfully build all the requirements? yes
2. Did your spaghetti structure survive building without 20 seconds of intense shaking? Why or why not? yes because I used a lot of spaghetti
3. What was your favorite part of the engineering design process? BUILDING
I liked building

If you could make any improvements to this challenge what would they be?
I would have more money in the year
and different materials
such as wooden blocks and duct tape

5. If we had more time on this challenge what would you do differently to your spaghetti building? I would use more spaghetti
I would use more marshmallows
I would use more duct tape
I would use more string
I would use more paper

The top reflection is William's responses and the bottom reflection is Thomas and Sam's responses. Both engineering companies felt the building was their favorite part of the engineering design process. They also both wanted more money in their budget for building supplies.

Sam and Thomas wanted to build with different materials, such as wooden blocks and duct tape. If they had more time on this challenge Will wanted to distribute mass/load more equally and Sam and Thomas wanted to create a bigger marshmallow at the top for compression. I had the boys read their answers aloud to each other so they could share their experiences. Thomas also summed up his thoughts on building the best earthquake proof

building below:

 Conclusion

Teacher

Reflection

a. What went well with the engineering design challenge?

b. What did not go well with the engineering design challenge?

c. What concepts were covered (list standards and topics where appropriate)

Teacher Reflection

A. I found the building component of the Spaghetti Structure Engineering design challenge was fantastic. The boys were so driven to create a structure that would withstand 20 seconds of intense shaking from the earthquake shake apparatus. They loved the competition, figuring out if they had enough money in their budget for materials, and checking the requirements. Thomas' dad is a structural engineer and Thomas stood out in the competition. He was patient, creative, and was very hands-on during the building and actual design process. In fact, he came up with the name Building Buddies and the building logo.

B. The brainstorming component of the Spaghetti Structure Engineering design challenge was more challenging because my boys, Will and Sam, that are more sports-driven, and don't play with legos as much as Thomas, wanted to just start building and not listen to the research or concepts of the trusses, shapes, load, tension, and compression. I had to force them to watch the videos and pay attention to the visuals. I even had to threaten that we wouldn't go to the lake later in the day if they didn't pay attention and take the research seriously. I don't know if they just were misbehaving because I am also their mother or they just wanted to build/play without purpose. I find this to occur in my middle school classroom as well in my experience with design challenges.

C. Learning standards associated with this topic can be used from the NJSL 2020 Grades K-12.

https://www.nj.gov/education/standards/science/Docs/NJSL-Science_6-8.pdf

MS-ESS3: Earth and Human Activity

Students who demonstrate understanding can:

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ETS1: Engineering Design Students who demonstrate understanding can:

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in grades 6–8 builds on K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.

Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

(MS-ETS1-1)

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

The more precisely a design task's criteria and constraints can be defined, the more likely it is that the

designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)

ETS1.B: Developing Possible Solutions

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2)

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World

All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)

The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

Concepts on compression, tension, and load from how simple machines work is also relevant to this engineering design challenge.

d. How did the ED process help teach the science and mathematics concepts?

D. The engineering design process helped teach science and mathematics concepts. Mathematical concepts such as geometric shapes for the strength and stability of the structures were seen in the Imagining component and actual Building component as well. In the Plan section, budgeting materials for use used concepts of multiplying, adding, and writing out a check were vital in order to build. Scientific concepts such as compression, tension, and load were part of the Imagine, Plan, and Create section. The Ask section of the engineering design process helped the boys come up with a hypothesis of predicting which geometric shape, triangle, rectangle, or

e. Did I choose an appropriate engineering design process? Should I simplify or make it more complex?

f. How can I improve this activity to use with future students?

pentagon, would make the best base for an earthquake proof building.

E. I strongly feel the NASA engineering design process is the best process to use for grades K through 8. It is simple, follows the steps of the scientific method, allows students to build and explore, and is straightforward. I have always adored the jet propulsion resources as a science teacher and have been following the engineering design process without even realizing it at the time.

F. I know I can improve this activity with future students by making a Google Slides fill-in presentation to go over the concepts of tension, compression, and load. I also feel the students should make a poster or some other visual of their final results to communicate their findings to the rest of the class. I also think I need to increase the budget so students don't miss an opportunity to be creative while building their earthquake proof buildings.