

MeTEOR Learning Modules

STEM MEA (Model Eliciting Activity)

Building Structures



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CONNECTING THE DOTS



Building Structures: Can I make it work?

Reflective Planning

Description/Summary of Lesson:

In this activity Students are challenged to build an assigned structure. They are given a list of possible materials. Teams then have to work together to choose the right materials to build their structure and stay within a purchasing budget for those materials. Each team will build something different. This activity combines budgeting, physical properties, and the engineering design process.

Essential Questions:

- What are the specific qualities that go into engineering and design of a structure?
- How did prioritizing the purchase of materials affect your budget?
- How is math used in the planning stages of designing your structure?

Suggested Grade Level: Grade 5

Approximate Time: Two days (30 minute class periods)

Teacher's Role: Demonstrator and Facilitator

Class Set-Up: Groups of three-four students at tables or desks put together

Success Standards:

- Students can plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- Students can define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
- Students can generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and the constraints of the problem.
- Students can develop and use models.
- Students can define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions and defend conclusions.

Learning Purpose:

- Students will plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- Students will make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- Students will recognize and explain the need for repeated experimental trials.
- Students will recognize and explain that authentic scientific investigation frequently does not parallel the steps of "the scientific method."

Vocabulary:

- Budget
- Design
- Engineering

Math Practices:

- MP 1: Make sense of problems and persevere in solving them.
- MP 3: Construct viable arguments and critique the reasoning of others.
- MP 4: Model with mathematics.
- MP 6: Attend to precision.

Depth of Knowledge:

- DOK Level 3: Strategic Thinking

Materials:

- Craft sticks
- Rulers
- Paperclips
- Rubber Bands
- Cardboard Tubes
- Different Size Cups
- Straws
- Craft Foam
- Foil (pre-cut sheets in 12-inch lengths)
- Toothpicks
- Pipe Cleaners
- Cardstock
- Masking Tape
- Small Bowls
- Pennies
- Markers
- Marbles
- Small Toy Figures

Summary of Tasks/Experiences

Spark Activity: Mystery Picture

- Have students visit the website <http://floorsix.blogspot.com/> to see close-up photos of common objects. Students can try to figure out what the object is.
- Tell the students they are going to make a mystery structure that only their group will know. Once the structure is designed and built, the others will have to guess what they built. If their design is recognized, then they are praised for their design and construction.

Lesson Descriptions:

Introduction: Day 1

- Share with students that this challenge will test their group's ability to work together in building a mystery structure.
- Groups must not reveal to the other groups what they are building.

The students will:

- begin by taking a task card. (Each task card is different.)
- design independently the structure from their card onto paper (5 minutes).
- discuss commonalities between the designs.
- use the Cost Sheet; determine how to spend their \$10.
- take the Cost Sheet to the teacher in order to purchase their materials.
- build the structures, being careful not to reveal to others what they are building.
- present the completed structure to the class, and determine if others can identify it.
- reflect on what did and didn't work. Complete lab report.

Teacher facilitates class asking guiding questions as students work in groups or provides the questions in the form of a worksheet:

- What supplies did you choose? Why?
- What feature are you putting into your design so that it is recognizable?
- What mistakes did you make along the way?
- Were there supplies that you should have chosen but did not?
- If you could trade one of the things you bought for something else would you? Why?

Student Engagement

Social/Emotional Engagement:

- Students show positive, respectful and supportive small group interpersonal relationships and skills that provide friendship.
- Students share materials and work load.
- Students are involved together respectfully in the learning process as teacher and tutors as they give feedback to one another.

Physical Engagement:

- Students are involved with face-to-face interaction of student team members.
- Students complete all processes of building the structure as a group, each sharing in the responsibility.
- Positive group processing about their working relationships and response.

Cognitive Engagement

- Students monitor their own progress and thinking relative to their learning toward the Success Standards.
- Students support each other in clarification of the Success Standards, ensuring that each member of the group meets the standard.

Evidence of Learning

Checks for Understanding/Expected Outcomes:

- Students will utilize a budget to purchase supplies.
- Students will articulate why certain supplies were important to the structure's design.
- Students will design and build a recognizable structure.
- Students will complete the Reflection Worksheet.
- Students will be evaluated using the included Rubric.

Teacher notes:

- Through this STEM activity, students should be able to explain and reference the engineering process of design, build and modify on their Reflections and Understandings Sheet.
- Students should explain why each purchase led to the success of their structure.
- Budget should reflect up to \$10 thoughtfully spent.
- Student reflections should be individual thoughts, not group thoughts.
- Reflections and Understandings Sheet should show understanding of the engineering process. Sample answers are provided on answer sheet.

Building Structures Rubric

Category	4	3	2	1
Problem Solving	Actively looks for and suggests solutions to problems.	Refines solutions suggested by others.	Does not suggest or refine solutions but is willing to try other's solutions.	Does not try to solve problems or help others solve problems. Lets others do the work.
Contributions	Routinely provides useful ideas. Leader.	Occasionally provides useful ideas. Strong team leader.	Rarely provides useful ideas. A satisfactory team member.	Provides no useful ideas or refuses to participate.
Attitude	Never is publicly critical of the project or others. Positive attitude.	Rarely is publicly critical of the project or others. Often has a positive attitude.	Occasionally is publicly critical of the project or others. Sometimes has a positive attitude.	Often is publicly critical of the project or others. Has a negative attitude.
Focus on the Task	Constantly stays focused on task.	Mostly stays focused on task.	Hardly stays focused on task.	Rarely stays focused on task.
Working with others	Almost always listens and shares with others.	Mostly listens and shares with others.	Occasionally listens and shares with others.	Rarely or never listens and shares with others.
Comprehension of Concepts	Demonstrates understanding of concepts.	Demonstrates understanding of most concepts.	Demonstrates understanding of a few concepts.	No demonstration of understanding of concepts.

Total _____/24 Points

BUDGET SHEET

Building Structures: Can I make it work?

Your Budget: \$10.00

Name	Name	Name	Name
Item	Cost	Amount	Total
Craft Sticks	\$.50		
Paper Clips	\$.10		
Rubber Bands	\$.10		
Tubes	\$2.00		
Small Cup	\$1.00		
Large Cup	\$2.00		
Straws	\$.10		
Craft Foam	\$1.00		
Foil	\$2.00		
Toothpicks	\$.10		
Pipe Cleaner	\$1.00		
Card Stock	\$1.00		
		Grand Total	

Building Structures: Can I make it work?

Structure Cards

<p style="text-align: center;">Build a Rocket</p> <ul style="list-style-type: none"> • It must be at least 14 inches tall • It must have wings • It must stand alone 	<p style="text-align: center;">Build a Bridge</p> <ul style="list-style-type: none"> • It must have end supports • It must hold at least 20 pennies • The width must be at least 3 inches
<p style="text-align: center;">Build A Tower</p> <ul style="list-style-type: none"> • It must be at least 14 inches tall • It cannot be a rectangular prism • It must have a feature on top that holds 20 pennies 	<p style="text-align: center;">Build a Chair</p> <ul style="list-style-type: none"> • It must be at least 10 inches tall • It must rock • It must hold a bowl of 20 pennies
<p style="text-align: center;">Build a Piece of Playground Equipment</p> <ul style="list-style-type: none"> • It must either be 14 inches tall or 14 inches wide • It must have a feature that moves • It must “work” as demonstrated by a small toy figure 	<p style="text-align: center;">Build a Roller Coaster for a Marble</p> <ul style="list-style-type: none"> • It must be 14 inches high • It does not have to be free standing (it can lean or be fastened to something) • It must have a turn or a curve • It must have a tunnel • A marble should be able to be released at the top and travel smoothly to the bottom without falling off

Building Structures: Can I make it work?

Student Reflection Worksheet

Name _____	Structure _____
1. How did you determine which supplies to purchase?	2. Draw your design for your structure.
3. What was your job on your team?	4. What are some things that went well as you were building?
5. What are some things that did not go well as you were building?	6. What revisions did you make as you went along?
7. Was your team successful? How do you know?	8. Describe this building experience. Did it go well? What surprised you? What was the hardest part?

Building Structures: Can I make it work? Reflections and Understandings Sheet

1. Describe each phase of the engineering process:
 - a. Design

 - b. Build

 - c. Modify

2. How did you apply Design to your structure?

3. How did you apply Build to your structure?

4. How did you apply Modify to your structure?

5. What supplies did you choose and why?

6. What feature are you putting into your design so that it is recognizable?

7. What mistakes did you make along the way?

8. Were there supplies that you should have chosen but did not?

9. If you could trade one of the things you bought for something else would you? Why?

Building Structures: Can I make it work? Reflections and Understandings Sheet

1. Describe each phase of the engineering process:
 - a. **Design** Possible answers: considering material constraints; design the structure to be built

 - b. **Build** Possible answers: utilizing materials, create structure

 - c. **Modify** Possible answers: recognizing failures in design and build, redesign and build to new understanding. Repeat until satisfied with results.

2. How did you apply design to your structure? Possible answers: Sketch, material constraints

3. How did you apply Build to your structure? Possible answer: Built to design

4. How did you apply Modify to your structure? Possible answers: Modified as we went along, correcting design flaws

5. What supplies did you choose and why? Possible answers: Supplies for stability, design, recognizable traits

6. What feature are you putting into your design so that it is recognizable?
Answers will vary

7. What mistakes did you make along the way?
Answers will vary

8. Were there supplies that you should have chosen but did not?
Answers will vary

9. If you could trade one of the things you bought for something else would you? Why?
Answers will vary



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