What Floats Your Boat?
A Math/Science Integrated STEM activity

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Frederick County Public Schools - 3rd & 4th grade teachers
Project Goals

- To teach the lesson written in June 2014 with fidelity.
- To integrate math and science skills within a STEM activity.
- Improve students’ problem solving skills, thinking, and questioning.
- To facilitate communication between students through a problem solving process.
- To create additional lessons and activities that integrated math and science.
Targeted Objectives

**Science:** Given different materials, students will be able to design, and build a boat that will stay afloat as mass is added incrementally.

**Math:** Given materials of different costs and a budget of $5.00, students will be able to plan and calculate which materials are needed to build a boat without going over their budget.
Virginia Standards of Learning

**Science**
4.1 Scientific Investigation
   a) observations
   c) measurement
   e) predictions, inferences, & conclusions
   h) create a hypothesis
   i) data recording & evidence
   l) constructing models

**Math**
4.14 Data Analysis & Graphing
4.4b Adding & Subtracting Whole Numbers
4.5c Adding & Subtracting Decimals
4.6a Measure Mass
4.7a Measure Length
Process Integration with a Science Focus

Science
- hypothesis
- design
- data recording
- evidence
- observations
- engineering
- investigation
- evaluation
- predictions
- inferences

Math
- data
- graphing
- measurement
- money (decimals)
- addition
- subtraction
Summary of Lesson/Activities

1) Students brainstorm qualities a ship would have to float.
2) Students conduct an investigation to determine the buoyancy of different objects.
3) Students collect and purchase products they’d like to use to build a boat based on budget and qualities of a ship.
4) Students create a plan, illustrate, and construct their ship based on the materials they’ve selected.
5) Students measure the length of their ship and the mass.
6) Students predict and hypothesize the successfullness of their ship (How many gram stackers will it hold?).
7) Students will test their hypothesis.
8) Students record data and compare results with prediction. Students graph class data to compare all boats.
9) Students evaluate their results and critique their plan/model.
5E Structure of Lesson

ENGAGE:
- Use video or read aloud to build student interest and excitement.

EXPLORE:
- Students will be investigating objects which sink and float. They will record their data and hypothesis why some materials float or sink. They will use their findings later to design and construct a boat. Variables include materials and their shape.
- How does the shape of certain materials affect buoyancy? What does it mean for an object to have buoyancy?

EXPLAIN:
- Vocabulary to be introduced: hypothesis, observation, design, predictions, analyze, data, graphing, charts, inferences
- Questions for Students:
  1) Which materials would you use to build your boat and why?
  2) Which materials would you not use to build your boat and why?
  3) How will you use your observations from the sink and float activity to help you design a boat?
5E Structure of Lesson *continued*

**EXTEND:**
The students will use their observations to collaborate in order to design and construct a boat that will hold mass.

- The students will test the amount of mass their vessel will hold and gather data as evidence to either prove or disprove their hypothesis.
- The students will compare and contrast their results with those of other groups. Informal discussions should be held as students evaluate various designs.
- Students need to establish an understanding that there is a sequential process to be followed in problem solving: analyze the problem, design possible solutions, test the hypothesis and gather data to provide evidence to support the hypothesis and make changes as needed.

**EVALUATE:**
- How will students demonstrate that they have achieved the lesson objective?
  - post assessment
  - graph
  - reflection questions
  - student survey
Bloom’s Taxonomy

**Synthesis**

**Cognitive Verbs**
- Hypothesize
- Develop
- Design
- Construct
- Produce
- Plan
- Create
FCPS 4th Grade Students from Gainesboro, Greenwood Mill, and Orchard View Elementary Schools

<table>
<thead>
<tr>
<th></th>
<th>Gainesboro</th>
<th>Greenwood Mill</th>
<th>Orchard View</th>
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<tbody>
<tr>
<td><strong>Class Size</strong></td>
<td>21</td>
<td>24</td>
<td>23</td>
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<tr>
<td><strong>General Ed.</strong></td>
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<tr>
<td><strong>ESL</strong></td>
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</tbody>
</table>
Pre-Assessments

Pre-Assessment

1. You are asked to build a tower using craft sticks, glue, string, and one item of your choice. What would you do to design and build your tower?

   I would use cardboard for my item of choice and I would stack the cardboard vertically for four times. I would glue the cardboard pieces together and I would use craft sticks for the roof and use the string for accents for detail on the tower.

2. How can you organize data so that other people can easily understand it?

   I could make a step-by-step process and drawing on a piece of paper.

3. You have $5.00 to spend at the fair on games.

<table>
<thead>
<tr>
<th>Games</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>duck pond</td>
<td>$1.63</td>
</tr>
<tr>
<td>balloon pop</td>
<td>$1.21</td>
</tr>
<tr>
<td>basketball toss</td>
<td>$1.78</td>
</tr>
<tr>
<td>ring toss</td>
<td>$0.82</td>
</tr>
<tr>
<td>goldfish</td>
<td>$0.47</td>
</tr>
</tbody>
</table>

Which games can you play and how much money would you have left over?

You have enough to play all the games except for Goldfish.

Goldfish

Total:

\[
\begin{array}{c}
\text{duck pond: } 65 \\
\text{balloon pop: } 59 \\
\text{basketball toss: } 47 \\
\text{ring toss: } 47 \\
\text{goldfish: } 47 \\
\end{array}
\]
Boat Data Collection

Your team will design a boat that will hold the most mass. You have $5.00 to purchase materials.

Use the space below to draw and label your design for your boat. Be specific about how many of each item is needed as you create your drawing. Update your budget as you work so that you do not go over your $5.00 limit.

**Materials**
- aluminum foil: $1.00 per sheet
- plastic wrap: $1.00 per sheet
- craft sticks: $0.25 each
- string: $0.01 per cm
- tape: $0.05 per cm
- clay: $1.00 per piece
- glow sticks: $0.25 each
- paper clips: $0.10 each
- paper: $1.00 per sheet

*Sheets of aluminum foil and plastic wrap are 30cm x 25cm.
*Paper is standard computer-sized sheets.

**Budget**

- $5.00
- $0.50
- $2.50
- $1.00
- $0.25
- $0.10
- $0.05

**Drawings**

- [Diagram of boat design]

**Record your observations as you add mass to your boat:**

- It sank after 12 grams

**How close was your prediction? Explain.**

- My prediction was close because it was only 2 grams off.

**Reflections:**

- How do you think your boat did? What changes would you make based on your observations?

- I think our boat did ok. I would definitely make it bigger and use tinfoil to curve up the sides.
1. You are asked to build a tower using craft sticks, glue, string, and new item of your choice. What would you do to steep and build your tower?
   
   I would use the craft sticks for the shape of my tower and use the glue to stick the craft sticks together. Then I would use ball to give them and use my hammer to add the people too. And then use the string to wrap around the tower.

2. How can you organize data so that other people can easily understand it?
   
   One can put the data in a chart so people can easily understand it.

3. You have $5.00 to spend at the fair on games.

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   Which games can you play and how much money would you have left over? (You may play each game more than once.)

   $5.00 - $4.70 = $0.30

4. All day, 5 children played the duck pond, 7 children played the balloon pop, 4 played the basketball toss, 6 played the ring toss, and 8 played the goldfish game. In the space below, create a chart with this information. Then, on the provided graph paper, create a graph that displays this information.

   - Duck Pond
   - Basketball Toss
   - Ring Toss
   - Goldfish Game

5. Find the length and the height of the boat to the nearest centimeter.

<table>
<thead>
<tr>
<th>Boat</th>
<th>Length (cm)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sailboat</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>rowboat</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>float</td>
<td>2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

End of Unit Survey

1. Explain what your team was investigating.
   We were trying to make a boat that can float and hold mass

2. When you were designing your boat, why did you choose certain materials?
   Clay, so it would seal it.

3. In building your boat, what skills did you use?
   1. math
   2. science
   3. both

4. If you used math skills, what skills did you use?
   Multiplication
   Subtraction

5. If you used science skills, what skills did you use?
   Weight/ density

6. Did you have all the tools and materials you needed to create a boat that floated?
   1. yes
   2. no

7. If not, what other tools and materials would have helped you make your boat?

End of Unit Survey

1. Explain what your team was investigating.
   How many grains did different boats hold?

2. When you were designing your boat, why did you choose certain materials?
   We thought the material would help make the boat float

3. In building your boat, what skills did you use?
   1. math
   2. science
   3. both

4. If you used math skills, what skills did you use?
   Adding, measuring, money

5. If you used science skills, what skills did you use?
   The Scientific Method (sorta)

6. Did you have all the tools and materials you needed to create a boat that floated?
   1. yes
   2. no

7. If not, what other tools and materials would have helped you make your boat?
Lesson Challenges & Successes

Challenges

- Time constraints
- Budgeting money - scaffolding needed
- Communication skills between students - beginning of year (Oct.-Nov.)
- Explaining engineering process.

Successes

- Student engagement and excitement.
- Students who normally struggled had a chance to shine, which built their confidence.
- Students made connections between math and science.
- Post-test scores in one class increased by 20%.
- Problem solving abilities increased.
Next Steps

Since participating in the MSI Project, the teachers at FCPS have developed and taught additional project based lessons that have integrated not only math and science, but also Virginia Studies and Language Arts (reading, writing).

Students have been very receptive to this style of learning and it has created excitement and motivation to learn.