Survivor

TOPIC
Proportional Reasoning and Problem Solving

KEY QUESTION
How can you use a scale model to build a shelter based on three criteria?

LEARNING GOALS
Students will:
- Decide on a workable scale to create their shelter
- Use proportional thinking and engineering knowledge to create and test their shelter
- Make decisions about whether or not a solution meets the needs of a client
- Communicate the solution clearly to the client

GUIDING DOCUMENTS
This activity has the potential to address many mathematics standards, as well as address engineering principles. Please see pages 4-5 for a complete list of mathematics standards.

RECOMMENDED SUPPLIES FOR ALL MODEL-ELICITING ACTIVITIES
It is recommended to have all of these supplies in a central location in the room. It is recommended to let the students know that they are available, but not to encourage them to use anything in particular.

- Overhead transparencies and transparency markers/pens or whiteboards, or other presentation tools such as a document camera.
- Calculators
- Rulers, scissors, tape
- Markers, colored pencils, pencils
- Construction paper, graph paper, lined paper
- Paper towels or tissues (for cleaning transparencies)
- Manila folders or paper clips for collecting the students' work
- Optional: Computers with programs such as Microsoft Word and Excel

WHAT ARE MODEL-ELICITING ACTIVITIES (MEAs)?
Model-Eliciting Activities are problem activities explicitly designed to help students develop conceptual foundations for deeper and higher order ideas in mathematics, science, engineering, and other disciplines. Each task asks students to mathematically interpret a complex real-world situation and requires the formation of a mathematical description, procedure, or method for the purpose of making a decision for a realistic client. Because teams of students are producing a description, procedure, or method (instead of a one-word or one-number answer), students' solutions to the task reveal explicitly how they are thinking about the given situation.

THE Survivor MEA CONSISTS OF FOUR COMPONENTS:
1) **Video:** Students watch a video to become familiar with the context of the problem. This handout is on page 6.
2) **Readiness questions:** Students individually answer these reading comprehension questions about the newspaper article to become even more familiar with the context and beginning thinking about the problem. This handout is on page 6.
3) **Problem statement:** In teams of three or four, students work on the problem statement for 45 – 90 minutes. This time range depends on the amount of self-reflection and revision you want the students to do. It can be shorter if you are looking for students' first thoughts, and can be longer if you expect a polished solution and well-written letter. The handouts are on pages 7.
4) **Process of sharing solutions:** Each team writes their solution in a letter or memo to the client. Then, each team presents their solution to the class. Whole class discussion is intermingled with these presentations to discuss the different solutions, the mathematics involved, and the effectiveness of the different solutions in meeting the needs of the client.

In totality, each MEA takes approximately 2-3 class periods to implement, but can be shortened by having students do the individual work during out-of-class time. The Presentation Form can be useful and is explained on page 4 and found on page 9.

RECOMMENDED PROGRESSION OF THE Survivor MEA

While other implementation options are possible for MEAs, it is recommended that the MEA be implemented in a cooperative learning format. Numerous research studies have proven cooperative learning to be effective at improving student achievement, understanding, and problem solving skills. In this method students will complete work individually (Video and readiness questions; as well as initial thoughts on the problem statement) and then work together as a group. This is important because brainstorming works best when students have individual time to think before working as a group. Students can be graded on both their individual and group contributions. Social skills' discussion at the beginning of the MEA and reflection questions at the end of the MEA are also essential aspects of cooperative learning.

Social Skills (3 -5 minutes)
Students must be taught how to communicate and work well in groups. Several social skills that are essential to group work are decision-making, asking questions, and communicating and listening. The teacher can show part of a YouTube video and discuss aspects of these skills before beginning the MEA. (http://www.youtube.com/user/flowmathem atics)

Video and Readiness Questions:
The purpose of the video and the readiness questions is to introduce the students to the context of the problem.

(10 minutes): Give the video link and the questions to the students the day before for homework. Then, in the next class, discuss as a class the answers to the readiness questions before beginning to discuss the problem statement.

Problem Statement:
You may want to read the problem statement to the students and then identify as a class: a) **the client that the students are working for** and b) **the product that the students are being asked to produce**. Once you have addressed the points above, allow the students to work on the problem statement. Let the students know that they will be sharing their solution to the rest of the class. Tell students you that you will randomly pick a group member to present for each group. Tell the students that they need to make sure that everyone understands their group's solution so they need to be sure to work together well. The group member who will present can be picked by assigning each group member a number.

Working on the Problem Statement (35-50 minutes)**:** Place the students in teams of three or four. Students should begin to work by sharing their initial ideas for solving the problem. If you already use teams in your classroom, it is best if you continue with these same teams since results for MEAs are better when the students have already developed a working relationship with their team members. If you do not use teams in your classroom and classroom management is an issue, the teacher may form the teams. If classroom management is not an issue, the students may form their own teams. You may want to have the students choose a name for their team to promote unity.

> *Teachers' role:* As they work, your role should be one of a facilitator and observer. Avoid questions or comments that steer the students toward a particular solution. Try to answer their questions with questions so that the student teams figure out their own issues. Also during this time, try to get a sense of how the students are solving the problem so that you can ask them questions

about their solutions during their presentations.

Presentations of Solutions (15-30 minutes)**:** The teams present their solutions to the class. There are several options of how you do this. Doing this electronically or assigning students to give feedback as out-of-class work can lessen the time spent on presentations. If you choose to do this in class, which offers the chance for the richest discussions, the following are recommendations for implementation. Each presentation typically takes $3 - 5$ minutes. You may want to limit the number of presentations to five or six or limit the number of presentations to the number of original (or significantly different) solutions to the MEA.

Before beginning the presentations, encourage the other students to not only listen to the other teams' presentations but also to a) ***try to understand the other teams' solutions*** and b) ***consider how well these other solutions meet the needs of the client.*** You may want to offer points to students that ask 'good' questions of the other teams, or you may want students to complete a reflection page (explanation – page 4, form – page 9) in which they explain how they would revise their solution after hearing about the other solutions. As students offer their presentations and ask questions, whole class discussions should be intermixed with the presentations in order to address conflicts or differences in solutions. When the presentations are over, collect the student teams' memos/letters, presentation overheads, and any other work you would like to look over or assess.

ASSESSMENT OF STUDENTS' WORK
You can decide if you wish to evaluate the students' work. If you decide to do so, you may find the following Assessment Guide Rubric helpful:

Performance Level Effectiveness: Does the solution meet the client's needs?

Requires redirection*:* The product is on the wrong track. Working longer or harder with this approach will not work. The students may need additional feedback from the teacher.

Requires major extensions or refinements*:* The product is a good start toward meeting the client's needs, but a lot more work is needed to respond to all of the issues.

Requires editing and revisions*:* The product is on a good track to be used. It still needs modifications, additions or refinements.

Useful for this specific data given, but not shareable and reusable OR Almost shareable and reusable but requires minor revisions*:* No changes will be needed to meet the immediate needs of the client for this set of data, but not generalized OR Small changes needed to meet the generalized needs of the client.

Share-able or re-usable*:* The tool not only works for the immediate solution, but it would be easy for others to modify and use in similar situations. OR The solution goes above and beyond meeting the immediate needs of the client.

IMPLEMENTING AN MEA WITH STUDENTS FOR THE FIRST TIME
You may want to let students know the following about MEAs:
- MEAs are longer problems; there are no immediate answers. Instead, students should expect to work on the problem and gradually revise their solution over a period of 45 minutes to an hour.
- MEAs often have more than one solution or one way of thinking about the problem.
- Let the students know ahead of time that they will be presenting their solutions to the class. Tell them to prepare for a 3-5 minute presentation, and that they may use overhead transparencies or other visuals during their presentation.

- Let the students know that you won't be answering questions such as "Is this the right way to do it?" or "Are we done yet?" You can tell them that you will answer clarification questions, but that you will not guide them through the MEA.
- Remind students to make sure that they have returned to the problem statement to verify that they have fully answered the question.
- If students struggle with writing the letter, encourage them to read the letter out loud to each other. This usually helps them identify omissions and errors.

OBSERVING STUDENTS AS THEY WORK ON THE Survivor MEA

You may find the Observation Form (page 8) useful for making notes about one or more of your teams of students as they work on the MEA. We have found that the form could be filled out "real-time" as you observe the students working or sometime shortly after you observe the students. The form can be used to record observations about what concepts the students are using, how they are interacting as a team, how they are organizing the data, what tools they use, what revisions to their solutions they may make, and any other miscellaneous comments.

PRESENTATION FORM (Optional)

As the teams of students present their solutions to the class, you may find it helpful to have each student complete the presentation form on page 9. This form asks students to evaluate and provide feedback about the solutions of at least two teams. It also asks students to consider how they would revise their own solution to the Survivor MEA after hearing of the other teams' solutions.

STUDENT REFLECTION FORM

Common Core Math Standards

3. MD.7.**b**   Relate area to the operations of multiplication and addition. Multiply side lengths to find areas of rectangles with whole- number side lengths in the context

You may find the Student Reflection Form (page 10) useful for concluding the MEA with the students. The form is a debriefing tool, and it asks students to consider the concepts that they used in solving the MEA and to consider how they would revise their previous solution after hearing of all the different solutions presented by the various teams. Students typically fill out this form after the team presentations.

STANDARDS ADDRESSED
NCTM MATHEMATICS STANDARDS

Numbers and Operations:
- Understand and use ratios and proportions to represent quantitative relationships
- Judge the reasonableness of numerical computations and their results

Algebra
- Relate and compare different forms of representation for a relationship
- Draw reasonable conclusions about a situation being modeled

Measurement
- Analyze precision, accuracy, and approximate error in measurement situations

Problem Solving
- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving

Communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Analyze and evaluate the mathematical thinking and strategies of others

Connections
- Recognize and apply mathematics in contexts outside of mathematics

Representation
- Use representations to model and interpret physical, social, and mathematical phenomena

of solving real world and mathematical problems, and represent whole-number products as rectangular areas in mathematical reasoning.

5. NF.5a Interpret multiplication as scaling (resizing), by: a. Comparing the size of a product to the size of

one factor on the basis of the size of the other factor, without performing the indicated multiplication.

5. MD. 3   Recognize volume as an attribute of solid figures and understand concepts of volume measurement.
a.   A cube with side length 1 unit, called a "unit cube," is said to have "one cubic unit" of volume, and can be used to measure volume.
b. A solid figure which can be packed without gaps or overlaps using n unit cubes is said to have a volume of n cubic units.

6.RP.1   Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."

7.RP. Analyze proportional relationships and use them to solve real-world and mathematical problems.

Standards for Mathematical Practices integration with MEAs

Mathematical Practice	How it occurs in MEAs
1. Make sense of problems and persevere in solving them.	As participants work through iterations of their models they continue to gain new insights into ways to use mathematics to develop their models. The structure of MEAs allows for participants to stay engaged and to have sustained problem solving experiences.
2. Reason abstractly and quantitatively	MEAs allow participants to both contextualize, by focusing on the real world context of the situation, and
	decontextualize by representing a situation symbolically.
3. Construct viable arguments and critique the reasoning of others.	Throughout MEAs while groups are working and presenting their models.
4. Model with mathematics.	This is the essential focus of MEAs; for participants to apply the mathematics that they know to solve problems in everyday life, society, or the workplace. This is done through iterative cycles of model construction, evaluation, and revision.
5. Use appropriate tools strategically.	Materials are made available for groups as they work on MEAs including graph paper, graphing calculators, computers, applets, dynamic software, spreadsheets, and measuring devices.
6. Attend to precision.	Precise communication is essential in MEAs and participants develop the ability to communicate their mathematical understanding through different representations including written, verbal, symbolic, graphical, pictorial, concrete, and realistic.
7. Look for and make use of structure.	Participants in MEAs can use their knowledge of mathematical properties and algebraic expressions to develop their solutions.
8. Look for and express regularity in repeated reasoning.	As participants develop their models the patterns they notice can assist in their model development.

Video Questions (https://www.youtube.com/watch?v=V7J5_Ds5Xf4)

1. What things would you have to consider when building a shelter?

2. How would you describe the rain in Costa Rica?

3. If you have ever seen Survivor would you consider going on the show?

4. What is the benefit of building a scale model?

Survivor Model-Eliciting Activity

Problem Statement

Survivor returns to Costa Rica and Mark Burnett, the producer of Survivor, has decided to give survivors the materials to build a shelter as a reward for a challenge. He wants to provide materials to make the shelter as realistic as possible to one that the survivors of a plane crash might build. He will be providing a strip of metal supposedly from a plane, tarp from the rescue raft, rope that has washed ashore and of course mud from the island. To determine who will be the contestants on the show he wants to see who can design the best scale model of a shelter. The shelter must fit three people and withstand both wind and rain. Design a quality shelter and your team could be on the next show of survivor!

Your shelter must:

- Not move, tip or be damaged when given three gusts of wind simulated by fanning a clipboard
- Remain dry when given three squirts of water to simulate rain
- Have enough room to fit three people with at least 1 cubic meter of space

Before building your scale model decide on a scale that you will use to determine how much of each material that you will use. For example, if your scale was 1 meter:2cm, then you would have 20 craft sticks that are 6 cm long.

Actual materials that will be provided on the island	Materials that you will be given
Logs (20 logs, 3 meters long each) 　　　(Total of 60 meters)	Craft sticks: 20 sticks of length ____cm: Total of _____cm
Plane siding (2.5 meters x 4 meters)	Aluminum foil: ____ cm x ____ cm
Tarp (1 piece 3 meters x 5 meters)	Wax paper: ____cm x ____ cm
Rope (6 meters)	String: ____ cm
Mud (1 bucket with 1 cubic meter (m^3)(1m x 1m x 1m)	Playdough: __ cm x___cm x___cm

After designing and testing the shelter write Mark Burnett a letter describing why your shelter is the best. Include in the letter the design for the shelter, the materials that you used, and general guidelines for how to make scale models for any purpose.

OBSERVATION FORM FOR TEACHER - Survivor MEA

Team: _____

STEM (Science, Technology, Engineering, & Mathematics) Concepts Used:
What STEM concepts and skills did the students use to solve the problem?

Team Interactions:
How did the students interact within their team or share insights with each other?

Data Organization & Problem Perspective:
How did the students organize the problem data? How did the students interpret the task? What perspective did they take?

Tools:
What tools did the students use? How did they use these tools?

Miscellaneous Comments about the team functionality or the problem:

Cycles of Assessment & Justification:
How did the students question their problem-solving processes and their results? How did they justify their assumptions and results? What cycles did they go through?

PRESENTATION FORM – Survivor MEA

Name_____

While the presentations are happening, choose TWO teams to evaluate. Look for things that you like about their solution and/or things that you would change in their solution. You are not evaluating their style of presenting. For example, don't write, "They should have organized their presentation better." Evaluate their solution only.

Team _____

What I liked about their solution:

What I didn't like about their solution:

Team _____

What I liked about their solution:

 What I didn't like about their solution:

After seeing the other presentations, how would you change your solution? If you would not change your solution, give reasons why your solution does not need changes.

STUDENT REFLECTION FORM – Survivor MEA

Name _____ Date_____

1. What mathematical or scientific concepts and skills (e.g. ratios, proportions, forces, etc.) did you use to solve this problem?

2. How well did you understand the concepts you used?

Not at all   A little bit   Some   Most of it   All of it

Explain your choice:

3. How well did your team work together? How could you improve your teamwork?

4. Did this activity change how you think about mathematics?

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