TOPIC
Sports, Data Analysis, Probability and Statistics, Communication, and Problem Solving

KEY QUESTION
How do you develop a procedure for deciding which basketball team is better when the teams played in different decades?

LEARNING GOALS
Students will:
• Use dotplots, histograms, boxplots, and measures of center and variation to decide which basketball team is better.
• Consider how to use and exclude data
• 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 and science standards. Please see pages 4-7 for a complete list of mathematics and science 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, whiteboards and markers, posterboards, or other presentation tools such as a document camera.
• Calculators
• Rulers
• Markers, colored pencils, pencils
• 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 ALUMINUM BATS MEA CONSISTS OF FOUR COMPONENTS:
1) Newspaper article: Students individually read the newspaper article to become familiar with the context of the problem. This handout is on pages 8-9.
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 10.
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 11.
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 14.

**RECOMMENDED PROGRESSION OF THE DREAM TEAM 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 (Newspaper article 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/flowmathematics)

**Newspaper Article and Readiness Questions:**

The purpose of the newspaper article and the readiness questions is to introduce the students to the context of the problem.

(10 minutes): Give the article 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 14) 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 DREAM TEAM MEA
You may find the Observation Form (page 13) 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 14. 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 Aluminum Bats MEA after hearing of the other teams’ solutions.

STUDENT REFLECTION FORM
The Student Reflection Form (page 15) is a useful way 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.

NRC SCIENCE STANDARDS

Inquiry
- Use appropriate tools and techniques to gather, analyze and interpret data
- Develop descriptions, explanations, predictions, and models using evidence
- Think critically and logically to make the relationships between evidence and explanations
- Recognize and analyze alternative explanations and predictions
- Communicate scientific procedures and explanations
- Use mathematics in all aspects of scientific inquiry
- Use technology and mathematics to improve investigations and communications
- Communicate and defend a scientific argument

ABILITIES OF TECHNOLOGICAL DESIGN
- Identify appropriate problems for technological design.
- Design a solution or product.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY
- Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.
- Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.
Common Core Math Standards

- 5 MD-2: represent and interpret data
- 6 SP-2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.
- 6 SP-3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.
- 6 SP-4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- 6 SP-5 Summarize numerical data sets in relation to their context, such as by:
  a. Reporting the number of observations.
  b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
  c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.
  d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

7-SP-3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.

7-SP-4 Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.

- High School S-ID Summarize, represent, and interpret data on a single count or measurement variable.
  1. Represent data with plots on the real number line (dot plots, histograms, and box plots).
  2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
  3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

- High school S-IC-1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
### Standards for Mathematical Practices integration with MEAs

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<thead>
<tr>
<th>Mathematical Practice</th>
<th>How it occurs in MEAs</th>
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<tr>
<td>1. Make sense of problems and persevere in solving them.</td>
<td>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.</td>
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<td>2. Reason abstractly and quantitatively</td>
<td>MEAs allow participants to both contextualize, by focusing on the real world context of the situation, and decontextualize by representing a situation symbolically.</td>
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<td>3. Construct viable arguments and critique the reasoning of others.</td>
<td>Throughout MEAs while groups are working and presenting their models.</td>
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<td>4. Model with mathematics.</td>
<td>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.</td>
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<td>5. Use appropriate tools strategically.</td>
<td>Materials are made available for groups as they work on MEAs including graph paper, graphing calculators, computers, applets, dynamic software, spreadsheets, and measuring devices.</td>
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<td>6. Attend to precision.</td>
<td>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.</td>
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<td>7. Look for and make use of structure.</td>
<td>Participants in MEAs can use their knowledge of mathematical properties and algebraic expressions to develop their solutions.</td>
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<td>8. Look for and express regularity in repeated reasoning.</td>
<td>As participants develop their models the patterns they notice can assist in their model development.</td>
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Is the 1992 US Olympic Dream Team better than the 2012 version with Kobe Bryant and LeBron James?

By Tim Morrissey  The Daily Telegraph

The 1992 Dream Team headlined by Michael Jordan, Magic Johnson and Larry Bird is considered the greatest team assembled in any sport. Twenty years ago in Barcelona, they put on a show the world will never forget. But are they better than today's generation of NBA superstars? It's the debate that even has the world's most powerful man taking sides. Which team is better: the original Dream Team or the 2012 version led by Kobe Bryant, Lebron James and Kevin Durant?

The Los Angeles superstar ignited this classic debate last week when Bryant declared the 2012 US men's basketball team for the London Games would beat the "Dream Team." "Well, just from a basketball standpoint, they obviously have a lot more size than we do - you know, with (David) Robinson and (Patrick) Ewing and (Karl) Malone and those guys," Bryant said this week. "But they were also - some of those wing players - were also a lot older, at kind of the end of their careers. We have just a bunch of young racehorses, guys that are eager to compete. It'd be a tough one, but I think we'd pull it out."

Jordan for one reckons that someone should tell Kobe he's dreaming. "For him to compare those two teams is not one of the smarter things he ever could have done," Jordan said.
US president Barrack Obama agreed while watching Bryant and the 2012 team stumble their way to an 80-69 win over Brazil in an exhibition game on Tuesday. On NBA championships alone the '92 team smashes this year's squad by a score of 22-7. Add to the mix the original cast boasted 11 NBA Hall of Famers and an average winning margin of 43 points on the way to Barcelona gold while the current "dream-on" team has just three future Hall of Famer locks.

After Bryant threw down the gauntlet other members of the original Dream Team rose out of their walking frames to weigh into the debate. Jordan's Chicago Bulls teammate Scottie Pippen declared his team would win by 25 points. Fellow '92er Charles Barkley joined the condescension by brushing aside the age factor and claiming only three 2012 players -- Bryant, the Heat's LeBron James and the Thunder's Kevin Durant -- would have even made the 1992 U.S. roster.

"How old is Kobe Bryant? He's 34? And he's calling us old? At the time, we were only like 28, 29. Michael Jordan and me were the same age. We were both 29," Barkley said. "Other than Kobe, LeBron (James) and Kevin Durant, I don't think anybody else on (the 2012) team makes our team." Boston Celtics legend Larry Bird may have ended the debate with this gem. When asked if the 2012 club could pull the upset, Bird said, "They probably could. I haven't played in 20 years and we're all old now."

As Dream Team version 2012 -- with a salary bill of more than $150 million a year with their NBA clubs -- touched down in Manchester point guard Chris Paul took a more diplomatic tone with comparisons. "Man, you know we try not to compare ourselves too much to tell you the truth," Paul said.

Readiness Questions

1. What is your favorite sport in the Olympics?

2. What would be a good way to decide which dream team, the 1992 or the 2012, would win in a game of basketball?

3. What basketball statistics are the most important for contributing to a team winning?

4. If given the two teams basketball statistics, what type of graphs or calculations could you use to compare the two teams?
**Problem Statement**

Kobe Bryant of the 2012 dream team and Michael Jordan of the 1992 dream team would like your help to decide which team was better. They have compiled the basketball statistics for both teams. Since the 1992 players are all out of the NBA (National Basketball Association) it would not be fair to use their statistics for their entire careers in the NBA since the 2012 players are still playing. It was agreed that the data set for the 1992 players' would just be their statistics up until the year, 1992, when they played in the Olympics. This way a more equal comparison can be made.

Using the data provided and the *Tinkerplots* program you need to come up with at least four statements that support either the 1992 team or the 2012 team being better. Your statements should be supported with boxplots, histograms, dotplots, and measures of center or spread. Use the definitions of the basketball statistics as a refresher if necessary. Also, give general guidelines to tell how one team is better than another team in case this debate would occur with different teams in the future.
Basketball Definitions

Games played: Number of games a player participated in.

Minutes: The amount of time a player was on the basketball court during a game.
Point: When a player scores either from freethrows (1 point) a regular shot (2 points) or a shot from a longer distance behind the three point line (3 points)

Rebounds: When a player grabs a ball that is coming off the rim or backboard after a shot attempt.
Offensive Rebound: A rebound of a team’s own missed shot.
Defensive Rebound: A rebound of the other team’s missed shot.
Assists: The last pass to a teammate that leads directly to a field goal.
Steals: When a defensive player legally causes a turnover by his or her positive, aggressive action.
Blocks: The successful deflection of a shot by touching part of the ball on its way to the basket.
Field Goals Percentage: The number of field goals made divided by the number of field goals attempted.
Free Throws Percentage: The number of free throws made divided by the number of free throws attempted.
Three-point Field Goals Percentage: The number of three-point field goals made divided by the number of three-point field goals attempted.
Field Goals Made: The number of times a player gets the ball through the basket from a 2 point shot or a 3 point shot.
Field Goals Attempted: The number of times a player attempts to get the ball through the basket from a 2 point shot or a 3 point shot.
Free Throw: An unguarded shot taken from the foul line. It is worth 1 point
Free Throws Made: The number of times a player makes a 1 point shot.
Free Throws Attempted: The number of times a player attempts a 1 point shot.
Three-point Field Goals Made: The number of times a player makes a 3 point shot.
Three-point Field Goals Attempted: The number of times a player attempts a 3 point shot.
Turnovers: When the team with the ball loses possession through its own fault.
Foul: Actions by players which break the rules by illegally contacting a player on the other team.

You can also look at these categories: __________per game: This is on average what a player would do for one game. For example, if a player had 80 rebounds in 20 games, they would average 4 rebounds per game.
OBSERVATION FORM FOR TEACHER - Dream Team 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 – Dream Team 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 – Dream Team 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?