Web Unit Plan

Title: Play Ball!

Description: From slugging percentages to earned run averages (ERAs), students explore the mathematics of baseball using spreadsheets and create an informative presentation that makes the national pastime even more enjoyable for its fans.

At a Glance

Grade Level: 7–10

Subject sort (for Web site index): Math

Subject: Statistics

Topics: Comparative Analysis

Higher-Order Thinking Skills: Analysis, Investigation

Key Learnings: Data Analysis, Graphing Statistics, Comparing Means

Time Needed: 2–3 weeks, 1-hour lessons, 4–5 times per week

Background: From the Classroom in Florida, United States

Unit Summary

The first box score was printed in 1845, and ever since, people have calculated and analyzed baseball statistics. Not everyone understands the numerical joys of the sport. Therefore, your class has been hired by the Major League Baseball Commissioner to explain the mathematics of baseball so more people can appreciate the game. The class compares statistics, such as batting averages and earned run averages, and analyzes the speed of pitches, the shape of the diamond, and the distances players cover. Finally, the class develops a presentation that explains an aspect of these topics, making the national pastime more enjoyable for all.

Curriculum-Framing Questions

- **Essential Question**
  How can we use mathematics to help us understand daily life?

- **Unit Questions**
  How do numbers make our games more fun?
  How do statistics help us understand the game of baseball?
  How can we use statistics to help make decisions?

- **Content Questions**
  What is the difference between a player's batting average and slugging average?
  Why is information often presented in graphs instead of just in a list or table?
  How do you choose the appropriate graphical representations for certain sets of data?

Assessment Processes

View how a variety of student-centered assessments are used in the Play Ball! Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Introduction (1 day)

The Essential Question, *How can we use mathematics to help us understand daily life?* can be used as a yearlong theme. Keep referring to it as you introduce new mathematical topics. Pose the question again as you begin this unit on baseball. To tap students' prior knowledge, conduct a class discussion about how math helps us understand our world. More than likely, students will bring up the topic of sports in relation to math. Guide the discussion by asking students the following questions:

- *How do numbers make our games more fun?*

- *How do statistics help us understand the game of baseball?*

- *What would baseball be like without statistics?*

Starting with students' prior experiences, discuss why baseball is called "America's pastime." Engage in vocabulary and writing activities to develop a shared interest in the topic. Tap into students' prior knowledge about the game of baseball by having them brainstorm as many words and ideas as they can that they associate with baseball. Give students about one minute to brainstorm on their own, and then have students share concepts with the whole class. Give historical background and introduce the importance of statistics as a feature of baseball. Give students a baseball trading card to look at, and discuss what they understand about the statistics shown on the back. For a review of baseball statistics definitions and formulas, view the [Baseball Almanac Web site](#)*.

Develop the following scenario for students:

> We have been hired by the Major League Baseball Commissioner to explain the mathematics of baseball so more people can appreciate the game. Your job is to analyze a variety of statistics related to baseball and then use what you have learned to publish an explanation of some aspect of baseball statistics, so people can get greater enjoyment from the game. You will use spreadsheets to make calculations using equations and visually analyze data.

Investigating Statistics (6 or 7 days)

Batting Averages: Starting with the question, *Who is the greatest hitter of all time?* teach the statistics of batting averages, home runs, and runs batted in (RBI). To explore batting averages, students take data from the [Batting Averages Table](#) showing the statistics of four players and create a scatter graph in a spreadsheet program showing how the averages change over time. Have students analyze the graph, looking for strength and consistency over time, to determine the relative value of players. After this investigation is completed, have students share their thoughts about the Content Questions, *Why is information often presented in graphs instead of just in a list or table?* and *How do you choose the appropriate graphical representations for certain sets of data?*

Slugging Percentage: Discuss batting averages and how batting can be analyzed more deeply. To decide who is more important to winning baseball games, show students how to compare batting averages to slugging percentages using the [slugging table](#) worksheet and [slugging answer key](#). Ask students to discuss what this statistic seems to calculate. Make sure students conclude that

the slugging percentage tells the average number of bases a player advances for each time at bat. Have students discuss the difference between a player's batting average and slugging percentage.

On-Base Percentage: Explain how this statistic shows the percentage of time a player can be expected to reach base safely by either a hit or walk. To calculate this number, divide the total times a player reaches base safely by their total at bats. Present the Player Comparison sheet to students and ask them to recommend the best player for a team they are managing. Students should back up their choice using data.

Earned Run Average (Pitching): Begin the study of pitching by comparing the number of wins a pitcher has using the All-Time Winning Pitchers (Active) sheet. Discuss the factors influencing the number of wins, and the concept and computation of the earned run average (ERA). Students pretend to be a team manager comparing pitchers, and compute the ERAs of the all-time winning pitchers. Using the statistics, have students create a bar graph, determine who is best, and defend their reasoning. Students with more knowledge of baseball may want to consider other pitching factors as well.

Physical Dimensions: Discuss the physical dimensions of baseball, such as the throwing distance from third to first base, the size of the strike zone, and pitching speed. Have students complete a baseball treasure hunt assignment to practice research and math skills needed to solve real baseball problems. Students can check their answers using the treasure hunt answer key.

Preparing and Giving the Presentation (3 or 4 days)

Have each student team begin their research and create a slideshow presentation that shows the math of baseball and helps the audience appreciate the numerical joys of the sport. Allow students to choose the type of baseball data they want to research—active or non-active players; male or female; local, national, or international leagues; and so on. A list of topics might include:

- Compare player statistics and salaries

- Compare the performance of two players during any year

- Evaluate the greatest hitters of all time

- Compare and contrast a group of players' individual statistics

- Highlight a recent game's statistics

Discuss the qualities of a good presentation in terms of content, organization, visual presentation, and attention to the audience. Review the baseball presentation scoring guide with students before students begin researching and developing their presentations. Check for student understanding before students get started. Teach the presentation software tools, and designate student experts to help. This phase of the project may take several extra days, depending on the experience of your students. View an example of a student presentation.

Each team's presentation should include:

- Introduction to how statistics helps us understand the game of baseball

- Overview of the topic—each student team poses an investigative question

- Important statistics evaluated by the team and why

- Justification of the team's position using data and graphs
- Conclusion
- Citation of sources

Meet with groups periodically to check for understanding and monitor progress among individuals in the group.

Have students get peer feedback to get suggestions and feedback on their presentations using the peer feedback form. After students have received feedback, have them incorporate the suggestions into their presentations before the final presentations are handed in.

Wrapping Up

Set aside a day for students to present their findings. Encourage audience members to take notes and generate questions to ask the students after each team presentation. Give students the opportunity to express relevant observations. Ask students to reflect on the Essential Question, *How can we use mathematics to help us understand daily life?* Have students discuss the question in relation to the Play Ball! unit and share their ideas with a partner.

Prerequisite Skills

- Experience researching on the Internet
- Knowledge of spreadsheets, graphing tools, and presentation applications
- Understanding of percent, decimal, and fractions

Differentiated Instruction

Resource Student

- As students work in pairs or groups, establish rules so all students participate
- Demonstrate the use of spreadsheets to perform all calculations
- Provide step-by-step instructions
- Reduce the number of players and calculations considered

Gifted Student

- Encourage the student to consider more challenging problems, such as who is the greatest hitter of all time using a variety of statistics; the physics of the curve ball; how *sabermetrics*, the statistics of baseball, is used to predict who will win a game; and so on
- Have the student present information on an interactive Web site that includes graphics and information

English Language Learner

- Ask the ELL support teacher to help the student develop a glossary of terms in both English and the student's first language
- Enlist the help of bilingual students to help with translation and interpretation of concepts
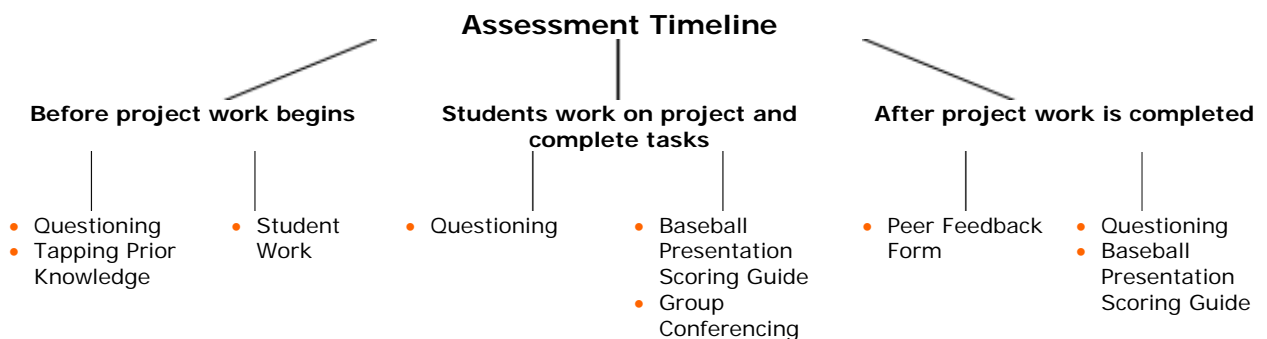- Allow for visual representations to reduce the language load

- Allow the student to write in the student's first language for later translation

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Credits

Belinda Dukes participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

THINGS YOU NEED (highlight box)

Assessment Plan

Assessment Timeline

Before project work begins	Students work on project and complete tasks	After project work is completed
• Questioning • Tapping Prior Knowledge	• Student Work	• Questioning	• Baseball Presentation Scoring Guide • Group Conferencing	• Peer Feedback Form	• Questioning • Baseball Presentation Scoring Guide

Informal questioning takes place throughout the unit to promote higher-order thinking and engage students in discussion. Brainstorming baseball topics helps to tap prior knowledge and assess students' understanding of concepts being taught. Use student work, such as spreadsheets and graphs, to assess student progress. Reteach any skills that are not visible in student work.

Students are assessed based on thoughtful participation in group discussions, completion and quality of statistical activities, and on their final presentation. Conferencing with groups during work sessions provides an opportunity to answer questions and monitor progress to ensure student success. The peer feedback form provides documentation for the revision process and allows for student accountability. Students use the baseball presentation scoring guide to meet expectations for the project. Use the same scoring guide to assess the final presentations.

Targeted Content Standards and Benchmarks

Targeted National Content Standards
NCTM Principles and Standards for School Mathematics Grades 6-8

Data Analysis

- Formulate questions, design studies, and collect data about a characteristic shared by two populations or different characteristics within one population

- Select, create, and use appropriate graphical representations of data, including histograms, box plots, and scatter plots

Algebra

- Develop an initial conceptual understanding of different uses of variables

- Model and solve contextualized problems using various representations, such as graphs, tables, and equations

Number and Operations

- Work flexibly with fractions, decimals, and percents to solve problems

- Understand and use ratios and proportions to represent quantitative relationships

- Select appropriate methods and tools for computing with fractions and decimals from among mental computation, estimation, calculators or computers, and paper and pencil, depending on the situation, and apply the selected methods

Student Objectives:

Students will be able to:

- Use mathematics to solve real-world problems
- Display and analyze data using bar graphs and tables
- Compute and compare averages
- Convert and compare fractions, decimals, and percentages
- Use order of operations to compare formulas
- Use formulas to calculate averages
- Research relevant information, and synthesize it into reports
- Use presentation tools to organize and portray information
- Use spreadsheets to analyze and display data
- Work cooperatively to organize and present information
- Choose appropriate scales to display data accurately

Materials and Resources

Printed Materials

- Davis, S., & Stephens, S. (1997). *The sporting life (the accidental scientist).* New York: Henry Holt and Company.

- Flatow, I. (1989). *Rainbows, curveballs, and other wonders of the natural world explained*. New York: Harper and Row.

- Gregorich, B. (1993). *Women at play: The story of women in baseball*. San Diego, CA: Harcourt Brace and Company.

- Johnson, S. E. (1994). *When women played hardball*. Seattle, WA: Seal Press.

- Light, J. (1997). *The cultural encyclopedia of baseball.* Jefferson, NC: McFarland & Co.

- Scheidt, T. (1994). *Fantasy baseball*. Jamul, CA: Giant Step Press.

- Thorn, J., Palmer, P., & Gershman, M. (Eds.). (2001). *Total baseball: The official encyclopedia of major league baseball*, 7th edition. New York: Total Sports.

Supplies
- Baseball cards
- Newspaper sports pages
- *The Sporting News*
- *Sports Illustrated*

Internet Resources
- Major League Baseball
  www.mlb.com*
  Resource for player statistics
- Sports Illustrated
  http://sportsillustrated.cnn.com/baseball*
  Statistics, schedules, scores
- ESPN Baseball
  http://sports.espn.go.com/mlb/statistics?season=2&year=2004*
  Statistics calculator and lots of great quotes, history, and anecdotes
- Exploratorium
  www.exploratorium.edu/baseball*
  Science of baseball explained and illustrated
- Baseball-Reference
  www.baseball-reference.com*
  Player and team references
- Baseball Almanac
  http://baseball-almanac.com/stats.shtml*
  Definitions and calculations for offensive statistics
- An Introduction to Sabermetrics
  www-math.bgsu.edu/~albert/papers/saber.html*
  Introduction to the mathematical and statistical analysis of baseball records
- Ken Burns on PBS
  www.pbs.org/kenburns/baseball*
  Lessons integrating the theme of baseball across the curriculum
- Learning from Baseball
  www.teachersfirst.com/baseball.htm*
  Collection of baseball-related lessons from around the Web
- All-American Girls Professional Baseball League
  www.aagpbl.org*
  History, photos, and biographies

Microsoft Encarta* 2001/Online
- Sources include Baseball Field, Baseball Diamond, Baseball Scorecard, Baseball Contents, Baseball Pictures, How Baseball is Played, and History of Baseball

Technology—Hardware
- Internet connection for independent research

Technology—Software
- Spreadsheet software for performing statistical calculations and creating graphs

- Multimedia software to create final presentations