Chicago Cubs STEAM Fair

Student Project Guidelines

April 30, 2022

Pacing Plan

Objective

To complete STEAM projects for the Cubs STEAM Fair on April 30th, presented by Horizon. If you have further questions please contact Carly Stevens at carly@sciencesport.org.

Timeline

The following schedule is recommended:

Week 1: Review project objectives, assign projects

Students should be presented with the four recommended project ideas provided and either choose one of them to create or use an existing project that they have been working on this year. The project does not have to focus on baseball or softball examples, we just wanted to make sure to provide some unique ideas. assigned one of them or given the opportunity to choose.

Week 2: Background research, write hypotheses, gather materials, write out procedure

Once students have chosen a project they should perform a literature search. This involves finding news articles, books, and other sources available on the internet that relate to the experiment. Specific keywords are provided for each project. Good starting points are Google Scholar (https://scholar.google.com) and Wikipedia (https://www.wikipedia.org). Students should determine how to obtain the necessary materials to perform the experiment.

Each project should have a testable hypothesis that describes what the student thinks the outcome of the project will be. Students should also explain why they think that will be the outcome. An example hypothesis is: *I think the tennis ball will bounce higher than the baseball when dropped from the same height.* Students should gather the necessary materials to perform the experiment and write out the step by step procedure they will follow to perform the experiment.

Week 3: Identify variables, collect data, take photos, create drawings

Students should identify variables that are relevant to the experiment and determine which variables will be changed (independent variables) and which will be kept the same (dependent variables). Remember to only change one variable at a time otherwise it will be impossible to isolate the effects of a single variable on the result. For example, if the effects of angle of trajectory on the distance of flight are being explored then everything should be kept constant (materials, field, direction of launch, weather conditions, tension on the water balloon launcher, etc.) while only changing one variable (angle of trajectory). Students should collect data in a lab notebook and document their procedure with photos or drawings so that others may replicate their experiment.

Week 4: Analyze results, create projects on posters, practice presenting

Once numerical data are collected, results should be summarized in a table, chart, or graph. Students should also provide a discussion of the results and an assessment of whether the hypothesis was correct or incorrect. Following the standard science fair format, students should create a poster that includes a visual summary of the results. An example is provided below.
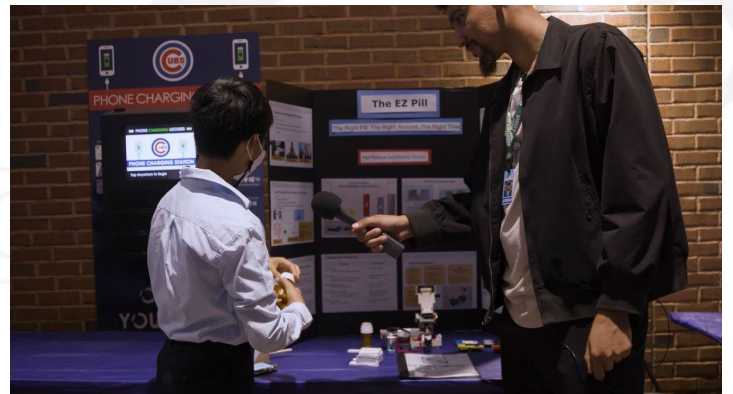
FAQ:

- What is the rubric/criteria on which students will be judged?
- Projects that focus on the Scientific Method
- Projects will be judged on the following: Knowledge gained, scientific approach, experimental approach, data collection, conclusion validity, creativity, artistic quality, and presentation skills.
- Projects should be able to fit onto a 6 ft table or the space on the ground within that perimeter.
- Judges will be asking questions that vary depending on the project.
- A poster board is not required if all criteria is met.
- Outlets are available upon request.
- Students that require technology should bring their own laptops or device.
- The top three projects will receive a prize and will get recognized at the May 17th game. Winning teams will also be able to participate in an exclusive one-week summer camp held at Wrigley Field.

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Option 1: Build Your Own MLB Roster

Introduction

Students will create their own MLB roster based on batting and pitching statistics, within a $100 million dollar salary cap.

Objectives

1. Research batting and pitching statistics https://www.baseball-reference.com/
2. Research player salaries https://www.usatoday.com/sports/mlb/salaries/
3. Create the best possible roster within a $100 million salary cap (using active players only)

Keywords to Get You Started

Batting average, home runs, earned run average, wins above replacement, salary cap

Materials and Equipment

- None

Constraints

Students may only select 9 active players for their MLB roster. The sum of their 2021 salary must not exceed $100 million dollars. A manager may also be selected, although their salary does not count towards the salary cap.

Procedure

1. Search for players by position. Select only nine active players: pitcher, catcher, first baseman, second baseman, third baseman, shortstop, and three outfielders. Use batting statistics to select the best position players: batting average, home runs, slugging percentage, on base percentage, etc. Use pitching statistics to select the best pitcher: earned run average, wins, strikeouts, etc.

http://mlb.mlb.com/mlb/players/

Batting Average = (Hits)/(At Bats)

BA = (H)/(AB)

On Base Percentage = (Hits + Walks + Hit By Pitches)/(At Bats + Walks + Hit By Pitches + Sacrifice Flies)

OBP = (H + BB + HBP)/(AB + BB + HBP + SF)

Slugging Percentage = (Singles + 2*Doubles + 3*Triples + 4*Home Runs)/(At Bats)

SLG = (1B + 2*2B + 3*3B + 4*HR)/(AB)

2. For the players selected, find their salary for the 2019 season.

http://www.usatoday.com/sports/mlb/salaries/

3. Add the salaries of the 9 players. The budget is $100 million. If the sum of their salaries is lower than $100 million, you are done. If it is higher than $100 million, then select different players until the roster fits the budget.
4. Select any active MLB Manager. Their salary does not count towards the salary cap.
5. Create a poster showing the team roster following the example below.
6. Justify why you selected each of the 9 players and their manager.

Team City	Create a Roster	Team Manager
(List/Describe A City/Stadium You Would Want To Visit To Watch A Baseball Game Below)	Team Name: _____ Student Name: _____ 1B: _____ Salary: _____ Stats/Info: _____ 2B: _____ Salary: _____ Stats/Info: _____ 3B: _____ Salary: _____ Stats/Info: _____ SS: _____ Salary: _____ Stats/Info: _____ LF: _____ Salary: _____ Stats/Info: _____ CF: _____ Salary: _____ Stats/Info: _____ RF: _____ Salary: _____ Stats/Info: _____ C: _____ Salary: _____ Stats/Info: _____ P: _____ Salary: _____ Total Salary: _____	(List/Justify The Team Manager Below)

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Option 2: Stadium Design

Introduction

Students will research MLB stadiums and develop a proposal for a new stadium.

Objectives
1. Learn about existing MLB stadiums and their architecture.
2. Propose a new design to improve fan experience

Keywords to Get You Started

https://en.wikipedia.org/wiki/List_of_Major_League_Baseball_stadiums

http://mlb.mlb.com/team

http://www.ballparksofbaseball.com/AmericanLeague.htm

http://www.ballparksofbaseball.com/NationalLeague.htm

https://www.yahoo.com/food/the-best-food-at-every-mlb-ballpark-across-america-126936163357.html

Procedure

1. Give students the American League and National League "Name the Team and the Stadium" worksheets, and have them fill in all of the answers they know.
2. Review worksheets to find out which of them know the most teams and stadiums without any hints. Give students the "Hint Sheet", then find out which of them know the most teams and stadiums after giving them that sheet.
3. Ask students to research four different MLB stadiums, two from the National League and two from the American League, that were each opened in a different decade, and compare the following features:
   a. ● Year Opened
   b. ● Seating capacity
   c. ● Unique features of the stadium, including architecture, dimensions, and food offering.
4. Use the "Compare Stadiums" worksheet to record the information.

Years in which MLB stadiums were opened:

- 1910s - Red Sox (1912), Cubs (1914)
- 1960s - Dodgers (1962), Angels (1966), Athletics (1966)
- 1970s - Royals (1973)
- 1980s - Blue Jays (1989)
- 1990s - Rays (1990), White Sox (1991), Orioles (1992), Indians (1994), Rangers (1994),
- Rockies (1995), Diamondbacks (1998), Mariners (1999)
- 2000s - Astros (2000), Giants (2000), Tigers (2000), Brewers (2001), Pirates (2001), Reds (2003),
- Padres (2004), Phillies (2004), Cardinals (2006), Nationals (2008), Mets (2009), Yankees (2009)
- 2010s - Twins (2010), Marlins (2012), Braves (2017)

5. Using information from their stadium research, students design and create drawings or a physical model of their own minor league or MLB stadium. Here are some questions that should be considered:

- What are some unique architectural features of your stadium (e.g., scoreboard, roof, corporate sponsorship, etc.)
- What are the outfield wall distances (left, center, right) from home plate?
- What is the seating capacity?
- How will the seating sections be arranged?
- How much should be charged for each seat in each section?
- How many bathrooms will be needed?
- How many food and merchandise stores will be needed?
- What will be a unique food item?
- What is the parking capacity?

6. Students are encouraged to be creative and "think outside the box" when designing and creating the drawings or models of their stadiums.

7. Students prepare their stadium design projects for presentation using a three-sided foldable presentation board:

- Left side of presentation board: Add pictures of and identify at least two stadiums that inspired the stadium design.
- Center of presentation board: The design of the stadium
- Right side of presentation board: Features of the stadium such as food, ticket prices, capacity, parking, etc.

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Option 3: Which ball bounces higher?

Introduction

How high can a ball bounce? Would different types of balls bounce differently? Does the material that a ball is made of matter? This project explores the concept of elasticity and materials used to make different balls used for sports.

Objectives

1. Compare the elasticity of different balls when dropped from the same height
2. Determine whether the materials that a ball is made of affects its elasticity

Key Words to Get You Started

Elasticity, bounce, materials, force, gravity

Materials and Equipment

- Baseball
- Softball
- Tennis ball
- Tape measure
- Lab notebook

Hypothesis

Students will form hypotheses about which ball bounces higher based on their intuition or knowledge about sports.

Experimental Procedure

1. Elasticity is a physical property of materials which return to their original shape after they are deformed. A ball's elasticity and material composition determine how it "bounces" when it hits the same surface like a bat, dirt, grass, etc.
2. Feel how much you can squeeze the tennis ball, softball and baseball without damaging it. What does this say about the elasticity of each ball? What does it say about the material of the ball?
3. Find a hard floor surface and drop each of the balls from the same height (shoulder length). Be careful not to throw the ball; just drop it from your hand.
    a. How high did the baseball bounce? How many times did it bounce before coming to rest? Measure the height of the bounce using the tape measure (10 ft.) and document it in your lab notebook. Record the number of bounces after each drop.
    b. How high did the tennis ball bounce? How many times did it bounce before coming to rest? Measure the height of the bounce using the tape measure (10 ft.) and document it in your lab notebook. Record the number of bounces after each drop.
    c. How high did the softball bounce? How many times did it bounce before coming to rest? Measure the height of the bounce using the tape measure (10 ft.) and

document it in your lab notebook. Record the number of bounces after each drop.
4.   Measure the height of the first bounce three times and write down the results in the table provided.
5.   If time permits, try other sports balls like basketball, soccer ball, etc.

	Trial 1 Bounce Height (inches)	Trial 2 Bounce Height (inches)	Trial 3 Bounce Height (inches)	*Average Bounce Height (inches)*
Baseball				
Softball				
Tennis Ball				
Other_____				
Other_____				

If time permits, repeat the previous drop tests on carpet, tile, or grass surface. What would happen if the drop test was repeated over a small pool filled with water?

Compare the number of bounces for each type of ball on a single surface type. How does the number of bounces relate to the elasticity of the ball material? Now, compare the number of bounces for the tennis ball on more than one surface type. How does the number of bounces correlate to the elasticity of the surface material?

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Option 4: Game Attendance Prediction

Introduction
Groups of students will form teams to predict the total home attendance for three future Cubs home games.

Objectives
1. Research Wrigley Field fan capacity
2. Review historical attendance trends at Wrigley Field
3. Identify factors that influence home game attendance
4. Predict home game attendance

Key Words to Get You Started
Prediction, capacity, home games

Materials and Equipment
- None

Hypothesis
Students will form hypotheses about the attendance at future home games at Wrigley Field based on historical trends.

Procedure
1. Research the capacity of Wrigley Field
   https://en.wikipedia.org/wiki/Wrigley_Field
2. Review the historical attendance of Cubs home games from past seasons
   https://www.baseball-reference.com/teams/CHC/2021-schedule-scores.shtml
   https://www.baseball-reference.com/teams/CHC/2019-schedule-scores.shtml
   https://www.baseball-reference.com/teams/CHC/2018-schedule-scores.shtml
3. Identify what affects the attendance of a home game. Determine whether these things increase or decrease the amount of fans who attend the game: weather, promotions like bobble heads, opponent, team's chances of making the playoffs, starting pitchers, day of the week.
4. Select three home games in April and predict the attendance using the worksheets below.
   https://www.mlb.com/cubs/schedule
5. After the games take place, research the actual attendance and write it down.
   https://www.baseball-reference.com/teams/CHC/2022-schedule-scores.shtml
   Calculate the difference between the predicted attendance and the actual attendance. This will either be a negative number or a positive number.
6. Explain why there is a difference between your prediction and the actual attendance.
7. Propose ways to increase attendance at Cubs home games.

Cubs Attendance Prediction Form (Wrigley Field)

GAME DATE: _____

CUBS OPPONENT: _____

ATTENDANCE PREDICTION: _____

ACTUAL ATTENDANCE: _____

DIFFERENCE BETWEEN PREDICTION AND ACTUAL: _____

EXPLANATION: _____

_____

GAME DATE: _____

CUBS OPPONENT: _____

ATTENDANCE PREDICTION: _____

ACTUAL ATTENDANCE: _____

DIFFERENCE BETWEEN PREDICTION AND ACTUAL: _____

EXPLANATION: _____

_____

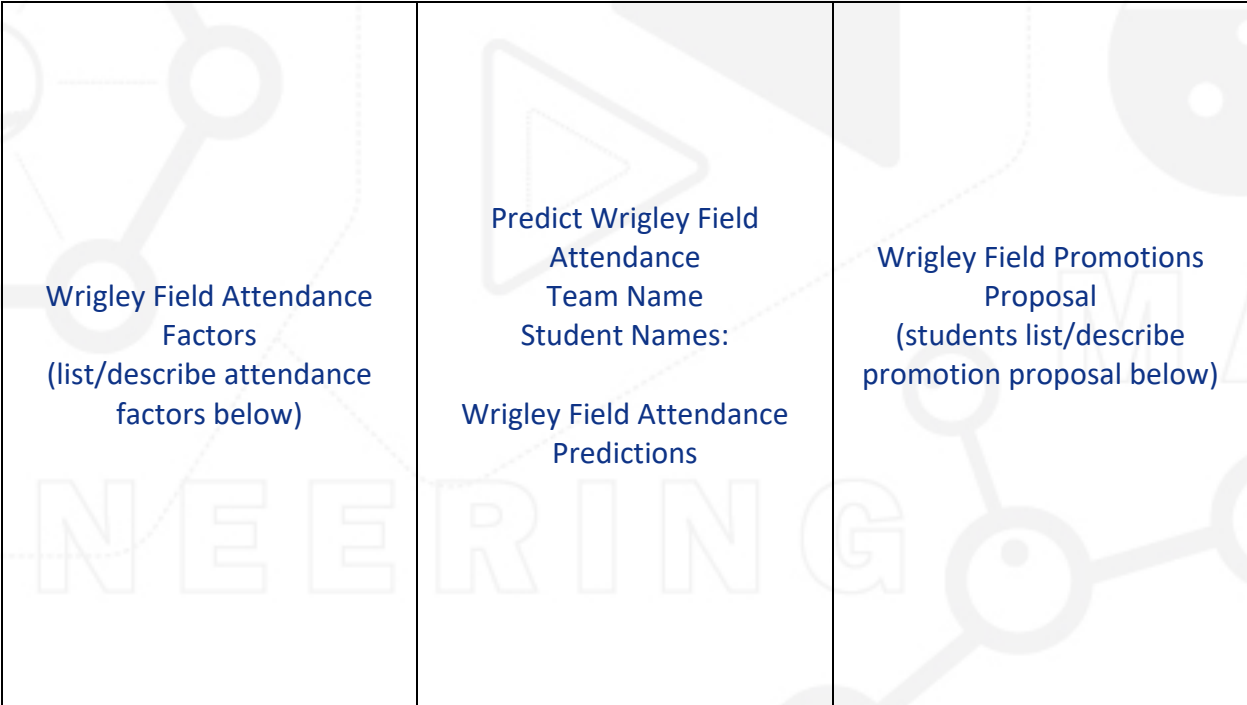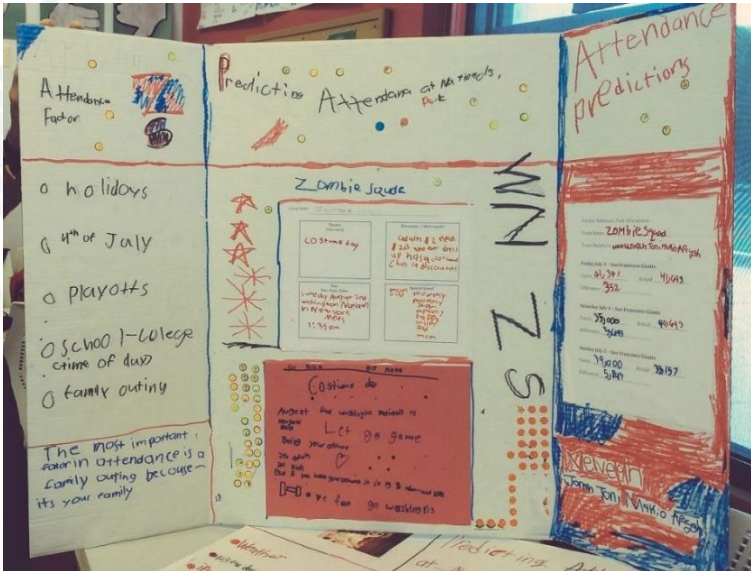GAME DATE: _____

CUBS OPPONENT: _____

ATTENDANCE PREDICTION: _____

ACTUAL ATTENDANCE: _____

DIFFERENCE BETWEEN PREDICTION AND ACTUAL: _____

EXPLANATION: _____

Recommended tri-fold poster layout

Wrigley Field Attendance Factors (list/describe attendance factors below)	Predict Wrigley Field Attendance Team Name Student Names: Wrigley Field Attendance Predictions	Wrigley Field Promotions Proposal (students list/describe promotion proposal below)

Poster example

Option 5: Bat Chooser

Introduction

What is the ideal bat weight for each player?

Objectives

1. Predict the ideal bat weight for each player
2. Utilize formula to identify the ideal bat weight using a player's height
3. Test different bat weights to determine which feels better

Key Words to Get You Started

Ounces, bat weight

Video of how baseball bats are made: How Baseball Bats Are Made

Materials and Equipment

·　　Baseball bats (not provided)

·　　Tape measure

Hypothesis

Students will form hypotheses about the weight of the bat for players of different body types.

Experimental Procedure

1. Ask students to guess how much their ideal bat weighs (Hint: bats weigh between 18 and 35 ounces)
2. Write down the guesses on the board
3. Based on the results of a study of ideal bat weights, how would your guess change?
    Show students results of Bahill study (Table 2)[1]

TABLE 2. Ideal Bat Weights.

Team	Mean Ideal Bat Weight (oz)	Standard Deviation	Typical Pitch Speed (mph)	Number of Subjects
Professional, major league	31.1	3.6	90	27
University baseball	29.4	4.2	80	9
University softball	29.7	4.3	60	19
Junior league, age 13–15	21.7	4.9	55	6
Little league, age 11–12	21.3	2.9	50	34
Little league, age 9–10	21.5	3.7	40	29
Little league, age 7–8	19.0	3.1	35	27
Slow pitch softball	25.7	3.7	20	12

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[1] Bahill, T. A. and Freitas, M. M. (1995). Two Methods for Recommending Bat Weights, *Annals of Biomedical Engineering,* Vol. 23, pp. 436-444.

4. Based on your age and playing level, select the appropriate formula for calculating your idea bat weight

TABLE 5. Simple integer models for recommending bat weights.

Group	Recommended Bat Weight (oz)
Baseball, major league	Height/3 + 7
Baseball, amateur	Height/3 + 6
Softball, fast pitch	Height/7 + 20
Junior league (13 & 15 years)	Height/3 + 1
Little league (11 & 12 years)	Weight/18 + 16
Little league (9 & 10 years)	Height/3 + 4
Little league (7 & 8 years)	Age*2 + 4
Softball, slow pitch	Weight/115 + 24

Age (years); height (inches); weight (pounds).

5. Example: Little Leaguer who is 9 years old should use this formula

$$Recommended\ Bat\ Weight\ (oz.) = \left(\frac{Height}{3}\right) + 4$$

6. Measure your height in inches. Typical height for a 9-year-old boy is 54 inches.

$$Recommended\ Bat\ Weight\ (oz.) = \left(\frac{54}{3}\right) + 4$$

$$Recommended\ Bat\ Weight\ (oz.) = (18) + 4$$

$$Recommended\ Bat\ Weight\ (oz.) = 22$$

7. Your ideal bat weight is 22 ounces.
8. Find a bat that is close to your ideal weight and swing it.
9. Try **heavier** bats and see if they are easier or harder to swing.
10. Try **lighter** bats and see if they are easier or harder to swing.
11. Discuss other factors that could affect your selection of bat weight. Possible answers are body strength, body type, and gender.

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