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SCIENCE CURRICULUM

Appendices

Lesson Plan 1
"The Green Under Your Feet"

Students explore plant life and discuss the purpose of grass as a playing surface in baseball.

Reference to Ohio Academic Content Standards:
K-2/Life Sciences: A. Discover that there are living things, non-living things and pretend things, and describe the basic needs of living things (organisms). Scientific Inquiry: B. Design and conduct a simple investigation to explore a question.

Objectives:
Through class discussion and actually growing grass in the classroom, students will discover the basic needs of plants.

Materials:
Grass seed, Containers in which to grow grass, soil, and water

Before the Game:
Discuss as a class what plants need to grow. Provide the students with materials to grow grass in the classroom. Discuss how and why the grass at a ballpark is different. Provide an example of turf and garss at home to touch and see.

At the Game:
Students should observe where grass is growing at the ballpark and where there is just dirt. Observe the groundskeepers as well. What things do they do to care for the field? Why is it a good idea to play baseball on grass? Are there other surfaces used to play baseball? Which is best? Why do you think that baseball has been played on grass fields?

Beyond the Game:
Discuss the observations the students made at the ballpark. What areas were grass? Which were dirt? Why is each used? How does the grass grown in class compare to the grass at the ballpark? Did the grass grow in the classroom? Discuss why it did or did not.
Discuss artificial grass/turf differences from the stadium and grass at home or at golf courses. What do stadiums do to maintain the turf?

Lesson Plan 2
"Game Sense(s)"

Children actively observe during their experience at the baseball game, using all five senses to gather information.

Reference to Ohio Academic Content Standards:
K-2/Scientific Inquiry: C. Gather and communicate information from careful observation and simple investigation through a variety of methods.

Objectives:
The child will describe observations made with all five senses.

Materials:
An assortment of coins, game food, wood, leather, sunflower seeds, cardboard, tape recorders and cassette tapes

Before the Game:
Discuss how we take in information using all of our senses and use that information to understand the world. Begin making lists of words that describe a day at school, classifying each one as data gained from looking, smelling, tasting, hearing or touching. Have students try this while blindfolded. Record as classified. Also, discuss adjectives as describing words prior to the game.

At the Game:
Play with senses. Predict which coin(s) will cover an outfielder's or catcher's head when held at arm's length in the direction of that player. During loud fan noise, use fingers to quickly plug and unplug ears to make the sound come and go. Try tasting the baseball food while holding one's nose plugged. Does it taste the same? Make a point to thoughtfully touch objects usually taken for granted: the seats, a ticket, a hot dog bun, the railings, etc. Have students play "The Alphabet Game," attempting to identify each of the senses for every letter of the alphabet. Incorporate a game of I Spy___, I Smell ___, I Feel ___, etc., and use adjectives or adverbs until other students are able to guess the particular sensation. This can be done on the way to and from the game.

Beyond the Game:
Have children work in teams to make games, posters, a book, tape recordings or ANYTHING to showcase the sensory experiences of the baseball game. For instance, a "Smellers" team could choose to make smell boxes of gameday smells: the leather of the mitt, the wood of the bat, the sweat of a player, etc. A "Touchers" team could choose to approximate some of the textures of gameday with classroom items, and classify the items touched at the game as rough, smooth, cool, warm, soft, etc. on a poster chart.
Make practical activities and relate them everyday experience - Where do you feel these type of textures in your home or classroom?
Make charts "What we saw, tasted, heard, smelled, touched. From this list children may illustrate a page. All pages can be combined to form a book.

Lesson Plan 3
"Rain Delay"

The children will describe the weather on the day of the game and apply their understanding of weather to other game conditions.

Reference to Ohio Academic Content Standards:
K-2/Earth and Space Sciences: C. Observe, describe and measure changes in the weather, both long term and short term.

Objectives:
The child will create a simple weather report.

Materials:
Thermometers, weather sections of newspaper, video of weather portions of news, paper and pencil

Before the Game:
As a class, children will make observations of weather on a daily basis and devise means to record their weather observations. These should include notations of temperature, precipitation and sky conditions. Periodically, watch on television or on videotape some weather reports and discuss what is included in these reports and how they are expressed and explained. Use the internet as well. Even dress a doll or puppet for different type of weather.
How do the weather reporters use maps, tables, charts, and graphic displays to communicate and explain the weather to their viewers? Talk about appropriate clothing for rainy days and sunny days. Make a prediction on the forecast for Education Day including temperature and weather conditions.

At the Game:
Dress appropriately for the game. Make careful observations of the weather conditions on gameday and note if any weather elements interfere with the game. Note the temperature on the Beacon Journal clock as you enter or leave downtown.

Beyond the Game:
Children make a full weather report of the gameday conditions. This gives them an opportunity to combine their experiences with television weather forecasting with the weather conditions they experienced at gameday. These may be videotaped, recorded or simply enjoyed by their classmates. Include predictions that were made before the game and how close the predictions were to the actual results. The teacher may want to use props and dramatic play

Other Variations: Discuss why baseball games are cancelled or postponed due to certain weather conditions. Have children research the relationship between other sports and weather conditions. Are football games cancelled when it rains or when it is cold? Why or why not? What about soccer, hockey, basketball, horse racing, auto racing, fishing or other sports?

Lesson Plan 4
"Building of a stadium"

Children will explore what happens when a building is being created.

Reference to Ohio Academic Content Standards:
K-2/Physical Science: A. Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change.

Objectives:
Children will be able to list ways an area may be impacted through the building of a stadium, and identify different building materials used in construction of the stadium and surrounding buildings.

Materials:
Pictures, newspapers, articles, and picture books, of the area surrounding Canal Park before the stadium was built. Pictures and books pertaining to the Erie Canal.

Before the Game:
Have the children build a model of a house or look at pictures of different types of houses, and list all of the impacts on the environment, landscape, waterways, and the displacement of wildlife. Have the children list all of the types of building materials that are used in your building. Discuss various layers within the Earth's surface. Which of these items are living organisms? How do the non-living organisms effect the living?

At the Game:
Discuss one building around Canal Park and have students look for it while in the stadium. Have children identify some of the building materials that were used to construct Canal Park.

Beyond the Game:
Have the children notice and list the changes that they have seen in their own neighborhoods. Discuss the changes they saw in the area of the stadium from the photographs and books - a before and after look. The student may write a short description or draw a picture of the area before the stadium was built.
The teacher may wish to create a before/after chart or a "what is new"/"what is old" chart using student information.

Lesson Plan 5
"Competition is the Mother of Invention"

Children conceptualize an invention that would improve the performance of a particular position player on a baseball team, or an invention that would make the job of a stadium worker a little bit easier.

Reference to Ohio Academic Content Standards:
K-2/Scientific Inquiry: B. Design and conduct a simple investigation to explore a question.

Objectives:
The child will observe events and explain how to effect a change in that event for a specific purpose.

Materials:
Paper and pencil, models of simple machines

Before the Game:
Identify the difference between a tool and a machine. List the people who the students will likely be able to observe at the ballgame. What are their roles and functions? Children choose which role they would like to analyze in order to invent a simple machine for them. Teams of children can decide to work for the pitcher, the batter, the fielder, the catcher, the ticket taker, the food vendor, the usher or the fan. Discuss simple machines in everyday life and have children
identify simple machines in their school building.

At the Game:
As the children enjoy the game, they also should make careful observations of their "client" and their movements and of the tools they use. Also, make note of the inventions already in place: bills of the players' caps, change dispensers for the vendors, the weight rings on the batters' bats before batting, rosin for the pitcher, binoculars, a big scoreboard for the fans, and more.

Beyond the Game:
Teams discuss the observations they made of their "client" at the ballgame. Choose one component of that person's actions or an attribute of the tools they use, or of the stadium/environment itself, and invent a way to improve or simplify their performance. Their improvements might consist of a more efficient way of moving, an improvement on a tool, a new tool to use, an adjustment made to the working environment or something the "client" might wear. Diagrams and descriptions of these inventions can be shared with the other teams of inventors and the best ones sent to the Aeros.

Lesson Plan 6
"The Greatest Distance is Sound"

Reference to Ohio Academic Content Standards:
3-5/Physical Science: C. Describe the forces that directly affect objects and their motion. F. Describe the properties of light and sound.

Materials:
Hammer or piece of wood the size of a hammer, baseball bat (aluminum and/or wooden bat), ruler

Before the Game: (the teacher should deomonstrate the activity first)
With the students in small groups, hold the bat horizontally with one hand. With your other hand, pick up a hammer or piece of wood. Strike the bat at points that are one inch (2.5 cm) apart. Start at the heavier end of the bat. Listen to the sound the bat makes each time you hit it (note all changes of sound as you move from one end to the other). Have the students try this as well. Then, have the groups write down their results and compare.

1. What did you notice about the sound of the bat each time you hit it?
2. Where is the spot that makes the clearest, most solid sound?
3. Measure how far this spot is from the thick end of the bat (inches or centimeters).
4. Why do you think this spot is called the "center of percussion?" (Hint: Which band instruments are called percussion instruments?)

At the Game:
1. Observe the sound that Aeros players' bats make. Are these sounds different from the sounds of your bat? Do ground balls sound different than fly balls?
2. Have various students close their eyes for one half inning of the game (students will need a partner with their eyes open). Have these students attempt to determine the distance that the ball travelled based on the sound off of the bat. Have your students track the difference between their "guess" and the actual distance of the ball.

Beyond the Game:
1. Experiment with other sports equipment (e.g. tennis racquet, racquetball racquet, hockey stick, etc.) to find the "center of percussion." Graph your findings.
2. Why do professional players use wooden bats whereas, collegiate players down through little league use aluminum bats? Note that collegiate baseball players are now slowly being required to switch from aluminum bats to wooden bats. Why?

Lesson Plan 7
"Nutrition at the game"

Students will be able to determine if they are able to eat a balanced meal at a baseball game and give suggestions on what products they would have available at the game that would be healthier taking into account if the product is feasible based on product cost, preparation time, and shelf life.

Reference to Ohio Academic Content Standards:

3-5/Life Sciences: C. Compare changes in an organism's ecosystem/habitat that affect its survival.
6-8/Life Sciences: C. Explain how energy entering the ecosystems as sunlight supports the life of organisms through photosynthesis and the transfer of energy through the interactions of organisms and the environment.

Materials:

Paper and pen/pencil, nutritional pyramid

Before the Game:

Introducing the nutritional pyramid - go through many examples with the students.
Have the students monitor everything they eat for a week, while classifying each item as they note it. They will find that some items have two and three different classifications, you may have to discuss portions with the students.
At the end of the week have the students determine if they ate a well balanced diet.
"What could they do to make their diet better?"

At the Game:

List consumable products that you see at the game. Create a list of items that are observed or consumed.

Beyond the Game:

Create a class list of food items seen/consumed at the game.
Discuss where do the products on the list fall within the food pyramid?
Did the students find a complete meal at the stadium?
What did they eat? Was it a balanced meal?
Have the students brainstorm ideas of items that can be sold at the game taking into account the cost, preparation time, handling, shelf life, etc…
Was the nutritional food more expensive that the fattier foods?

Further work:
Have the students get into small groups and write a persuasive letter to the Akron Aeros Concessions Coordinator regarding items your group believes would be feasible to sell at the stadium and would be healthier for the fans.

Lesson Plan 8
"Ice Cream You Scream We All Scream For Ice Cream"

Reference to Ohio Academic Content Standards:
6-8/Scientific Inquiry: K-2 Nature of Matter: Explore and observe that things can be done to materials to change their properties (e.g., heating, freezing, mixing, cutting, wetting, dissolving, bending and exposing to light).

Objectives: The students will be able to research information on the history of ice cream. The students will create ice cream in the classroom and observe the change in the properties form liquid to solid.

Materials: Books and Internet sites about the history of ice cream, and ice cream maker and ingredients needed (based on specific maker being used).

Before the Game: The teacher will lead a discussion asking the students how they think ice cream is created and what ingredients are needed. A class list of ingredients will be created on the board with the students ideas. The students will research in small groups through the use of books and internet web sites the history of ice cream and how it is currently developed in the United States. The teacher will then lead a discussion on what information was found allowing each group to present their findings. The class will compare and contrast their predictions along with their findings.

At the Game: The teacher can purchase samples of Dip-N-Dots and regular ice cream so students can observe the properties of each

Beyond the Game: The students will create and enjoy ice cream in the classroom while discussing and observing how the properties of the materials change form. Students will discuss how different flavors and colors of ice cream could be created and how different ingredients would affect the property of the ice cream. Students will brainstorm and create a new classroom flavor.

Evaluation Method: The students will be evaluated by their participation in the research and presentation of the information along with their participation in the creation of the actual ice cream.

Lesson Plan 9
"The Center of Gravity"

Reference to Ohio Academic Content Standards:
6-8/Scientific Inquiry: A. Explain that there are differing sets of procedures for guiding scientific investigations and procedures are determined by the nature of the investigation, safety considerations and appropriate tools. B. Analyze and interpret data from scientific investigations using appropriate mathematical skills in order to draw valid conclusions.

Materials:
Variety of baseball bats, 2 feet of string

Before the Game:
As an introduction, have the students stand on one leg and try to balance themselves. On every bat, just as with every person, there is a spot where the weight is concentrated. This spot is called the center of gravity. The students can find the spot by following the directions.

1. Instruct the students to predict where they think the center of gravity may be located.
2. Take the string and tie it to the bat somewhere around the middle. Make the knot loose because you may need to slide the knot up and down the bat.
3. Let the bat hang horizontally from the string so that the bat becomes balanced. This is the time when the knot should be adjusted to enable the bat to hang balanced.
4. When the bat becomes balanced, this spot is the center of gravity for the bat. Measure the distance from the thick end of the bat to the place at which the knot is balancing the bat.
5. How far off were students from their predictions?

At the Game:
Observe players' baseball bats and their batting stance as they step up to home plate.
Observe the stadium. Where do you see balance? Together create a list of people that need to demonstrate balance in order to do their job.

Beyond the Game:
Discuss with students and show them the centers of gravity on athletes. Provide examples by showing a basketball player shooting, a football player tackling, a baseball player swinging, etc.
Ask students about other careers that require materials that are perfectly balanced? List those materials. What careers require physical balance? List those careers. Discuss reasons why different players use different size bats.

Lesson Plan 10
"Galileo's Principles"

Reference to Ohio Academic Content Standards:
6-8/Physical Sciences: B. In simple cases, describe the motion of objects and conceptually describe the effects of forces on an object. Scientific Inquiry: B. Analyze and interpret data from scientific investigations using appropriate mathematical skills in order to draw conclusions.
8-10/Mathematics-Patterns, Functions & Algebra: B. Generalize and explain patterns and sequences in order to find the next term and the nth term. B. Identify and classify functions as linear or non-linear and contrast their properties using tables, graphs or equations.

Materials:
Pencil, baseball, stopwatch

Before the Game:
Using the charts on the following page, find the rule or formula used in each chart. Allow students to experiment with formulas determined from the tables with a baseball.

SEE NEXT PAGE FOR CHARTS

Time & Velocity of Falling Objects

Total Time of Fall (seconds)	Velocity of Object (feet per second)
1	32
2	64
3	96
4	128
5	160
6	
7	
8	
9	

Time of an Object's Fall & Distance Travelled During Fall

Total Time of Fall (seconds)	Distance (feet)
1	16
2	64
3	144
4	256
5	400
6	
7	
8	
9	

Total Time in Air & Velocity Object Was Thrown

Total Time in Air (seconds)	Velocity Thrown (miles/hr)
1	11
2	22
3	33
4	44
5	55
6	
7	
8	
9	

Total Time in Air & Maximum Height Reached if Thrown Vertically

Total Time in Air (seconds)	Height Reached (feet)
1	4
2	16
3	36
4	64
5	100
6	
7	
8	
9	

At the Game:

1. Using your stopwatch, collect sample data from the following:
   a) Total time in air of fly balls.
   b) Total time of the descent of a fly ball.
   c) Estimate the height and the distance travelled by each fly ball.

Beyond the Game:

1. Using the sample data collected at the game, does your data support the theories from the tables above?
2. What outside forces may have affected your findings (in relation to the charts)?

Lesson Plan 10
"The Center of Gravity" - Part II

Reference to Ohio Academic Content Standards:
6-8/Earth & Space Sciences: B. Explain that the universe is composed of vast amounts of matter, most of which is at incomprehensible distances and held together by gravitational force. Describe how the universe is studied by the use of equipment such as telescopes, probes, satellites and spacecraft. Physical Science: D. Describe that energy takes many forms, some forms represent kinetic energy and some forms represent potential energy; and during energy transformations the total amount of energy remains constant.
9-10/Scientific Inquiry: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate, and communicate the results of these investigations.

Materials:
Variety of baseball bats, 2 feet of string

Before the Game:
On every bat, there is a spot where the weight is concentrated. This spot is called the center of gravity. The students can find the spot by following the directions.

1. Instruct the students to predict where they think the center of gravity may be located.
2. Take the string and tie it to the bat somewhere around the middle. Make the knot loose because you may need to slide the knot up and down the bat.
3. Let the bat hang horizontally from the string so that the bat becomes balanced. This is the time when the knot should be adjusted to enable the bat to hang balanced.
4. When the bat becomes balanced, this spot is the center of gravity for the bat. Measure the distance from the thick end of the bat to the place at which the knot is balancing the bat.
5. How far off were students from their predictions?
6. Discuss gravity and the importance of the center of gravity with the class.

At the Game:
Compare hits from around the center of gravity, middle of the bat vs. hits from the end of the bat or inner part of the bat. List the observations made while making a determination on the hit balls (ex. direction, sound, speed).

Beyond the Game:
1. What other careers require materials that are perfectly balanced? List those materials.
2. Discuss the importance of perfectly balanced materials in other careers. What would happen if the materials were not balanced?
3. Discuss reasons why different players use different size bats.
4. Discuss the importance of a balanced baseball. What would happen if the ball was lopsided?

Lesson Plan 11
The Coefficient of Restitution

Reference to Ohio Academic Content Standards:
6-8/Physical Sciences: B. In simple cases, describe the motion of objects and conceptually describe the effects of forces on an object. D. Describe that energy takes many forms, some forms represent kinetic energy and some forms represent potential energy; and during energy transformations the total amount of energy remains constant. Scientific Inquiry: B. Analyze and interpret data from scientific investigations using appropriate mathematical skills in order to draw valid conclusions.

Materials:
3 Baseballs, 3 Golf Balls, 1 Tennis Ball, freezer, calculator.

Before the Game:
Students, with the assistance of their teacher, will dissect a baseball, a golf ball, and a tennis ball to determine their construction. They will then compare the three types of balls. Create a chart with three columns. List the characteristics and descriptions of each ball
(i.e. circumference, diameter, material, etc.)
Discuss the coefficient of restitution (The measure of elasticity of the collision between ball and bat).
Freeze one baseball and one golf ball.
Drop one frozen ball and one room temperature ball of each type to show the effect of temperature on the coefficient of restitution.
Discuss how weather and temperature may affect a baseball game.

$$c = \sqrt{\frac{h}{H}}$$

c = coefficient of restitution (dimensionless)
h = bounce height
H = drop height

At the Game:
Students will note the game time temperature and then take notes based on the travel of the ball as it relates to the temperature. Does the distance change as the day gets warmer or cooler?

Beyond the Game:
Students will participate in a class discussion based on the transfer of kinetic energy from the bat to the ball. Where else does energy transfer other than the ball? What assumptions may be made if you replaced the baseball with a golf ball?

Lesson Plan 12
"The Greatest Distance is Sound"

Reference to Ohio Academic Content Standards:
9-10/Physical Sciences: C. Describe the identifiable physical properties of substances. Explain how these changes can occur without changing the chemical nature of the substance. G. Demonstrate that waves (e.g. sound, seismic, water, light) have energy and waves can transfer energy when they interact with matter. Scientific Inquiry: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.

Materials:
Hammer or piece of wood the size of a hammer, Baseball bat (aluminum and/or wooden bat), ruler

Before the Game:
Hold the bat horizontally with one hand. With your other hand, pick up a hammer or piece of wood. Strike the bat at points that are one inch (2.5 cm) apart. Start at the heavier end of the bat. Listen to the sound the bat makes each time you hit it. (Note all changes of sound as you move from one end to the other.)

1. What did you notice about the sound of the bat each time you hit it?
2. Where is the spot that makes the clearest, most solid sound?
3. Measure how far this spot is from the thick end of the bat (inches or cm).
4. Why do you think this spot is called the "center of percussion"? (Hint: Which band instruments are called percussion instruments?)

At the Game:
1. Observe the sound that Aeros players' bats make. Are these sounds different from the sounds of your bat? Do ground balls sound different than fly balls?
2. Have various students close their eyes for one half inning of the game. Have these students attempt to determine the distance that the ball travelled based on the sound off the bat. Have your students track the difference between their "guess" and the actual distance of the ball.

Beyond the Game:
1. Experiment with other sports equipment (e.g. tennis racquet, racquetball racquet, hockey stick, etc.) to find the "center of percussion." Graph your findings.
2. Why do professional players use wooden bats whereas collegiate players down through little league use aluminum bats? Note that collegiate baseball players are now slowly being required to switch from aluminum bats to wooden bats. Why?

Reference to Ohio Academic Content Standards:
6-8/Physical Sciences: B. Scientific Inquiry: A.
9-10/Life Sciences: F., G. Scientific Inquiry: A.

• Examining Scientific Relationships

Using a baseball or a softball, have students determine the relationships between time, velocity, distance, and height.

a) Use your visit to Canal Park to determine the speed, velocity, or distance of a fly ball.
b) During your visit, determine the speed or velocity of a throw across the infield.

• Relationship between Distance and Angle

In baseball, the angle of the swing has a dramatic effect on the angle of the baseball and, therefore, the ball's distance. Experiments can be staged to emphasize the effect of the swing angle.

a) Have students swing a baseball bat off of a batting tee using different angles. Determine which angle allowed the greatest distance. Which angle produced the worst results in terms of distance? What factors do your students feel affected your results (either positively or negatively)?
b) Using videotape, examine the swing of home run champion Mark McGwire, Sammy Sosa or Barry Bonds versus the swing of one of your students or of a baseball "singles" hitter. What factors have caused McGwire, Sosa, and Bonds to be so successful?
c) Use the following web site to illustrate this concept (powerful computer likely needed to run these intense graphics): http://www.exploratorium.edu/baseball/

• Determining the Effects of Weather and Air Density on a Baseball

In class, discuss the differences during a baseball game between games played in ideal weather conditions versus games played in rain, cold, humidity, precipitation. Also discuss the effect that air density has on the distance that a ball will travel (e.g. in cities such as Denver).

a) What was the weather like at Canal Park on "Education Day"? Attempt to anticipate how well the ball will travel based on your class's earlier findings.

• Using Levers

A baseball bat is a first-class lever. Using a baseball bat as an example, determine the fulcrum, the force, and the load. What are other examples of other first, second, and third-class levers? in baseball and in general?

• Bernoulli's Principle

Test the effects of lift, drag and thrust on ball movement. How does the pitcher's grip on a baseball or delivery motion affect ball movement?

• Angle of the Sun

Using what students know about the sun and the lay-out of Canal Park, what seat would be the best if it was going to be a sunny, hot day? Which direction would you normally expect the wind to blow?

• Machinery & Baseball

In what way has the development of machinery improved/hurt the cultural experience of the game of baseball? How was the game played before machines such as hot dog warmers, pitching machines and scoreboards were invented?

• Ecological Aspects of Canal Park

Knowing that many old buildings were torn down to build Canal Park, ask students to write a persuasive paragraph (pro or con) about the ecological aspects of building the stadium.

• Life Cycles

Ask students to spend one inning recording all observable life. Create diagrams of the cycle that was observed.

• Baseball Inventions

Have students state which invention had the largest impact on professional baseball. Discuss. Research and list a number of inventions that have improved the game of baseball over the years. Ask them to create a new invention that would improve baseball.

• Swinging the Baseball Bat

Using Appendix R, determine the appropriate bat length and weight for each Aeros player (see Appendix E) as well as each student in class. Discuss why some players use larger or smaller bats than what is prescribed? Conduct experiments outside the classroom using a variety of baseball bat weights and lengths.