Nicolina Scarpelli
EMAT 6450
Mathematics in Context – Final Project

Mathematics in Sports

Introduction:

We encounter mathematics quite frequently in our daily lives, whether it is simple addition or complex algebra, mathematics is everywhere. Mathematics is present in a wide variety of careers ranging from architecture to interior designing and is even in sports. This document contains instructional materials that focus specifically on the concept of mathematics in sports, and how to incorporate this topic into the secondary education curriculum. I think one of the most challenging aspects of teaching is relating the material to students' lives through the use of real – life examples. Therefore, finding ways to relate the material to students' everyday lives and having the student's explore applications in the real – world is essential to higher order thinking and greater student involvement. The goal of this lesson is to recognize and utilize the Pythagorean Theorem by connecting it to the dimensions of a baseball field and then later various sports fields/courts. In addition, exploring the projectile motion, velocity, and acceleration of baseballs, basketballs, or footballs can make an extension to this lesson.

Lesson Plan:

Lesson Plan Template	
Teacher:	Nicolina Scarpelli
Class:	10th grade Analytic Geometry
Course Unit:	Unit 2: Right Triangle Trigonometry
Lesson Title:	The Pythagorean Theorem in Baseball
Allotted Time:	One – 90 minute block period
LESSON OVERVIEW	Summary of the task, challenge, investigation, career-related scenario, problem, or community link
This lesson will have students use mathematical models relating sports ideas along with algebraic properties to understand the Pythagorean Theorem. The teacher will take the students out to the high school baseball field and provide them with measuring devices. Students will measure the distances between the bases, design a sketch of the baseball diamond, and use algebraic properties to understand the Pythagorean Theorem, its converse, and properties of special right triangles.	
STANDARDS	Identify what you want to teach. Reference State, Common Core, ACT College Readiness Standards and/or State Competencies.
Common Core Georgia Performance Standards **MCC9-12.G.SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.**	

OBJECTIVE	Clear, Specific, and Measurable – NOT ACTIVITIES Student-friendly

1. Understand the Pythagorean Theorem and how it is related to the side lengths of a right triangle
2. Use the Pythagorean Theorem to solve for a missing side length in a right triangle given the measures of the other two side lengths
3. Discover the converse of the Pythagorean Theorem

ASSESSMENT / EVALUATION	Students show evidence of proficiency through a variety of assessments. Aligned with the Lesson Objective Formative / Summative Performance-Based / Rubric Formal / Informal

After visiting the baseball field, we will return to the classroom and discuss the answers and data that the students found. While out at the baseball diamond, students will complete the worksheet attached in the appendix. Students will turn in their work at the end of class and will be assessed based on their group's use of the Pythagorean Theorem and accurate calculations, along with explanations to the questions on the worksheet.

PRIOR KNOWLEDGE	Prior knowledge that is required for student's to know before lesson

- Students should be knowledgeable of the properties of a square (four congruent sides, four right angles, diagonals are congruent and bisect each other, and that a square forms two right triangles when the square is cut by a diagonal).
- Students should be knowledgeable of the properties of a diamond (rhombus) and what makes it different from a square.
- Students should understand the concept of what it means for a number to be squared and inversely should understand what occurs when the square root of a number is taken.
- Students should be able to use a scientific calculator to square numbers and take square roots of numbers
- Students should be able to accurately measure and record measurements using a yardstick, and be knowledgeable of conversions from yards to feet.
- Students should know what the midpoint of a line is, and what the properties of the midpoint are.

MATERIALS	Aligned with the Lesson Objective Rigorous & Relevant

- SMARTboard (Internet Connection)
- Paper/Pencil
- Fifteen standard yard sticks (used as measurement tool)
- Scientific Calculator
- The Pythagorean Theorem in Baseball Worksheet

ACTIVATING STRATEGY	Motivator / Hook An Essential Question encourages students to put forth more effort when faced with complex, open-ended, challenging, meaningful and authentic questions.

Warm – up (15 minutes): In order to get students involved with the lesson and start gathering background knowledge, the following questions will be posed in order to facilitate general class discussion:

- How many of you play or enjoy baseball?
- How many of you have been to a baseball game or seen one on television?

The teacher will then display an image of a baseball field on the SMARTboard. Students will then complete a think – pair – share activity and answer the following questions:

- Why is a baseball field usually called a diamond?
- Is there a better name for the shape that the bases make in the infield?
- What are some specific properties of the shape of the infield of the baseball diamond? Write down at least 3 properties.

The think – pair – share activity will get students to think about the properties of a baseball field and visualize it as a square, and if a square is cut along one of its diagonals it forms a right triangle. A follow up discussion about these questions will take place before walking to the baseball field.

INSTRUCTION	Step-By-Step Procedures – Sequence Discover / Explain – Direct Instruction Modeling Expectations – "I Do" Questioning / Encourages Higher Order Thinking Grouping Strategies Differentiated Instructional Strategies to Provide Intervention & Extension

I. Opening Activity: Warm – up (15 minutes)
II. Outdoor Baseball Field Lesson (50 minutes) – (time allotted includes 5 minutes for walking outside and 5 minutes for walking back inside)
III. Closing Activity (25 minutes)

GUIDED & INDEPENDENT PRACTICE	"We Do" – " You Do" Encourage Higher Order Thinking & Problem Solving Relevance Differentiated Strategies for Practice to Provide Intervention & Extension

I. Opening Activity: Warm – up (15 minutes): In order to get students involved with the lesson and start gathering background knowledge, the following questions will be posed in order to facilitate general class discussion:
   - How many of you play or enjoy baseball?
   - How many of you have been to a baseball game or seen one on television?

The teacher will then display an image of a baseball field on the SMARTboard. Students will then complete a think – pair – share activity and answer the following questions:
   - Why is a baseball field usually called a diamond?
   - Is there a better name for the shape that the bases make in the infield?
   - What are some specific properties of the shape of the infield of the baseball diamond? Write down at least 3 properties.

The think – pair – share activity will get students to think about the properties of a baseball field and visualize it as a square, and if a square is cut along one of its diagonals it forms a right triangle. A follow up discussion about these questions will take place before walking to the baseball field. In addition, the teacher will assign students to groups of about 3 – 4 people. Then, the teacher will pass out the activity worksheet, and tell the students to bring a calculator, pencil, and the worksheet with them outside.

II. Outdoor Baseball Field Lesson: (50 minutes)

Once the class has traveled to the baseball field, the teacher will explain that each group is to measure the distance between each of the bases using a yard stick. In addition, they need to measure the distance between the pitcher's mound and home plate. Then, they need to convert the measurements from yards to feet and record their results. Once they have completed the measurements, they will need to sketch and label a diagram of the baseball field onto they're worksheet and answer the following questions:

1) Given the distance between each base, how far would the catcher have to throw the ball from home plate to second base? (i.e. find the distance the catcher would have to throw the ball from home plate to second base) Record your answers in feet. Simplify any radicals.
2) According to www.MLB.com, the official site of Major League Baseball, the pitcher's mound is 60 feet 6 inches from home plate. Given this information, is the pitcher's mound the midpoint of the diagonal from home plate to second base? (Use your answer to number 1 to help solve this problem).
3) Using your answer to number 2 along with the properties of the diagonals of a square, is the pitchers mound located directly in the center of the baseball diamond? How do you know?
4) What is the shortest distance, to the nearest tenth of a foot, between first base and third base?
5) Find the distance of a throw made from the catcher approximately 3 feet behind home plate in an attempt to throw out a runner trying to steal second base.
6) What is the total distance around a baseball diamond (i.e. what is the perimeter)?
7) What is the area of the baseball diamond? How does the area of a square relate to its side length?
8) Is the numerical value of the area of a square always greater than the numerical value of the perimeter of a square? (i.e. For what values will the perimeter, $4s$ be greater than or equal to the area, s^2). Explain your answer.

9) What happens to the perimeter and area of the baseball diamond if the original side lengths are doubled?
10) What happens to the perimeter and area of the baseball diamond if the sides are reduced to one-third the original length?
11) A little league baseball field has smaller dimensions than a professional baseball field. Given the distance between the catcher and second base is 50 feet, and the distance between the catcher and first base is 40 feet, what is the distance between first base and second base?
12) Number 8 is an example of a Pythagorean Triple. Identify and list at least two other Pythagorean Triples. Explain how you derived them.

Once the students have completed taking measurements and answering these questions, the class will head back inside to the classroom. Once back in the classroom, the teacher will have a discussion with the students about their findings.

CLOSURE	Reflection / Wrap-Up Summarizing, Reminding, Reflecting, Restating, Connecting

I. For the closing activity, the teacher will have the students turn in their Pythagorean Theorem worksheets and complete a ticket out the door.
II. Ticket out the Door Question:
    - If I told you a triangle with sides 45 cm, 60 cm, and 75 cm was a right triangle, how would you verify my statement? Develop an argument to convince yourself and your partner that my statement is correct. Write your argument on a piece of paper.

CROSS-CURRICULAR CONNECTIONS

There are many cross-curricular connections that can be made with Physics. This lesson can be extended to focus on projectile motion specifically. Quadratic equations are taught in the Analytic Geometry CCGPS standards; thus, projectile motion can be focused on within those standards. Further, there is a cross – curricular connection made with English and language arts in the closing activity where students have to come up with an argument, and write an justification explaining whether or not the triangle would be a right triangle or not.

MODIFICATIONS/ACCOMODATIONS:

Modifications/accommodations will be made as required by individual students' IEPs/504 plans. Worksheets with pre – filled out measurements and a diagram of a baseball field will be provided if need in order to help students follow along with the notes easily, and help save time.

If needed, a hard copy of the SMARTboard notes will be printed out for the student. In addition, SMARTboard slides and notes will be saved as a PDF file and uploaded on the class website.

If my English language learners are having trouble understanding the material, I will accommodate them by giving them a personal dictionary to help with translation and comprehension.

LESSON EXTENSION:

This lesson can be extended to the law of physics and students can explore linear and projectile motion. A baseball thrown from any baseball player to another player or to a person at bat has projectile motion. Students could explore how certain variables such as the angle, initial velocity, and air resistance influence the range of a projectile. Further, students could possibly investigate how much force is needed for a player to hit a homerun. In addition, this lesson can be extended to other sports as well such as basketball or football. Students could use the law of physics to determine whether their jump shot will go in the basket. They could use their height, the distance from the basket, the ball's angle, and the ball's speed to calculate whether or not the shot will go in the basket.

The following links are great ideas for a lesson extension:

http://www.nbclearn.com/portal/site/learn/nfl/cuecard/50689/

http://teachers.egfi-k12.org/lesson-projectile-motion/