WAMC Lab Template

Math Concept(s): Quadratic Functions
Developed by: Michelle McCallum
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Date: Summer Conference 2022

Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Students will engage in a quadratic application of baseball. Students will be placed in groups of 5 (one to hit the ball, one to track time, one to calculate height, one to track distance, one to keep record). Student will then use the various measurements from their teammates ball hit, to later plot a quadratic graph of the baseball's path of travel.

Lab Plan

Lab Title: Quadratic Home-Run

Prerequisite skills:

- Basic understanding of a quadratic function and parabolic shape
- Use of measuring wheel
- Use of inclinometer/inclometer
- Use of stop watch

Lab objective: Students will graph a negative quadratic formula

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*

Mathematics K–12 Learning Standards:

- HSF-IF.C.7- Analyze functions using different representations
- HSF.LE.B.5- Interpret expression for functions in terms of the situation they model

Standards for Mathematical Practice:

- Reason abstractly and quantitatively
- Modeling with mathematics
- Use appropriate tools strategically

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

- In response to the essential questions:
    - W.9-10.4- Produce clear and coherent writing in when the development organization and style are appropriate to task, purpose, and audience.

- SL.9-10.4- Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience and task.

K-12 Science Standards

- WHST.9-10.4- Produce clear and coherent writing in which the development organization and style are appropriate to task, purpose, and audience

Technology

- 2.4.1 Formulate and synthesize new knowledge

Engineering

- Systems and System Models: Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4)

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☐ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☐ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
☐ Think Creatively
☒ Work Creatively with Others
☐ Implement Innovations
Critical Thinking and Problem Solving
☒ Reason Effectively
☐ Use Systems Thinking
☐ Make Judgments and Decisions
☐ Solve Problems
Communication and Collaboration
☒ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
☒ Access and Evaluate Information
☐ Use and manage Information
Media Literacy
☐ Analyze Media
☐ Create Media Products
Information, Communications and Technology (ICT Literacy)
☐ Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
☐ Adapt to Change
☐ Be Flexible
Initiative and Self-Direction
☒ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners
Social and Cross-Cultural
☒ Interact Effectively with Others
☒ Work Effectively in Diverse Teams

Productivity and Accountability
☐ Manage Projects
☒ Produce Results
Leadership and Responsibility
☒ Guide and Lead Others
☒ Be Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Stop Watch (or stop watch apps on phones)
- Measuring Wheel (1- (1/5 of classroom size)
- Baseball Bat x1
- Base Ball x1
- Inclometer/Inclinometer (2-(1/5 of classroom size)
- Record resources (paper and writing utensils)

Set-Up Required:

- Pre-determine which students will have which jobs
    - Record keeper; running/listening for different read-outs
    - Inclinometer/inclometer reader; watching to determine the peak height of the ball using a special tool
    - Distance *runner*; will track distance of the ball hit with a measure wheel
    - Hitter; will need to hit the baseball with a baseball bat without injuring teacher or classmates
    - Timer; will start the stopwatch the second the ball comes in contact with the bat and stop it the second the ball lands on the ground
- Have items and procedure laid out for students ahead of time because everyone will be very separated on the field at time of lab.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Work Creatively with Others
- Reason Effectively
- Access and Evaluate Information
- Manage Goals and Time
- Interact Effectively with Others
- Work Effectively in Diverse Teams
- Produce Results
- Be Responsible to Others
- Opportunities to… Guide and Lead Others

Cooperative Learning:

- Students will be sharing thinking in end-of-work reflection
- Students will be working together to interpret data (height/angle of ball's peak height, time, distance)
- Students will be working together to make predictions and interpret parabolic curves.

Expectations:

- Students will dictate role in lab
- Students will work together to make lab work effectively
- Students will graph each ball hitters ball trajectory from data collected and parabolic knowledge

Timeline:

- Teacher will introduce quadratic equations in 1-2 previous lessons
- Student and Teacher will work to be prepared for lab by the day before
- Day of…
    - Students will grab their equipment
    - get set up on football field
    - Teacher will throw ball for student to hit while other students begin to track data
    - Once all data is collected from one ball hit, then next student will go and the process will repeat.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- The effects of gravity on an object in motion traveling through the air
- Students get the opportunity to "play ball"
- Students practice recording data
- Students practice interpreting data

Career Applications

- Students practice recording data
- Students practice interpreting data
- Baseball player
- Baseball stat recorder

Optional or Extension Activities

- Since we are using inclinometer/inclometer, this can be extended by having students work on their own using trig to determine the height of the ball (for geometry students) instead of the teacher determining height based on angle measurement using trig (for algebra students)
- Students could work to determine the equation of balls trajectory

WAMC Lesson Plan

Name(s): Michelle McCallum
Email Address: michelle.mccallum@vansd.org
Lesson Title: Quadratic Home-Run
Date: Summer Conference 2022

<table>
<tr><td colspan="2">Big Idea (Cluster): Developing-an-understanding-of and Graphing Quadratic Functions</td></tr>
<tr><td colspan="2">Mathematics K–12 Learning Standards:
HSF-IF.C.7- Analyze functions using different representations
HSF.LE.B.5- Interpret expression for functions in terms of the situation they model</td></tr>
<tr><td colspan="2">Mathematical Practice(s):
Reason abstractly and quantitatively
Modeling with mathematics
Use appropriate tools strategically</td></tr>
<tr><td>Content Objectives:
Students will build an understanding of the behavior of a quadratic function and develop an understanding of its role in the world</td><td>Language Objectives (ELL):
Students will be able to make predictions of the behavior of a quadratic function and convert their verbal/observational understanding into a graphed quadratic function</td></tr>
<tr><td>Vocabulary:
Parabola
Vertex
Independent Variable
Dependent Variable
Intercepts</td><td>Connections to Prior Learning:
Students will make connections with their prepared into-understanding of quadratic understanding
Students will make connections between linear and quadratic functions
Students will use their understanding of the coordinate plane in their understanding of quadratic functions</td></tr>
<tr><td>Questions to Develop Mathematical Thinking:
Which side of the parabola is longer?
At what time would the ball have reached its peak height?
What is the starting height of the ball?
At what point in time might the ball start at the height of zero?
What other applications could you see this lab working with?</td><td>Common Misconceptions:
The ball’s height starting at 0
Misuse of tools</td></tr>
</table>

Assessment (Formative and Summative):

- The final production of the parabolas

Materials:

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- Measuring Wheel (1- (1/5 of classroom size)
- Baseball Bat x1
- Base Ball x1
- Inclinometers (2-(1/5 of classroom size)
- Record resources (paper and writing utensils)
- Whiteboard and classroom for some lesson work

Instruction Plan:

Introduction: Teacher introduces parabolas and quadratic functions

Explore: Students will make observations based on a model of a parabolic function
Then engage in a lab surrounding the idea

When I observe students:
I will see… correct use of vocab
Discussion surrounding the shape of a parabola/quadratic function
Students tracking data from their lab and implementing it into their graphs

Questions to Develop Mathematical Thinking as you observe:

- Which side of the parabola is longer?
  - At what time would the ball have reached its peak height?
- What is the starting height of the ball?
  - At what point in time might the ball start at the height of zero?
- What other applications could you see this lab working with?

Answers:

- Each side of the parabola is the same; a parabola is symmetric about the vertex
- The peak height would occur (theoretically) in the middle of the time from the moment the ball is hit to when it hits the ground
- The starting height of the ball would be the height of the ball when it hits the bat (half that of the person hitting?)
- Students would calculate at what point the ball was theoretically at the same height as starting (before it hits the ground in the end) and add the time between that point and it hitting the ground, to the starting time…
- Any activity/action where an object is moving through the air

Summarize: Students will be introduced to parabolas and quadratic functions, they will make observations based on a quadratic model, students will be assigned/choose roles for the lab, students will engage in lab, students will practice producing various quadratic graphs based on lab.

Career Application(s):

Applications of quadratic functions:

- Electrical, chemical, and computer engineers work with many complex systems that involve quadratic equations
- Audio engineers use quadratics equations to design sound systems that have the best sound quality possible.
- Astronomers use quadratic equations to describe the orbits of planets, solar systems and galaxies. Physicists use them to describe different types of motion.
- Chemists need quadratic equations in order to describe certain types of chemical reactions.
- Quadratic equations are also used in agriculture in situations of finding optimal arrangement of boundaries to produce the biggest fields and pens given the materials on hand.

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