Haberlach Lab #2 WAMC

Math Concept(s):

Understanding nonlinear relationship using concrete representations and modeling to address real world problems including elements of estimations, measurement, interpreting data and vector quantities as indicated in the CCSSM listed below.

Source / Text:

Lab: Modified from: A basketball and a tennis ball

Curriculum: Agile Mind Digital Curriculum: Algebra I

Topic 12: Other Nonlinear Relationships

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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):

This lab takes place at the beginning of the first week of Topic 12. Other "Nonlinear Relationships" in our Agile Mind Algebra I curriculum. Every Friday we do "hands on" projects, called STEM challenges that connect the math that we are studying to real world applications that include elements of the other STEM disciplines, as well as topics of interest to students. Thinking about the forces acting on different size dropping balls and testing them will provide students with the opportunity to make, study, and learn from modeling with concrete representations of forces involved in collisions of different size objects. Additionally, we will be extending the math concepts to include numerical and graphical representations in math modeling and a short introduction to systems thinking, forces, and vectors quantities in Week #2.

Lab Plan

Lab Title: Follow the Bouncing Balls!

Prerequisite skills: The student must be proficient at measuring distance (length/height) with a ruler in inches or cm and making estimations of height above ground.

Lab objectives: The main objective of this lab is for the student to gain understanding of the characteristics associated with nonlinear relationships using an easy and engaging real world activity after beginning to explore nonlinear relationships and compare them to linear relationships earlier in the week. This lab will also serve to introduce students to the forces associated with bouncing balls, the scientific concepts of mass, momentum and kinetic energy. Students will also learn to organize data to understand possible correlations and make predictions.

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

Mathematics K–12 Learning Standards:

- CCSS MATH. CONTENT. HSF. IF. B.4.; CCSS.MATH.CONTENT.HSF. IF. B.2; CCSS.MATH.CONTENT.HSF. IF. B.6; CCSS.MATH.CONTENT.HSF. IF. C.7; CCSS.MATH.CONTENT.HSS.ID.B.6 CCSS.MATH.CONTENT.HSN.VM.A.1;

Standards for Mathematical Practice:

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of others.
- Model with mathematics.
- Use appropriate tools strategically

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

- CCSS.ELA-LITERACY.SL 9-10.1.B (working with peers to set rules for collegial discussion and decision making.

K-12 Science Standards:

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).

Technology

After completion of lab to better understand results:

- 3.a Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
- 3.b Students evaluate the accuracy, credibility, and relevance of information, media, data or other resources.

Engineering

N/A

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 for follow the bouncing balls: one tennis ball, one basketball, and one meter stick for each group and paper/pencil to record the height of all three drops

Set-Up Required:

- No special set up required. However, the tennis balls can reach impressive heights, so should be done outdoors and appropriate safety measures should be taken to protect students and property. To mitigate safety issues, when dropped together, tennis ball should be aligned as closely as possible to the center of the basketball.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

Cooperative Learning:

- Students will do the lab in groups of 2, 3 or 4 with students all helping to construct elements of the bridge, as well as measuring and/or testing and data testing/collection.

Expectations:

- Students will describe how each contributed to the project on the lab sheet for each group

Timeline:

- The lab is expected to take approximately 40 minutes as described in the lab instructions: 5 min- intro/lab instructions; 10 min – move outside make all three drops and record data; 5 min move back inside; 10 min consolidate results and make conjectures in group discussion. 10 min to complete lab sheet and submit

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from making concrete representations from lab, measuring, recording, collecting different types of data.

In this lab students will also gain further skill using concrete representations, mathematical modeling, exploring nonlinear data, organizing data and predicting future outcomes.

Career Applications

- athletes, physicists.

Optional or Extension Activities

- This lab can be adapted/extended to cover many math and science concepts such as forces, systems, and using/understanding vector quantities

Copy of Lab Instructions:

Follow the Bouncing Ball

You can do this in groups of 3 or 4 with folks from your table

Materials:

1 basketball

1 tennis ball

One meter stick

Paper and pencil to record heights/estimated heights

Chromebook or phone to take photos or videos

Goal. Each team will estimate and document the heights achieved by each ball or combination of both from a dead drop of 1 meter. Each person will also document the estimated heights achieved, individual contributions to the work and reflections on a lab sheet that will be turned in with photos on Canvas by the end of our class period.

Rules: All ball drops will be conducted and recorded OUTSIDE away from the building and other people. When dropping balls together, please be aware of those around you and try to drop the balls with the tennis ball as closely aligned to the center of the basketball.

Before class, please complete the short survey. You must complete this survey to be able to complete the lab sheet. The link is on Canvas.

(Note to reviewer: This google form is survey that asks students to predict which ball will bounce the highest from a still drop from 1 meter. a) basketball b) tennis ball c) both together)

1. Drop (Do NOT throw) each ball from still position (dead drop) from a height of one meter

2. Measure/estimate the height of its first bounce (you might need a couple of people, objects of know size, and some practice to obtain any degree of accuracy) You may also wish to use a phone to take a photo or video to capture a picture of the height at first bounce and use that to improve your estimate)

3. If time allows you may conduct each ball drop more than once

6. You have about 10 minutes to complete all three drops

7. You will drop the basketball first, then the tennis, and then both balls together and record each trial.

8. Then we will all come back into the classroom and discuss the results.

9. After our discussion, we will watch a short video that will help you understand what is going on in this lab. Here is the link: Physics Girl and the Bouncing Balls

10. Please submit completed individual lab sheet as well as any photos from your group's lab on Canvas for credit.

Rubric for Lab Participation- 4 pt scale

1- Attended class, participated in survey, and/or activity and/or discussion-as noted by teacher- submitted nothing- Emerging

2-Attended class, participated in survey, activity and discussion, submitted incomplete lab sheet/photos-Basic

3-Attended class, participated in survey, activity and discussion, submitted complete lab sheet/photos-Proficient

4- Attended class, participated in survey, activity and discussion, submitted complete lab sheet/photos that either were very detailed, demonstrated interesting/innovative connections to learning OR submitted completed set of lab sheets/photos for two different designs-Distinguished

Student Lab Collection and Reflection Sheet

Name_____

Period_____

Paper Span Bridge Project Day 1

1. After your download and submit your photos- if any- then please write down the names of the members of your group and describe one thing each person did to help the group:

2. Please record your group's data below. You may show it any way you would like to include sketches if you would prefer. Please make sure that you include the units of measurement for all data.

3a. What was your original prediction on the google form on what would bounce the highest?

b. What bounced the highest? _____

4. Please reflect on your prediction, the group's results, and our class results and answer the following three questions:

What, if anything, surprised you?

What, if anything, did you learn about forces/energy/collisions in this lab?

Based on our work this week comparing linear and nonlinear relationships if you were to see a graph of the tennis ball's speed right before and immediately after its collision with the basketball do you think it look linear or nonlinear? Why?

Washington Applied Math Council

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