Sports Collisions: What makes a player great?

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Grade: 4th

Engaging phenomena or data

Students will be shown the chart of the most homeruns ever hit and watch a clip of the longest homerun ever hit. Both sets of records are held by Barry Bonds. Students will be questioned as to why his ball traveled as far as it did. Over the course of the lesson, the students will record the distances of one type of ball colliding with another object, tennis ball to racket, car to car (Nascar), baseball to bat, softball to bat, and attempt to adjust distances with varying forces. They will relate the collisions to the transfer of energy.

http://www.baseball-reference.com/leaders/HR_career.shtml

https://www.youtube.com/watch?v=MDDcJndvvQ0

Cultural Relevance

Since I teach at a low income, rural, Title 1 school many of my student pass their after school time by playing neighborhood pick-up games of sports or even return to school to use the provided courts and fields. Many of my students play or watch organized sports in which objects collide. This lesson will take them outside of the classroom and will be applicable across many sports and gym classes, not just baseball. Students will be able to perform the work in cooperative groups and engage in science discourse.

E-learning connections

The students will record their lab stations and makerspace on I-pads so that evidence and data can be saved and observations derived.

Materials

Lab report
Rubric for lab report
Rubric for makerspace engineering and design challenge
Makerspace supplies/marbles
Various sports equipment for collisions (i.e. tennis ball to racket, car to car (Nascar), baseball to bat, softball to bat)
iPads

Lesson Section/Time	Teacher and Student Activities (Include formative assessment throughout)	Key Questions
Engage	Teacher will: • show chart of the most homeruns ever hit • show a clip of the longest homerun ever hit. • Question S and lead S to create questions related to collisions. Student will: • view the materials related to Barry Bonds • Generate questions that will be useful in investigating the transfer of energy by contact forces between colliding objects.	Why do you think Barry Bonds was so successful at the game of baseball? Why did his baseball travel as far as it did? What do you think affects the trajectory?
Explore	Student will: • work in groups at stations to record the distances of one type of ball colliding with another object, tennis ball to racket, car to car (Nascar), baseball to bat, softball to bat, and attempt to adjust distances with varying forces. They will relate the collisions to the transfer of energy while completing a lab report. They will hypothesize what they think will happen when they change the forces of the sporting equipment. • record raw data (distance) from each attempt at each sporting station on their lab report • Record their actual collision attempts on the ipad for observation purposes Teacher will: • Give expectations for stations and lab report • Question and facilitate	Where does the "crash" sound come from? What cause/effect relationships and patterns to you see? What conclusions can be drawn regarding the types of equipment and distances?

	Teacher will: • Begin to label students finding regarding Newton's Laws • Explain the cause of sounds in collisions • Explain the change in speeds and challenge the students to control the collisions Student will: • Experiment with collisions by changing speeds to hit certain targets on the playground from central locations • Experiment with collisions by trying to create louder air energy transfer	What patterns can you predict for every sports collision? What variables affect those given patters? What causes the change in motion during the collision?
Explain	Teacher will: • Give expectations for makerspace groups • Question and facilitate groups Student will: • Using a makerspace, they will use their understanding of the transfer in energy caused by collision to engineer a "track" that moves marbles through into a centralized bullseye. There will a large bullseye in the floor in the middle of the room. Students will be assigned to workspaces around the outside of the room and will design tracks to land a marble in the bullseye. Each group must use a collision with a transfer of energy from one marble to another in order to accomplish their goal. Students will record all attempts on iPads in order to diagnosis errors and make needed changes.	Where will you place your second marble? How will you hold it stationary until the collision occurs? How will changing your design alter your marble's trajectory?
Evaluate	1. Students will complete a lab report throughout the lesson and complete the conclusion to the report to close the lesson. At the beginning of the lesson, the students will hypothesize what they think will happen when they change the forces of the sporting equipment. Throughout the lab, they will record the raw data from each attempt at each sporting station. At the end of the lesson, they will use their data to write a conclusion statement aligning with their hypothesis. Lab reports will be scored using a rubric. 2. Students will also record questions they have asked during each sporting station as predictions are made.	Were you able to support your hypothesis? What was your question and how did you do your investigation to answer that question?

	3. Students will be scored on a rubric for their transfer of energy makerspaces.	

NGSS Performance Expectations 4-PS3-3.

Students who demonstrate understanding can:
Ask questions and predict outcomes about the changes in energy that occur when objects collide.

[Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships	PS3.A: Definitions of Energy • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. PS3.B: Conservation of Energy and Energy Transfer • Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. PS3.C: Relationship Between Energy and Forces • When objects collide, the contact forces transfer energy so as to change the objects' motions.	Energy and Matter • Energy can be transferred in various ways and between objects

Common Core State Standards (optional):

Math:

- 4 MD A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

- 4 MD A.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.

ELA:

- W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Student Learning Objectives (with DOK terms)

Students will be able to:

I can investigate that there is a transfer of energy by contact forces between colliding objects that results in a change in the motion of the objects.

Lab Report Rubric

	Excellent (4)	Good (3)	Needs Improvement (2)	Poor (1)	0
Introduction	1. Includes the question to be answered by the lab 2. States hypothesis that is based on research and/or sound reasoning 3. Title is relevant. 4. Hypothesis (prediction) is testable.	One of the "excellent" conditions is not met.	Two of the "excellent" conditions are not met.	Three of the "excellent" conditions are not met.	None of the "excellent" conditions are met.
Methods	A description or step-by-step list of how the experiment was performed.	A description or step-by-step list of how the experiment was performed	Description unclear, couldn't be repeated.	Description unclear, couldn't be repeated.	Description not included.
Results (Tables and Graphs)	Results and data are clearly recorded, organized so it is easy for the reader to see trends. All appropriate labels are included.	Results are clear and labeled, trends are not obvious,	Results are unclear, missing labels, trends are not obvious at all.	Results are present, though too disorganized or poorly recorded to make sense of.	Results are not included.
Data Analysis	The data and observations are analyzed accurately, trends are noted, enough data was taken to establish conclusion.	Analysis somewhat lacking in insight, enough data, though additional data would be more powerful	Analysis lacking in insight, not enough data was gathered to establish trends, OR analysis does not follow data.	Analysis poor, minimal data, inaccurate analysis.	Analysis not included.
Conclusions	1. Summarizes the essential data used to draw conclusions 2. Conclusions follow data (not wild guesses or leaps of logic) 3. Discusses applications of experiment ("real world" connections) 4. Hypothesis is rejected or accepted based on the data.	One of the "excellent" conditions is not met.	Two of the "excellent" conditions are not met.	Three of the "excellent" conditions are not met.	None of the "excellent" conditions are met.
Format	Neat, organized with headings, no spelling/grammar errors.	Organized with headings, few spelling/grammar errors.	Somewhat lacking in organization, multiple spelling/grammar errors.	Lacking in organization, multiple spelling/grammar errors, not neat.	No organization; multiple spelling/grammar errors, not neat, not all lab report components included.

*Rubric from modscience

Sample Rubric

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	UNSATISFACTORY	COMPETENT	PROFICIENT	DISTINGUISHED
TECHNIQUE /CONCEPTS	Work lacks understanding of concepts, materials and skills.	Work shows some understanding of concepts, materials and skills.	Work reflects understanding of concepts and materials, as well as use of skills discussed in class.	Work shows mastery of skills and reflects a deep understanding of concepts and materials.
HABITS OF MIND	Student passively attempts to fulfill assignment without much thought or explora-tion of possibilities. Student refuses to explore more than one idea.	Developing exploration of possible solutions and innovative thinking. Student has more than one idea but does not pursue.	Student explores multiple solutions and innovative thinking develops and expands during project.	Consistently displays willingness to try multiple solutions and ask thought provoking questions, leading to deeper, more distinctive results. Student fully explores multiple ideas and iterations.
REFLECTION & UNDERSTANDING	Student shows little awareness of their process. The work does not demonstrate under-standing of content.	Student demonstrates some self-awareness. Work shows some understanding of content, but student cannot justify all of their decisions.	Student shows self-aware-ness. Work demonstrates understanding of content and most decisions are conscious and justified.	Work reflects a deep understanding of the complexities of the content. Every decision is purposeful and thoughtful.
CRAFTSMANSHIP	Work is messy and craftsmanship detracts from overall presentation.	Work is somewhat messy and craftsmanship detracts somewhat from overall presentation.	Work is neat and craftsmanship is solid.	Work is impeccable and shows extreme care and thoughtfulness in its craftsmanship.
RESPONSIBILITY	Frequent non-necessary absences, tardiness, disrespect for classmates and teacher. Disregard for materials and work such as refusal to clean up or throwing out work.	Student is sometimes illegally absent, tardy, or disrespectful. Must be persuaded to assist in clean up and to take work home.	Student is most often present, on time, and respectful. Usually participates willingly in clean up and takes pride in work.	Student is consistently present, punctual, and respectful of classmates and teacher. Self-directed clean up and ownership of work.
EFFORT	Work is not completed in a satisfactory manner. Student shows minimal effort. Student does not use class time effectively.	Work complete but it lacks finishing touches or can be improved with a little effort. Student does just enough to meet requirements.	Completed work in an above average manner, yet more could have been done. Student needs to go one step further to achieve excellence.	Completed work with excellence and exceeded teacher expectations. Student exhibited exemplary commitment to the project.

Sample Lab Report

Title_____ Name_____ Date_____

Objective:
What do you want to know?

Background Information:
What do you already know?

Hypothesis:
What are your predictions?

Materials/Procedures:
What will you need? What steps will you take?

Data/Observations:
What did you find out/observe?

Conclusions:
What does your data tell you?