Advanced Manufacturing & Prototyping Integrated to Unlock Potential

Physical Science Data Visualization (8DVS)

"Riding the Concrete Wave" – Part 1

Helmet Challenge

Module Description	Students engage as crash-test scientists for the *SkateTech* company to test helmets for skateboarders. The students use a computer simulation to collect the data on helmet safety that will inform their recommendation on skateboarding safety. They present their data in tables, scatter plots and bar graphs to learn how visualizing and presenting the data in different ways can help illuminate the relationship between speed and kinetic energy. The module covers some basic concepts regarding energy, energy transfer and brain injuries in sports, seeding further exploration of GPS standards later in the semester or year.	
Related Georgia Performance Standards	**S8P2.** *Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system.* a. Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed, and potential energy to mass and height of an object.	
Module Timeline	**50-minute class periods:** 5 days Day 1: Section 1 Day 2: Section 2, 3 Day 3: Section 3 Day 4: Section 3,4 Day 5: Section 4	**90 minute blocks:** 3 days Day 1: Sections 1,2 Day 2: Section 3,4 Day 3: Section 4
Documents Included in the Download	**Student Materials Folder** • Student Edition *(recommended to be printed double sided)* • Student Worksheet Packet *(recommended to be printed double sided)* • Linear and Nonlinear Relationships Student Summary Page #5 *(recommended to be printed single sided)* • Data Visualization Transparency *(recommended to be printed single sided)* **Teacher Materials Folder** • Materials List • Annotated Teacher's Edition • Teacher Preparation Guide • Answer Keys • Videos	

5E Stage	Student Activities How will students engage actively in the three dimensions throughout the lesson?	Teacher Activities How will the teacher facilitate and monitor student learning throughout the lesson?
Engage How does the lesson capture student interest, activate prior knowledge, and connect to a complex question, global issue, or real world problem?	• Students are introduced to the Helmet Challenge and that they will use a computer simulation for collecting data for this challenge *(1.1,1.2)*	• Guide students through text to check for understanding & play (2) skateboarding videos • Activate prior knowledge about helmets, skateboarding and general head safety with students
Explore How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem?	• Students complete computer simulations where they investigate and record data related to height, speed and energy and record their data. *(1.2,3.1,3.3)*	• Review how students should work through each step of the sims. • Keep students on task during the sim, monitor that it is functioning well for each group. • Use discussion questions to check for understanding
Explain How does the lesson allow students to develop, share, critique, and revise their own explanations before connecting those to accepted scientific explanations and terminology?	• Students learn energy basics and terminology to apply to the simulations that they are exploring *(2.1,3.2)* • Students learn more about traumatic brain injuries, how helmets work and how energy transferred affects brain injuries *(3.4)*	• Facilitate reading and understanding about energy, kinetic energy and energy transfer • Discuss as a class evidence for energy transfer (as seen in the video) and how helmets work to protect the head
Elaborate How does the lesson allow students to extend their conceptual understanding of the three dimensions through opportunities to apply knowledge, skills, and abilities in new experiences?	• A new way of visualizing data- students create a bar graph that displays the max speed and kinetic energy for positions A through E. They then create a third graph that summarizes the speed and kinetic energy data. Students then use a transparency to create linear and non-linear graphs to better visualize the rate at which speed and kinetic energy change with height *(4.1,4.2)*	• Focus on the importance of visualization to communicate and make meaning for others. • Discuss the alternate visuals and what they communicate about the rates of increase as a skater changes position. • Review the linear and non-linear relationships evident in the measures of motion of a skater in a halfpipe. • Hold a culminating discussion about the module and personal connections. Illuminate the point that the visuals help to communicate the dramatic rise in KE even those the speed increases only a little.
Evaluate How does the lesson—through both formative assessments embedded throughout the lesson and a summative assessment that might coincide with the elaborate phase—make visible students' thinking and their ability to use practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions?	**Formative:** Ongoing questioning and discussion *(all sections)* Simulation Data, Section 1 Student Sheet *(1.2)* Simulation Data, Section 3 Student Sheet *(3.1)* Speed & Kinetic Energy Analysis Student Sheet *(3.4)* **Summative:** Data Visualization: Student Sheet (*4.2*)	

	1.1	1.2	2.1	3.1	3.2	3.3	3.4	4.1	4.2
Engage	—	—							
Explore		—		—		—			
Explain			—		—		—		
Elaborate								—	—
Evaluate		—		—			—		—

Section 1 – The Helmet Challenge *(50 minutes)*

The overall goal of the Helmet Challenge is to begin developing students' understanding of the usefulness of analyzing data through data visualization. While students will learn some aspects of energy and energy transfer, those are secondary outcomes. Here, developing data analysis skills should be the primary focus. Students will use simulation investigations to approximate the real-world effects of energy transfer on the heads of skateboarders. They will collect data from the simulation, graph data, and visualize the linear and nonlinear relationships associated with energy and speed. As the main engagement strategy, students will assist the skateboarding advocacy group SkateTech to educate other students about helmet safety. The focus of Section 1 is to provide students with a background of the challenge and to introduce them to the simulation that they will use for collecting data. Students complete two simulation investigations: to collect data on the speed of skaters in a half-pipe and to collect data on the damage done to a pumpkin when dropped from various heights. NOTE: Results from using the simulation may vary between groups very slightly. This is due to varying processor speeds in devices that run the sim (laptops, tablets, etc). These differences will be very small, and the general trends will remain clear to see.

Preparation

Materials	Student Pages
• Alana and Shaun Video • Skater Mishaps Video • Laptop or tablet • Simulation URL http://ampitup.gatech.edu/simulations Access code for Sims 1&2: homer	• Simulation Data, Section 1 Student Sheet
Prep the Day Before: Locate and prepare videos for projection. Review the section and challenge. Verify sims will run on laptops/tablets. Complete sim investigation, collecting your own data, and compare to answers on master copy.	

Planning

GPS	S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system. *a. Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed, and potential energy to mass and height of an object.*
NGSS	**Performance Expectation:** **MS-PS3-1:** *Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.* **Disciplinary Core Idea: PS3.A**: *Definitions of Energy.* **Practices**: *Analyzing and Interpreting Data* **Crosscutting Concepts:** *Patterns, Cause and Effect, Systems and Models, Energy and Matter*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Simulation	• How can a computer simulation be used to investigate helmet safety? • What data trend emerged from each investigation?	• Discussion Questions: **Participation** • Simulation Data, Section 1 Student Sheet: **Formative**

Section 2 – Add to Your Understanding- Energy Basics *(15 minutes)*

In order for students to understand the context of their challenge, students need to have some base-level knowledge of energy, specifically kinetic energy. Students will read a basic overview of kinetic energy and discuss examples.

Preparation

Materials	Student Pages
• N/A	• N/A
Prep the Day Before: Review the section and think of 4-5 other examples of "moving energy" to help students gain understanding of kinetic energy.	

Planning

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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Kinetic Energy • Joules	• Where and when does the skater or pumpkin have kinetic energy? Why?	• Discussion Questions: **Participation**

Section 3 – Investigate Kinetic Energy *(85 minutes)*

The focus of Section 3 is to provide students a better sense of how kinetic energy affects the head-on impact, and how helmets, in turn, affect the kinetic energy experienced by the head. Once again, students complete TWO simulation investigations: 1. To collect data on the kinetic energy of the pumpkin swinging from the five pendulum positions, and 2. To collect data on the kinetic energy a helmet absorbs when swung from the five different pendulum positions. Additionally, students will gain knowledge about energy transfer and they will learn about the varying levels of trauma that the brain experiences during different sized impacts. Ultimately, students begin to cross-reference their data collected with potential brain injury.

Preparation

Materials	Student Pages
• How Helmets Work Video • Skating Without a Helmet Video • Laptop or Tablet • Simulation URL http://ampitup.gatech.edu/simulations Access code for sim 3: epic sim 4: poem	• Simulation Data, Section 3 Student Sheet • Speed and Kinetic Energy Student Sheet
Prep the Day Before: Locate and prepare videos for projection. Review the section and challenge. Complete sim investigation, collecting your own data, and compare to answers on master copy. Verify sims will run on laptops/tablets.	

Planning

GPS	S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system. a. *Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed, and potential energy to mass and height of an object.*
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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Energy Transfer • Energy Absorbed	• How do these images provide us with important data about the health of deep water ecosystems and communities?	Discussion Questions: **Participation** Simulation Data, Section 3 Student Sheet: **Formative** Speed & Kinetic Energy Student Sheet: **Formative**

Section 4 – Making Your Results More Visual *(60 minutes)*

The focus of Section 4 is to zero-in on the real purpose of the module: data analysis, visualization in this case, is the powerful tool in understanding data that maybe to large or complex to summarize in table or charts. Students will create multiple visualizations of the speed and kinetic energy data they have collected. The bar graphs show how kinetic energy experiences large increases with position change, while speed only increases at a consistent rate. Students will then create a second visual so this distinction, but in a new format that they will compare and contrast to the bar graph. Finally, students use the bar graph visual to create a third visual that more efficiently, though more abstractly, displays the linear (speed) and non-linear (kinetic energy) relationships at work in the simulation and challenge. Eventually, students reflect on what these relationships mean for the challenge: helmets are necessary, even at low positions and speeds.

Preparation

Materials	Student Pages
• Colored Pencils (red, blue, green, orange, brown)- 1 of each per student • Wet/Dry Erase Markers- 1 per student	• Data Visualization Student Sheet • Data Visualization Transparency Handout • Linear and Non-Linear Relationships Handout
Prep the Day Before: Review the section. For practice, draw your own graphs for Section 4.2, Parts A-D and compare to master copy.	

Planning

GPS	S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system. c. *Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed, and potential energy to mass and height of an object.*
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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Linear Relationship • Non-linear Relationship • Bar Graph • Line Graph	• How do the changes in speed of the skater compare to the changes in kinetic energy of the skater as the skater moves to higher and higher positions? • Why do even small increases in ramp height dictate that skaters need to wear a helmet? • What is the key differences between linear and non-linear relationships when graphed? • How do data visualizations help communicate data more effectively than charts and tables?	• Class Discussion Question: **Participation** • Data Visualization Student Sheet: **Summative**