Advanced Manufacturing & Prototyping Integrated to Unlock Potential

Physical Science Data Visualization (8DMS)

"Riding the Concrete Wave" – Part 2

Skate Park Challenge

Module Description	Students engage as product reviewers for the *SkateTech* company's website to craft a product review of various helmets for various abilities of skateboarders. The students use computer simulations, data visualization, and computational skills to match a profiled skater to their best-fit helmet. Students use a *Decision Grid* (matrix) to weigh the multiple criteria necessary to make such a decision. Students work in teams to decipher their grids to make what is not always a clear-cut decision. The module covers some basic concepts regarding energy, energy transfer and brain injuries in sports, while mostly introducing and reinforcing the concept that good decisions are made on scientific evidence. This module features the work of Dr. Michelle LaPlaca and Georgia Institute of Technology Biomedical Engineering faculty investigating neurotrauma and traumatic brain injuries.	
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, 2 Day 2: Section 3 Day 3: Section 3, 4 Day 4: Section 4 Day 5: Section 5	**90 minute blocks:** 3 days Day 1: Sections 1,2,3 Day 2: Section 3,4 Day 3: Section 4,5
Documents Included in the Download	**<u>Student Materials Folder</u>** • Student Edition *(recommended to be printed double sided)* • Student Worksheet Packet *(recommended to be printed single sided)* **<u>Teacher Materials Folder</u>** • 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 Skate Park Challenge *(20 minutes)*

The overall goal of the Helmet Challenge is to begin developing students' understanding of how to use multiple pieces of evidence to make a decision. Often, real-life challenges require scientists and engineers to make decisions where there isn't always a clear answer. Scientific investigation and design can reveal useful information and data to solve a challenge, but scientists and engineers need to balance multiple types of information to make an informed, valid choice. While students will learn some aspects of energy and energy transfer, those are secondary outcomes. Here, developing decision making skills should be the primary focus. As the main engagement strategy, students will assist the skateboarding advocacy group SkateTech to review helmet types and match them to three profiled skaters. Students will use simulation investigations to approximate the real-world protection various helmets provide a skater. Additionally, they will be using skill and experience to select the proper helmet for one of the three profiled skaters. They will collect data from simulations and use a decision matrix to help them select the right helmet for each skater. The focus of Section 1 is to provide students with a background of the challenge and to introduce them to the skater profiles at the center of the challenge. Students learn that they will be writing helmet reviews for three profiled skaters to help readers of the SkateTech blog identify their helmet needs. Section 1 concludes with the class reviewing and discussing the three skater profiles. 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
• N/A	• N/A
Prep the Day Before: Read and review Section 1 and the challenge.	

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-PS3-5:** *Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.* **Disciplinary Core Idea: PS3.A**: *Definitions of Energy.* **Practices**: *Engaging in Argument from Evidence* **Crosscutting Concepts:** *Patterns, Cause and Effect, Systems and Models, Energy and Matter*

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Simulation	• What is the challenge presented? • What are we trying to figure out? • What are the types of factors that would affect a helmet choice?	• Discussion Questions: **Participation**

Section 2 – Investigate Helmet Performance *(30 minutes)*

Students complete two simulation investigations to collect data and determine how much energy different helmets absorb. The first simulation, "Smashing with Sensor," is part of the Helmet Challenge so if students still have that data they can just record it on the new student page. Students are introduced to 6 different helmets and they investigate how much protection they offer. Each group investigates a helmet and then the class shares data as a whole.

Preparation

Materials	Student Pages
• Laptop or tablet • Simulation URL http://ampitup.gatech.edu/simulations Access code: poem	• Helmet Tests, Section 2 Student Sheet
Prep the Day Before: 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

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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Kinetic Energy • Joules	• What data trend emerged from each investigation?	• Discussion Questions: **Participation** • Helmet Tests Section 2 Student Sheet: **Formative**

Section 3 – Skate Park Analysis *(70 minutes)*

Students complete analysis of how each of the SIX helmets would perform on TWO common skate park tracks. Using the kinetic energy profiles for The Big Kahuna and The Launchpad skate park runs, students will calculate the potential damaging kinetic energy not absorbed by each of the six helmets. Through analysis in Section 3.3, students obtain a risk profile of each helmet for each track. Section 3 concludes with the class reviewing and discussing four questions to help everyone reflect on the analysis.

Preparation

Materials	Student Pages
• Colored pencils: 1 red, yellow and green (per student) • Helmet Tests, Section 2 Student Sheet (already completed)	• Skate Park Analysis, Section 3 Student Sheet
Prep the Day Before: Review the section and complete the analysis using the masters for the *Skate Park Analysis – Section 3* sheet. Review the math students will need to perform and prepare for any possible math remediation needs of some students.	

Planning

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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Energy Absorbed • Non-Absorbed Energy ('Injury' Energy)	• Why do we need to calculate the energy that is not absorbed by the helmet? • How does color coding the risk help you analyze helmet performance?	• Discussion Questions: **Participation** • Skate Park Analysis, Section 3 Student Sheet: **Formative**

Section 4 – Making Decisions Based on Evidence *(85 minutes)*

The focus of Section 4 is to provide students the ability to systematically make a decision about the challenge, despite the fact that there are multiple criteria and points of data. Students will use a Decision Matrix to compare helmet performance against skater skill, experience, budget and helmet cost. The grid employs a color-coding schematic (red and green) to help students visualize which helmets might be a good candidate for each skater profile.

Preparation

Materials	Student Pages
• Colored Pencils (red and green)- 1 of each per student • Skate Park Analysis, Section 3 Student Sheets (already completed)	• Decision Matrix Student Sheets (3 for each student)
Prep the Day Before: Review the section and complete the Decision Matrix for each skater so that you understand the experience. Compare your answers to the masters' copies. Some individual answers may vary, but see if there is general agreement. Prepare an overhead or document projection of each Decision Matrix to assist in explaining how the grid works and to complete the Red helmet example for each skater with the class.	

Planning

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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Decision Matrix	• How does summarizing multiple pieces of information in a Decision Matrix help you analyze and select possible helmet choices? • How can color-coded visuals help communicate data more effectively than charts and tables?	• Class Discussion Question: **Participation** • Decision Matrix Student Sheet: **Summative**

Section 5 – Making Your Recommendation *(40 minutes)*

Students learn about an ongoing research project at Georgia Tech to study concussions in contact sports, like football. Researchers and engineers from Georgia Tech and Emory University have collaborated together to develop a medical device that can be used to assess the effects of concussions right on the sidelines. Students watch a video profiling the project. The section concludes with students finally making a single helmet recommendation in the form of a written review on Skate Tech's website for each skater.

Preparation

Materials	Student Pages
• Head Injuries Technology Video #1 • Decision Matrix Student Sheets (already completed)	• Helmet Recommendations Student Sheet
Prep the Day Before: Review the section. Watch and review the *Head Injuries Technology Video* and prepare for a class discussion. Prepare to help students think through two, possibly tough, helmet choices for a skater. Feel free to change the format of the recommendations, i.e. presentation or PowerPoint.	

Planning

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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Concussion • Traumatic Brain Injury	• What recommendation can you make for each skater, and what evidence can you provide to support that decision well?	• Class Discussion Question: **Participation** • Helmet Recommendations Student Sheet: **Summative**