

Lesson Title	Car Safety Expedition: How Can I Become A Safe Driver?
RET Project Connection	The work that I've done in Dr. Hashemi's lab this summer is in the area of mechanical engineering. The lab looks at the mechanics of bones, among other things. We've studied osteoporosis and other diseases of the bone. In order to learn more about how osteoporosis affects the mechanical properties of bone we have attempted to model the bone using a honeycomb structure. Bones are cellular structures that resemble a random honeycomb structure. By using aluminum honeycombs, filled with joint compound, we are attempting to model healthy bone. We then remove the joint compound from random honeycomb cells to simulate bone thinning, which occurs during osteoporosis. In my lesson I hope to incorporate the idea that scientists observe something about the natural world and then use models to attempt to study and subsequently explain in their observations.
RET Teacher	Carrie -Anne Sherwood
School	Codman Academy Charter Public School
Town/District	Dorchester, MA
Subject(s) Taught	9th/10th Grade Physics
Subjects covered in lesson	Forces, Newton's Laws, pressure, impulse, momentum
Grades Appropriate	9th
Lesson Duration	2 months
Goals/Objectives of lesson	<ol style="list-style-type: none">1. students design and build a fully-functional model car able to keep a passenger safe in a collision2. students research motor vehicle accidents in the U.S. and gather/compile statistical data to be presented in a formal report3. students keep accurate records of their changing model (from prototype to final product) with detailed explanations of why changes were made (based on concepts learned)4. students keep neat and organized data taken with their model cars throughout the unit, to be presented in a formal report5. students accurately and concisely explain the physics behind what happens to their car and passenger in a simulated collision, to be presented in a formal report6. statistical background data, student-gathered classroom data, physics explanations, and a letter/public service announcement to students/parents detailing why certain safety features are necessary in automobiles, and why everyone should be aware of these features, and employ these features if available.7. students present their research findings and public service announcement in a public forum
Background Information	kinematics, modeling in science, measurement and data collection techniques, engineering design process, prototypes, blueprints
Essential Questions	What forces are involved in collisions? What causes these forces to occur? What happens as a result of these forces? Do forces alone really cause damage? Why do I need to wear a seatbelt? What style of seatbelt protects me best? Why are some cars safer than other cars? How many deaths/injuries per year are the results of car accidents? What percentage of these involves teens? What percentage of these occurs in cities? What percentage of these involves minorities?

Does the mass/size/shape/design of a car affect its ability to protect its passengers in a collision? What brands of cars are the safest?

How do scientists determine safety in cars? How are scientists able to compare cars for safety?

How can so much damage be caused when the car was not moving that fast?

Links to Frameworks and Standards :

* National

Science as Inquiry

CONTENT STANDARD A: As a result of activities in grades 9-12, all students should develop: abilities necessary to do scientific inquiry and understandings about scientific inquiry

Physical Science

CONTENT STANDARD B: As a result of their activities in grades 9-12, all students should develop: an understanding of motions and forces.

Science and Technology

CONTENT STANDARD E: As a result of activities in grades 9-12, all students should develop: abilities of technological design, and understandings about science and technology

* State

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

SIS2. Design and conduct scientific investigations.

SIS3. Analyze and interpret results of scientific investigations.

SIS4. Communicate and apply the results of scientific investigations.

Introductory Physics High School Content Standards

1. Motion and Forces

1.4 Interpret and apply Newton's three laws of motion.

1.5 Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.

1.6 Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.

1.8 Describe conceptually the forces involved in circular motion.

2. Conservation of Energy and Momentum

2.5 Interpret and provide examples that linear momentum is the product of mass and velocity and is always conserved (law of conservation of momentum).

Calculate the momentum of an object.

Materials Required

force sensor, things to build model cars, pictures/videos of car collisions, statistical data

Lesson Development

Gather Background Knowledge: Students will be asked questions to see what they know already about automobiles and safety in automobiles--how does a car work? how do the brakes work? how does the steering wheel work? how does the accelerator work? how do bumpers/padded dashboards/seatbelts/airbags work? etc. Also, personal experience with crashes should be gathered--has anyone ever been in a car crash? has anyone ever known anyone who has been in a car crash? In addition, the class will be designing a survey of similar questions to give to students and teachers in the entire school before the expedition begins.

Immersion into the investigation: Students will be shown pictures/videos of car crashes/collisions. They will then be required to ask questions about what they see/hear. What do you want to know about what I have shown you? The students will pair up or work in groups to create a list of questions, then it will be whole class sharing and recording on chart paper, to be kept posted in the room

throughout the expedition. (I will have certain questions in mind based on what I want them to learn in this unit, and hopefully can help the students to ask these questions themselves.)

The Project is introduced: Students are informed of the general topic of the expedition (the physics of automobile safety) and are told what the outcome of this unit is to be. In their study of automobile safety, students will be conducting research and experiments to create a public service announcement about the necessities of awareness and employment of safety features in cars.

Ideas for Investigation: Students will then be confronted with, "How can we go about finding the answers to the questions we asked?" Hopefully students will conclude on their own the following need to be done to begin this investigation of safety: a) research statistical data, b) build a model car, c) model the types of collisions I have shown them.

The Model Car: Students will be told this is their prototype vehicle. They should draw multiple-view sketches of this prototype. This vehicle will be used throughout the unit to conduct the various experiments. As they learn more physics concepts they will be given the opportunity to alter their vehicles, with additional sketches. The goal is to have designed and built a safe automobile by the end of the unit.

Physics concepts investigated: Individual lessons on the physics topics of this unit might be more teacher-driven. However, the overarching investigation and product should be entirely student-driven.

Culminating Project: Students "test" their model cars in collisions, with an egg (possibly) as a passenger. PSAs are created (possible formats: written, audio recording, video recording) PSAs are then distributed to members of the school community, or demonstrated in some public arena. To end the expedition, a final survey is given to everyone in the school, and there is a discussion in class comparing the initial survey with the final survey.

Assessment

- Quizzes, homework assignments, and Do Nows, throughout the expedition
- Alteration, with explanation and accompanying sketches, of model car throughout the unit
- Class presentation of final car with sketches and demonstration of its safety features
- Written component, explaining the choice and function of the safety features on the model car, with data to support safety
- Public Service Announcement, both written and presented. PSA should include reasons/arguments for specific safety features in cars, with physics principles to explain, and statistical research to support.

References

National Science Education Standards, National Research Council

Massachusetts State Science Standards:

<http://www.doe.mass.edu/frameworks/scitech/0106standards.doc>

Active Physics curriculum materials

Professor Hamid Hashemi's Lab, Department of Mechanical Engineering,
Northeastern University