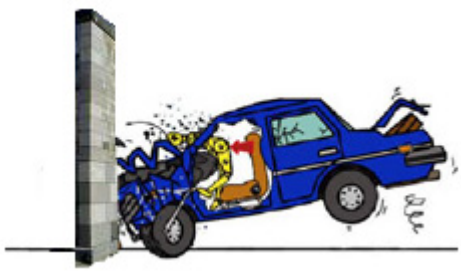
Forces and Motion – Forces on Passengers

Critical teaching ideas - Science Continuum F to 10
Level: Moving to level 10

Student everyday experiences

At this level of conceptual development many middle level students will still hold strong views based on their everyday experiences. (See Pushes and Pulls, and Pushes and Pulls – What is a force).

Students are sometimes unable to correctly identify the forces that act on them when they travel as a passenger in a train, bus or car. This confusion often originates from the perspective of viewing the vehicle's motion from inside the vehicle.



When a car brakes suddenly, students believe that they are thrown forward by a sudden "Forward" force (See Mitchell, 2007). Another everyday experience is the apparent sideways force that suddenly appears to act on occupants and objects in a car when the car turns a sharp corner.

The scientific view

When a car brakes, the force from the brakes slows the car but not any unrestrained occupants – they continue to move forward at the speed the car was travelling just before braking. To the occupant it appears as though they are thrown forward. In fact they continue to move with no new forces acting on them until they encounter a force from the restraining seat belt or air bag.

Seat belts and air bags are designed to apply braking forces to the passengers over an extended period of time so the impact forces on the passengers will be reduced and the chances of passenger survival increased.

As a car turns a sharp corner the seatbelt and car seat must push on the passengers to make them change in the same direction as the car.

Critical teaching ideas

- When a car breaks, the car slows down but any unrestrained passenger or object in the car does not.
- The unrestrained passenger or object will be stopped by a force on them from another object like, the windscreen, steering wheel or airbag.
- A larger force will slow an object down more quickly.
- An airbag or seat belt is designed to extend the time taken for a passenger to slow down during breaking reducing the forces on the passenger.

(See Mitchell, 2007 and Loughran Berry & Mulhall, 2006)

(See Pushes and Pulls for insights into students' alternative conceptions before developing the following.)

Activities should be selected that promote the discussion of the forces acting on objects that are moving and stationary in everyday life. A central purpose of these discussions is to identify whether the forces are in balance with each other, or if they result in a push or pull which changes the object's speed and or direction.

Students need to move towards an understanding that all the forces are in balance on a stationary object and that any imbalances will cause the object to either speed up or slowdown in the direction of the imbalance.

A more difficult understanding is that all the forces are also in balance for any object moving in a constant direction with a constant speed.

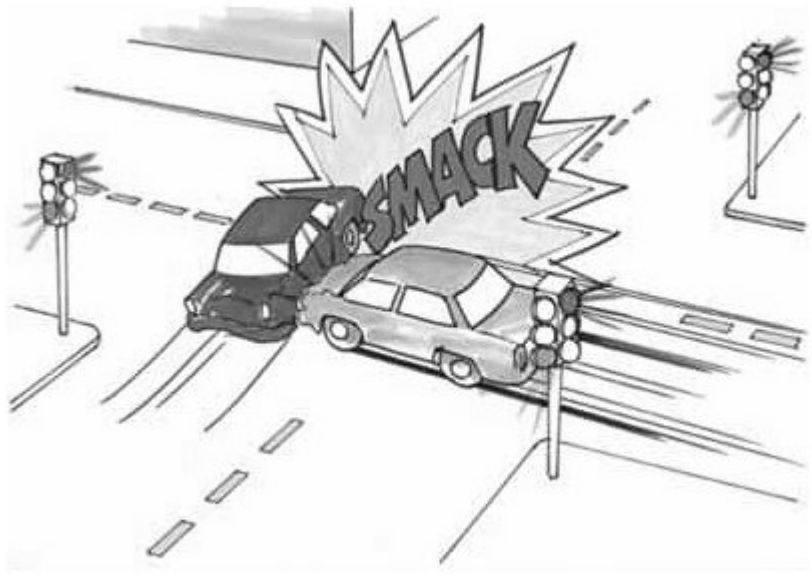
Eg. Students more easily accept the idea that the forces on a roller skating student are in balance if the student is standing still and find it harder to accept the idea if the student is roller skating at a constant 12 km/hr along a straight path.

(See AAAS map LM, Mitchell, 2007 and Loughran Berry & Mulhall, 2006)

Teaching activities

Open up discussion via a shared experience.
Attach a rubber band or a length of elastic to a laboratory cart with free rolling wheels. Ask students to predict what will happen if they pull the cart using the rubber band or elastic so it remains stretched by a fixed length. Get students to perform the activity and explain their observations in terms of balanced and unbalanced forces. Why is it difficult to maintain pulling the cart using this method for only a short period of time? (See Gunstone & Mitchell, 1998 and Loughran Berry & Mulhall, 2006)

Challenge some existing ideas.
POE (Predict-Observe-Explain) Using the same cart as above, loosely Blutak a plastic action figure to the cart and ask the students to predict what will happen when the cart collides at high speed with a stationary brick or another cart. Ask students to explain what they observe again in terms of balanced and unbalanced forces. Look to discuss the apparent Forward force as seen by the action figure in terms of the overall motion of the cart and the different forces acting on it and the action figure.



http://www.atsb.gov.au/road/novice_driver_safety/images/kf_collision.jpg

Provide an open problem to be explored via play.
Place a round glass marble on a flat table top and invite a student to make it move by blowing on it using a drinking straw. After asking students to identify the forces involved, see if they can then change its direction once it is moving again by just blowing through the drinking straw. Discuss how this would be best attempted.

Focus students' attention on hitherto overlooked detail.
There are many excellent road safety resources in schools that can be used to investigate the balanced and unbalanced forces at work in vehicle motion and collisions. Look to identify everyday experiences that students have with bicycles, skateboards, rollerblades, roller skates and scooters. Students are often experts at using this equipment to perform complex tricks but lack the precise language needed to identify the balanced and unbalanced forces and where they act.