Sports Science is Newton's Laws at Play!

Chérie Farrington & **Diana Cheng**

SportScience Fun
Cherie@SportsScienceFun.com
Please email or contact via Linked-In

Towson University
dcheng@towson.edu

Thursday, April 3rd, 2014: 4:15-5:30 pm
Convention Center: 231-232

Physical Education: K-12 Standards-based Instruction (includes Dance in PE)
Intended Audience: Elementary, Middle / High

Sports Science is Newton's Laws at play! If you want to design a skateboard park, throw a fast ball, or learn to fly an airplane, you need to understand concepts like inertia, flow, propulsion and parabolic arc. Sports provide a FUN way for students to make connections to physical science. Moving to cool songs, playing games, and conducting mini-experiments engages students with the science and math behind the sports they love.

Newton's Laws

Newton's 1st Law: An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force. Objects tend to keep on doing what they're doing unless acted upon by an unbalanced force.

Newton's 2nd Law: The acceleration of an object as produced by a net force (vector sum of all forces) is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object. An acceleration is change of an object's speed, direction, or both speed and direction.

Newton's 3rd Law: For every action, there is an equal and opposite reaction.

Thanks to:

US Games

SportScienceFUN
Run, Jump, Dive into Learning!

GAME 1: Tug of War

Groupings: 2 or more: Half on one side and half on the other side = equal tug

Equipment: Masking tape, Tug of war string

Instructions	Newton's Laws
1. Mark the floor with masking tape.	
2. Half students line up on Side A.	
3. Half students line up on Side B.	
4. One side pulls hard, but not too hard to get back to center.	Newton's 3rd Law –When getting the rope back to center, both sides needs to pull (in the horizontal direction) with equal and opposite forces.
5. Team wins: name a Law and explain	

Discussion Questions:

What makes tug of war hard to win?

When we align back to center, which side is pulling harder?

Could a side with fewer players win tug of war? (eg have unequal numbers of students on each side.)

GAME 2: Key Ring

Grouping: Groups of 2 or more

Equipment: Key ring, String, US Games "Tuff" ball bigger than ring (7 inch diameter)

Set-up: Explain the rules of the game to the students. They will need to use 8 students, each holding one of the strings connected to the ring

Goal: Move the ball from standing still to around the cone and back. They cannot drop the ball. They can have a 9th teammate coach them while they are participating in this challenge.

Instructions	Newton's Laws
1. Mark the floor with 2 pieces of masking tape with at least 10 feet apart or more.	
2. Each student takes one connected string and applies constant tension to keep the ball balanced.	Newton's 1st Law: The ball remains at rest until you apply a force upon it. Newton's 3rd Law: In order to keep the ball in the air, the net sum of vertical forces applied on it must be 0. (students need to experimentally determine how best to stabilize the ball in the air!)
3. Balance the ball and move the ball forward.	Newton's 1st Law: The team applies force to move the ball from rest. Newton's 2nd Law: The team applies forces which cause the ball to accelerate, that is, change the ball's speed (from 0).
4. Then try to move the ball around the cone.	Newton's 2nd Law: The team causes the ball to accelerate, that is, change the ball's direction (from traveling on a line to traveling around the cone).

Before Game Discussion Questions: Have students make predictions and have them discuss their strategies on the following topics:

What spacing should the 8 students who hold strings have?

What will happen if each student pulls the string hard? Should the team keep the string loose or tight?

How will the team get the ball to move forward? Should the team move quickly or slowly?

After Game Discussion Questions:

What causes the ball to drop? What causes the ball to be stabilized?

How can the ball be moved forward at a constant rate?

Compare your team's strategies to get around the cone and your team's strategies to move the ball forward.

You can also interview the students on the winning team (the team which gets the ball successfully back the fastest). Compare the strategies of the students on this team with strategies of students on other teams.

GAME 3: Newton's Flying Penguins

Grouping: 2 people

Equipment: US Games "Let It Fly" net for each group and 1 shared penguin or critter

Instructions	Newton's Laws
1. Put the critter on the net. He will stay at rest on the net until a force acts upon it. The critter is lifted by a force (you.)	Newton's 1st Law: Critter will remain at rest unless acted upon by an external force. Newton's 3rd Law: Critter and net have equal and opposite forces.
2. Toss the critter up into the air.	Newton's 2nd Law: Gravitational force pulls the critter down.
3. When the critter lands, catch it with the net.	Newton's 3rd Law: When you put your net under the critter, the critter pushes down on the net and you're using force to hold it up. Newton's 1st Law: If there wasn't a net obstructing the path of the critter, the critter would continue falling down.
4. Toss the critter EVEN higher.	Newton's 2nd Law: The critter's' acceleration (gravity) depends directly upon the net force acting upon it. In order to toss the critter higher, students need to put in additional force.

After Game Discussion Questions:

Was there a change in force between the 1st time (step #2) and the 2nd time (step #4)? Why?

What differences did you notice from the 1st time to the 2nd time?

If we were to draw the critter's height from start to finish, what would the graph look like?

Science Education Standards

PS2.A: **Forces and Motion**:

(3-PS2-1) Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

(3-PS2-2) The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular motion, future motion can be predicted from it.

(MS-PS2-1) For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction. (Newton's third law)

(MS-PS2-2) The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.

PS2.B: Forces and Motion:

(3-PS2-1) Objects in contact exert forces on each other.

(5-PS2-1) The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

(MS-PS3-2) When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

PS3.A: Definitions of Energy

(4-PS3-1) The faster a given object is moving, the more energy it possesses. (MS-PS3-1) Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.

(MS-PS3-2) A system of objects may also contain stored (potential) energy, depending on their relative positions.

PS3.B: Conservation of Energy and Energy Transfer

(4-PS3-2), (4-PS3-3) 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.

Connections to Nature of Science – Science is a Human Endeavor: Science affects everyday life. Most scientists work in teams.

(4-PS3-4) Most scientists and engineers work in teams

(4-PS3-4) Science affects everyday life

Engineering

ETS1.B: Developing Possible Solutions

(secondary to MS-PS3-3) A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.

ETS1.A: Defining and Delimiting an Engineering Problem

(secondary to MS-PS3-3) The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.

(secondary to 4-PS3-4) Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each takes the constraints into account.

PS3.C: Relationship between Energy and Forces

(4-PS3-3) When objects collide, the contact forces transfer energy so as to change the objects' motions.