EDUCATOR'S GUIDE

Sports: Science in Action

Disney Presents

the Eyes of Nye

For six seasons, millions of students came to understand, appreciate and enjoy the exploration of science through the series, *Bill Nye the Science Guy*. Bill returns with *The Eyes of Nye*, a more in-depth look at science subjects making news, changing lives, and impacting policy. From the future of alternate fuel sources and genetic engineering to population growth trends and issues of race, Bill and his expert cohorts bring science to life right in your classroom, helping you **Motivate** investigation; **Assess** available information; and **Propose** lines of argumentation.

This Educator's Guide includes:

- An **Introduction** that clearly defines the subject and offers an overview of the issue objectives of the guide; how it relates to science from both a social and personal perspective; as well as pertinent questions and insights regarding the topic.
- A listing of all **National Science Education Standards Addressed**.
- Detailed procedures highlighted in the MAP Framework (**Motivate, Assess, Propose**).
- Illustrative **Video Clips** from *The Eyes Of Nye* DVDs with pinpoint chapter cues.
- **Web Site Resources** to help students further investigate and locate research, charts, data as well as experts featured in the program material.
- Easily downloadable **Support Materials** that include articles, transparencies, charts, and much more.

Introduction:

"Science in Action" refers to the scientific principles that underlie the body and mind experience that is sports. *The Eyes of Nye – Sports: Science in Action* presents a light-hearted search for a possible solution to a mystery that eludes us all: why we so dearly love sports. It's the science!

Though not an issue in the conventional sense, the question of why we love sports warrants a thoughtful approach and honest consideration, given students' interest in sports, their too-often lack of interest in science due to lack of understanding, and the good reasons these two givens do not support one another. Can we raise academic interest if it becomes apparent our most beloved pastime—sports—is, after all, merely academic?

*Check the **MAP Teaching and Learning Framework** to explore the phases (motivate, assess, and propose) used in this guide.*

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National Science Education Standards Addressed

Science As Inquiry

- Abilities necessary to do scientific inquiry

  Identify questions and concepts that guide scientific investigations.

  Recognize and analyze alternative explanations and models.

  Communicate and defend a scientific argument.

- Understanding about scientific inquiry

Physical Science

- Motions and forces

Life Science

- Behavior of organisms

Science in Personal and Social Perspectives

- Personal and community health

History and Nature of Science

- Science as a human endeavor
- Nature of scientific knowledge

On the DVD:

Sports: Science in Action – Chapters

Chapter 1: *Science of Sports Preview*
Beginning through 1:28
Ends with title screen

Chapter 2: *Got Science?*
1:52—5:04
Starts with Bill saying, "So you guys are baseball fans."

Chapter 3: *Physics in Sports*
5:04—10:03
Starts with the footage of the tennis players.

Chapter 4: *Pushing the Envelope*
10:05—13:19
Starts with hippie skit.

Chapter 5: *Prehabilitation*
13:20—16:00
Starts with the long football pass.

Chapter 6: *Into the Zone*
16:01—21:37
Starts with Bill bouncing a basketball and saying, "Muscle condition…"

Chapter 7: *Why Play?*
21:37 through end of program
Starts with Bill saying, "We've talked a lot…"

Sports: Science in Action – Activity Clips

As Mankind Progresses
10:15—12:03
(referenced in Educator's Guide step 3)
Starts with Bill saying, "Since the time of Hercules…" Ends with Bill saying, "We should probably get outta here!"

Got Science?
1:52—3:04
(referenced in Educator's Guide step 3)
Starts with Bill saying, "So you guys are baseball fans." Ends with girl saying, "Great!"

Timing and Technique: It's in the Physics
3:04—3:45
(referenced in Educator's Guide step 5)
Starts with Bill asking, "So how much do athletes think about physics?" Ends with Mr. Shmock saying "…two different things."

The Spin On Things
4:01—4:46
(referenced in Educator's Guide step 6)
Starts with ice skater and Bill asking, "What's more beautiful than…" Ends with Bill asking, "A guy can dream, can't he?"

Torque Anyone?
5:04—6:17
(referenced in Educator's Guide step 7)
Starts with the footage of the tennis players. Ends with Dr. O'Kane saying "…you hit a tennis ball with your legs."

It's Outta Here!
8:52—10:03
(referenced in Educator's Guide step 8)
Starts with the baseball being hit just before Bill says, "The margin of victory…" Ends with Bill saying, "Hah! Not bad!"

What a Drag!
7:14—8:51
(referenced in Educator's Guide step 8)
Starts with the text The Principles of Drag. Ends with Coach Wender saying "…in creating the right body position."

Reactions: The Motor Pathways
16:01—18:26
(referenced in Educator's Guide step 9)
Starts with Bill bouncing a basketball and saying, "Muscle condition…" Ends with Hope Solo saying "…hopefully I make a save."

Procedure: Motivate Phase

1) Ask students if they love sports (count on it) and why. Some will claim it is the competition, or the physical feeling they have after playing. Some will wonder if you mean playing or watching—tell them you mean both. Ask if sports are more fun for people as time goes by, or less, and if the athletes get better or stay the same.

2) Distribute and discuss the trends in athlete's performances. Explain it is easy enough to see that athletes' abilities (speed in the 100-yard dash, for instance) and our attendance as spectators are similar—even with the rising cost of attendance. Suggest it seems these

abilities are pleasing to us, and we can't seem to get enough.

Encourage students to access and graph correlational data related to spectator interest and athletic performance over the past century. Ask students to compare the graphs and note similar trends.

3) Play ***"As Mankind Progresses,"*** in which Bill and Olympic sprinter Maurice Greene discuss the continuing improvement of athletes. Ask students if they think this is due to improvement in our own understanding of the *science* underlying the athletic performance; students know some of the principles we will investigate, but probably have never looked at them in light of sports achievement. Tell them they are not alone—play ***"Got Science?"*** Follow by suggesting we (all of us) perhaps have much to learn.

4) Pose the broad question, "Is science responsible for our athletic achievement, and ultimately, our love affair with sports?" Ask students suggest possible questions we could investigate in order to answer this question. Help them separate the questions into categories dealing with fundamental physical concepts of science at work in sports, improvement in processing and mental capabilities, and intangible social influences (ambition, competitiveness, willpower, etc.). Assist students with the structure of at least two scientific and one social question addressing these categories (see possibilities below).

Potential scientific questions

a) What scientific principles are responsible for outstanding physical feats?

b) How does science explain mental processing and activity associated with these feats?

Potential social question

c) What about these feats is so captivating?

Procedure: Assess Phase

5) Ask students consider the first question and begin by recalling some of the terms Bill used above in "Got Science." These may include (but are not limited to) drag, lift, collision, arc, momentum, as well as others students may suggest, such as mass, force, and speed. Play ***"Timing and Technique: It's in the Physics,"*** in which Peter Shmock, two-time Olympic shot-putter and founder of ZUM Health Club, talks about the interplay of timing and technique in sports. Ask students what the science of physics is all about. Explain when we work with physics we are dealing constantly with the motion of objects, our own bodies as well as inanimate ones. Tell them we will go through several brief "sports physics" lessons to explore the *real* reasons we see what we love in sports.

6) Ask students what they think of when they hear the term "momentum." In sports, most think of the momentum of the game or race—which athlete or team has things "going their way." Explain this is true in a sense, but technically in physics a

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See ***The Eyes of Nye*** *Issue Support* ***The Principles of Physics 101***

body's momentum is the product of its mass and velocity (or mass multiplied by velocity). Tell them when it is directed around a certain point (often called the point of origin) it becomes "angular momentum." Play ***"The Spin On Things,"*** in which Bill explains the concept of angular momentum, or more specifically, the *conservation of angular momentum*. Follow with using the first portion of the support, "The Principles of Physics 101" to more thoroughly explore the concept, as well as its original basis in Newton's first law of motion.

Teacher Note: *The straightforward nature of the science involved in "The Principles of Physics 101" and the ready availability of resources explaining those concepts provide good opportunities to encourage students to access additional explanatory materials and to design and develop simple tests for the laws they can perform in class. Work with students on establishing hypotheses, explaining procedures, performing the tests, collecting data, and making conclusions based on their results.*

7) Ask a student to hold an imaginary bat and model hitting a ball with the bat. Do the same with a student modeling hitting a tennis ball with a racket. As they model the movement, ask the rest of the students to closely observe the movements they make, then ask them to describe these movements. Tell students to watch for the movements and the description of physics involved as you play ***"Torque Anyone?"*** Review the movements afterward with one or more of your student models, emphasizing the axis of rotation, then use the second portion of the support, "The Principles of Physics 101" (step 6 above) to explain the concept further. Explain that, as with angular momentum, this physics principle goes way back to Isaac Newton and his laws of motion—this time primarily the second law.

Cars and kids—a good combination. If you wish to focus more heavily on torque, have students access various resources available for calculating torque created by automobile engines.

8) State Newton's third law of motion (see right). Ask students to suggest in what way we have just been demonstrating the third law. Relate the law to the balls on a billiard table, and explain when two balls collide, energy, though never created or destroyed, is transferred from one ball to another. Play ***"It's Outta Here!"*** in which Bill describes the physics at work in producing a home run. Explain the concept of drag is similar, except we are trying to reduce rather than enhance the *equal and opposite* force. Play ***"What a Drag!"*** Tell students these various principles they have been discussing apply in many ways to sports, and usually all in tandem, but there is more to it. Call students' attention to the batter's efforts to manage where and how the ball is struck. Recall Mr. Shmock's mention of technique, and suggest "technique" implies thinking. Tell students the mind must join the body in order to produce an astounding athletic feat.

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

9) Ask how many students have seen the movie *Miracle* or heard about how goalie Jim Craig made 39 saves to help the U.S. Olympic Hockey Team beat the Soviets in 1980. Ask

students if they think he was able to do that through quick reflexes. Tell students reflexes are not voluntary, while *reactions*, though we may not notice it, are voluntary and are processed through the brain. Introduce a new star goalie—Hope Solo—with the women's U.S. National Soccer Team. As you play ***"Reactions: The Motor Pathways,"*** ask students to note the paths taken as sensory input signals are relayed to the proper lobe in the brain, from there to the brain's motor centers, and then to the cerebellum, which coordinates the body's movements. Review the relays and the portions of the brain involved using the diagram and process outlined in "Anatomy of a Save!"

So how does our brain process sensory input so we can react physically? Believe it or not, just like an Olympic goalie!
See The Eyes of Nye Issue Support Anatomy of a Save!

10) Tell students a study of the science of sports wouldn't be complete without looking into how science helps us stay healthy and fit. If an athlete isn't playing, he or she can't attain those feats we love to watch. Play ***"Chapter 5: Prehabilitation"*** (end at the close of the discussion on injury prevention). Recall the old saying, "An ounce of prevention is worth a pound of cure!"

Discuss careers related to sports medicine.
Go to eyesofnye.org

Procedure: Propose Phase

11) Pose the question to students, "Would you watch sports for the thrill of the science involved?" Tell students to write a persuasive paper that convinces another reader there is science in those stars! Explain in their paper, they should first indicate one or two things they love to watch most in sports, and then describe at least three scientific principles underlying those feats of athleticism.

Persuasive paper format:

- *Introductory paragraph stating view and briefly listing three supporting reasons.*
- *Body consisting of explanation of reasons, preferably in three separate paragraphs.*
- *Conclusion that restates the view as an assertion based on evidence provided.*

12) As a class, ask students to volunteer some of their chosen "favorite feats" and their reasons supporting the science that makes them possible. In each instance, encourage their peers to suggest as many possibilities as they can to support something other than science for the physical performance mentioned. Categorize these with students and suggest they look more deeply into each and search for the science—it will be there.

Final Teacher Note: *The search for other aspects of the science beneath athletic feats of prowess can lead to a variety of fascinating understandings. For instance, many of the students' suggestions in step 12 will relate to emotion in myriad forms—anger, competitiveness, desire, pleasure, even frustration. Students should explore the limbic system of the human brain. Likewise, deeper analysis of the motor and sensory neurons can contribute to students' understanding of a wide range of science issues, and what could be a more interesting—or loved—venue for learning these concepts is there than sports?*

For more, go to eyesofnye.org

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Further Research

Investigating the Issue: Science of Sports

Why do we love sports? We've watched, shouted, moaned, and cheered feats of unbelievable grace and prowess for years. Students are doing the same. Is it the science? They may just be surprised.

Exploring the Science of Sports

In addition to the information presented in *The Eyes of Nye - Sports*, students may access a variety of informative sources related to sports medicine, physics and the laws of motion, as well as the human brain and sensory and motor neuron network.

Physics concepts:

- angular momentum
- buoyancy
- drag
- force
- Laws of Motion
- momentum
- torque

Sports-related careers:

- fitness instructor
- kinesiology
- massage therapist
- nutritionist
- orthopedics

- physical therapist
- podiatrist
- rehabilitation specialist
- sports physician
- sports psychology
- trainer

Cerebral and neuron network:

- cerebellum
- limbic system
- motor cortex
- motor neurons
- occipital lobe
- parietal lobe
- pre-motor cortex
- sensory neurons
- temporal lobe

Exploring the Feature Athletes

In order of their appearance in *The Eyes of Nye - Sports*, students may wish to read more about the following athletes:

- Maurice Greene, sprinter
- Peter Shmock, shot-putter
- Hope Solo, soccer goalie

Other featured athletes, coaches, and trainers, in order of appearance:

Dr. John O'Kane, associate professor	Orthopedics and Sports Medicine University of Washington
Mickey Wender, head swim coach	University of Washington
Justin Adrian, swimmer	University of Washington
Ben Mahdavi, football player	University of Washington
Kevin Essick, head athletic trainer	University of Washington

ISSUES SUPPORT MATERIAL

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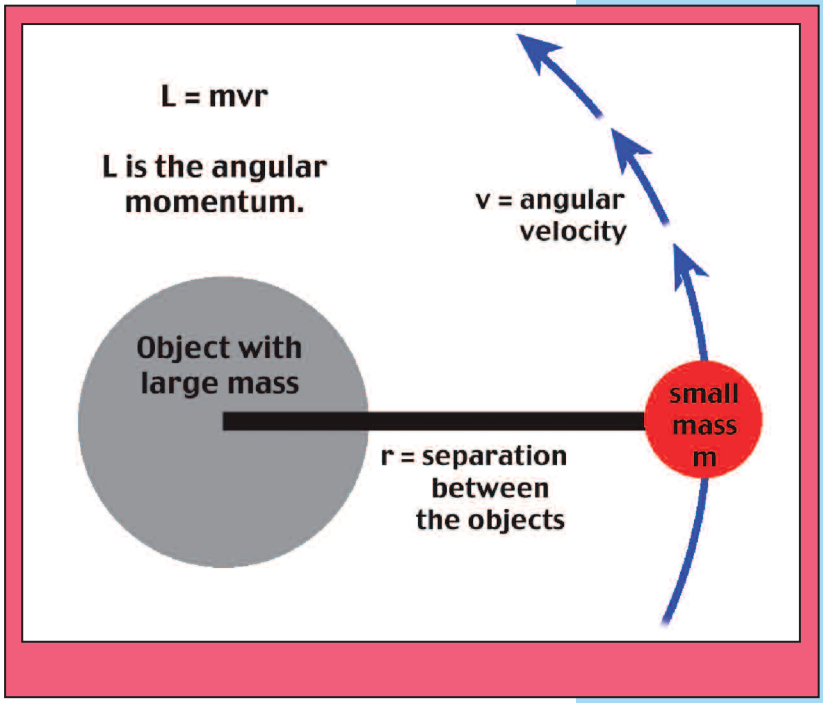
The Principles of Physics 101: Conservation of Angular Momentum

Momentum is conserved. In other words, it cannot be created or destroyed, only transferred. Unless something outside of the system acts on it, it just keeps on keeping on—just ask Isaac Newton!



The same principle applies to angular momentum, represented by motion around a point. In the case of a smaller mass executing a circular motion around a larger mass, the formula below describes the angular momentum. Since the angular momentum "L" cannot change, any change in the separation "r" causes an inverse change in the velocity "v" and vice-versa. This inverse relationship serves to keep "L" constant.

So, the neat part…is that when a gymnast or skater extends his or her arms, "r" increases and their angular velocity decreases—they turn more slowly. When they pull their arms inward, they spin faster! It's not their fault. It's how the universe works!

You heard it first from Sir Isaac Newton!

"Every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed on it."

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The Principles of Physics 101: Torque

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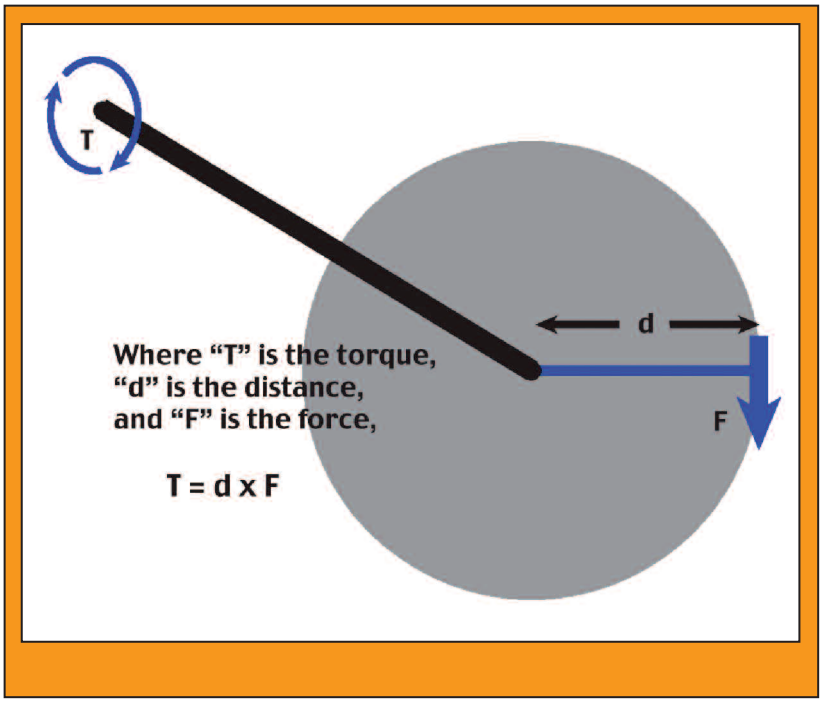
Now just a moment of force! In physics, that's what torque is called. It is the tendency of a force to rotate the body to which it is applied. The concept arose as an evolution of early concepts of force—just ask Isaac Newton!

The principle means that when you apply a force to a point at a right angle (perpendicular) to a body, the distance "d" of that point (sometimes called the moment arm) times the force "F" is equal to the torque "T" generated on the body.

So, the cool thing…is that when a tennis player or a baseball batter steps and turns from the legs, those turning shoulders carry torque. It's just how the universe works!



You heard it first from Sir Isaac Newton!

"Force is equal in the change in momentum (mv) per change in time. (For a constant mass, force equals mass times acceleration.)"

Anatomy of a Save!

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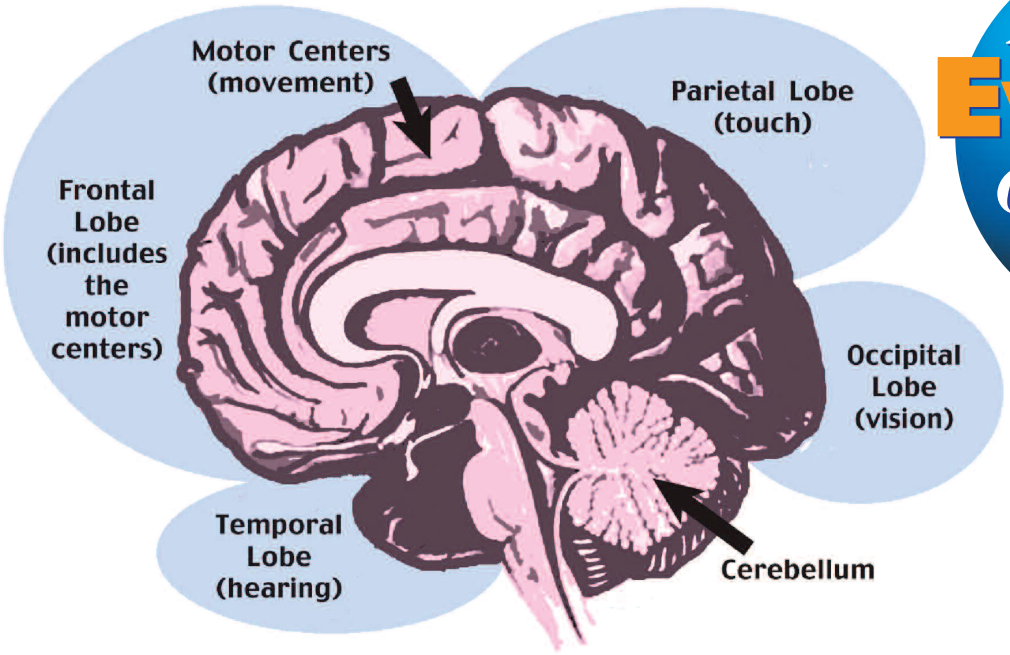

Hope Solo in action:

Hope gets sensory input.
Messages from her eyes go to her occipital lobe.
Messages from her ears go to her temporal lobe.
Messages from touch go to her parietal lobe.

Signals are transmitted from her lobes to her motor centers.

Her pre-motor cortex decides how to act and her motor cortex fires the muscles into continuous feedback loops with her cerebellum.

Hope pounces, and almost always gets the save!!