ABOUT ALBERT EINSTEIN

George Capaccio: *Albert Einstein: Relatively Speaking*
Grade levels: 4+

So much has been written about Albert Einstein (1879-1955) and his amazing discoveries in physics, an important branch of science. People who are not scientists might wonder what these discoveries have to do with our day-to-day lives of getting up, going to school or work, or just plain goofing around. Actually, Einstein gave the world a brand new way of understanding space and time and gravity. These are not easy ideas for anyone to really "get" the first time around. In fact, long before Einstein lived and worked, scientists tried very hard to figure out just what space is made of and whether time is the same for everyone no matter where they are. Sir Isaac Newton (1642-1727), one of the greatest scientists who ever lived, had his own ideas about space and time. His ideas were so convincing that for over two centuries, Newton had the final word. If you were an up-and-coming scientist, you risked losing the respect of other scientists if you disagreed with the great Newton.

Then along came Albert Einstein. He looked up to Newton as much as anyone else. But when it came to challenging ideas that other scientists accepted as the final truth, he didn't hesitate to follow his own intuitions, wherever they might lead. Throughout his life, he was a rebel who did the unexpected, took risks few others were willing to take, and put the pursuit of truth ahead of other concerns.

George Capaccio is not a scientist. He's an actor and a storyteller. In his show "Albert Einstein: Relatively Speaking," George hopes his audiences will come away from the performance with some sense of just how amazing Albert was and how much he has given to the world. His discoveries in physics over a hundred years ago paved the way for things we use and rely on in our daily lives. Take GPS, for instance. In our cars or smart phones, it gets us to where we want to go and keeps us from getting lost on the way. But the technology behind GPS is based on Einstein's theories of relativity. How about those bar-code scanners in stores and supermarkets? Once again, it was Einstein's work on the so-called "photo electric effect" in 1905 that eventually led to lasers. Plus, his realization that energy and mass are two sides of the same coin, and a small amount of mass contains an enormous amount of energy. To put this in the language of equations, Einstein wrote $E=MC^2$. And that equation led to the development of nuclear power and—tragically—the atomic bomb.

ABOUT THE PERFORMANCE

Einstein once said, "The true sign of intelligence is not knowledge but imagination." With this guidepost in mind, George has used his own imagination to present Einstein not as some superhuman character but as a real, honest-to-goodness person. In this performance, George will appear as Albert Einstein and will use a German accent, since Einstein was born and raised in Germany. George will mention some of the people and experiences that had a lasting effect on Einstein when he was just a boy, like the compass his father gave him when he was 5 years old.
The show follows the path of Einstein's life from his childhood to the year 1919 when he was 40 years old. That was the year his greatest theory was proven to be correct, and

overnight he became a worldwide celebrity as popular as today's superstars. But not just popular; Einstein was also loved and idolized by millions of people of all ages. His long, wild hair, his lively brown eyes, his quick wit, his childlike sense of wonder, and of course the brilliance of his mind made a deep impression on people.

George's performance will also introduce young audiences to the ideas that established Einstein as the equal of Isaac Newton. Like Newton, Einstein turned the world of science upside down and pointed the way to a whole new view of the universe. In presenting Einstein's theories of relativity, George will invite audience members to take part in simple, enjoyable activities. The theories themselves are challenging, to say the least, but not impossible to understand. They're challenging because they ask us to change our way of thinking, to see things in a new way. But isn't that what education is partly about?

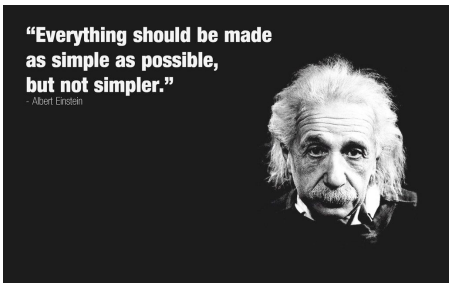
LEARNING GOALS:

1. To introduce students to the concept of relativity.

2. To develop in students an appreciation of Einstein's contributions to science and how his ideas changed our understanding of space, time, and gravity.

3. To inspire in students a willingness to think like Einstein by testing their own ideas about the world and what they think is true or not true.

PRE-ACTIVITY SUMMARY: *Think Like Einstein*



Remind students that the concept or idea of relativity was a major part of Einstein's scientific work. Emphasize that his curiosity and ways of thinking about a problem led him to his theory of relativity. For grades 4-5, pose a series of questions designed to show students that relativity is also a part of everyday life. For grades 6+, use more challenging questions to prompt them to think in relative terms.

POST-ACTIVITY SUMMARY: *Letter Writing*

Remind students that Albert Einstein was curious about many things. And he loved to learn about new things. He didn't live long enough to see some of the inventions and scientific breakthroughs that resulted from his theories. He passed away at the age of 76 in the year 1955. For this activity, students will write their own letters to Dr. Einstein in which they will tell him about something that wasn't invented while he was still alive.

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CURRICULUM LINKS:

Science and Technology; History and Social Science; Arts

PRE-ACTIVITY: *Think Like Einstein (for grades 4-5)*

LEARNING GOALS:

- To develop students' critical thinking skill
- To introduce the concept of relativity

MATERIALS/PREPARATION: No additional materials needed

TIME: 20-30 minutes

GENERAL TIP FOR THE TEACHER: Make sure that students understand that relativity is both a scientific concept and a part of everyday life.

STEP 1: Ask students the following series of questions:

1. Imagine that you are running home from your friend's house when it starts to rain. The wind is in your face, hitting you hard with raindrops. You decide to turn around and run back. Is the rain on your back hitting you just as hard? Why or why not?

Teaching Tip: Hard and soft are relative terms: When the wind is at your back, the rain will be hitting your face more softly.

2. Sara can run the bases for a home run in one minute. Does she run fast or slow?

Teaching Tip: Again, fast and slow are relative terms. We can't say for sure whether Sara's speed is fast or slow until we compare her speed to other players on her team or in her league.

3. Santiago is taller than the other students in his class, but he's not the tallest person in the classroom? The teacher is almost a whole foot taller than Santiago.

Teaching Tip: Whether someone is tall or short is relative to other people whose height we're comparing. Santiago is taller than his fellow students but shorter than his teacher.

4. Padma gets a weekly allowance of $5. She thinks that's a lot of money. Then Padma learns that Noah gets a weekly allowance of $10. Whose parents are more generous—Padma's or Noah's?

Teaching Tip: Even though Noah's allowance is twice as much as Padma's, that doesn't mean his parents are more generous than Padma's parents. The degree of

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generosity is relative to how much each family can afford to give their child.

STEP 2: After students have shared their responses to the preceding questions, go back over the concept of relativity as it pertains to everyday life. Emphasize that the performance they will soon see will present a more scientific treatment of relativity.

EXTENSIONS: TK

PRE-ACTIVITY: *Think Like Einstein (for grades 6+)*

LEARNING GOALS:

- To develop students' critical thinking skill
- To introduce the concept of relativity

MATERIALS/PREPARATION: No additional materials needed

TIME: 30-45 minutes

GENERAL TIP FOR THE TEACHER: For the purposes of this activity, it isn't necessary that students come up with the "right answer" to the above questions. The main focus is on their "thinking like Einstein."

STEP 1: Tell students that Albert Einstein was fond of telling people that his only laboratory was under his hat. In other words, he did much of his scientific research inside his own mind. The name he gave to his research is "thought experiments." In the German language, the word is *Gedankenexperiment.*

STEP 2: Invite students to use their minds to imagine the following situations (one at a time, of course). For each situation, there is a corresponding question for your students to think about. Have the students attempt to come up with answers based on their own thought experiments, or *Gedankenexperiment,* and then share their answers with the entire class.

a. You are riding on a bus with large windows. The bus is traveling about 20 miles per hour. You stand in the center of the aisle and begin bouncing a ball on the floor. Your friend Alex is standing at a bus stop. Alex watches the bus go by and sees you bouncing the ball. You see the movement of the ball one way. Your friend sees the movement of the ball in a different way.

> What is the difference between how you see the ball move and how your friend Alex sees the ball move as the bus goes by? Which way of describing the movement of the ball is the right one? (Careful: this is a trick question!)

b. You and Alex are now passengers riding on the same bus. The two of you stand in the aisle and begin playing a game of catch with the ball. You start by tossing

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the ball to Alex in the **same direction** in which the bus is moving. The bus is traveling at about 20 miles per hour. The ball travels at about 10 mph. A second friend—Maria—is standing at the bus stop as the bus goes by.

If you could ask Maria how fast the ball is traveling from where she's standing, what would her answer be?

c. The word "simultaneous" refers to two or more events that happen at the same time. Einstein's theory of **special relativity** requires us to think more carefully about whether two or more events really are simultaneous. Suppose you are riding on a school bus and looking out the window when you see a bolt of lightning split in two and strike an overhead power line in two different places. Let's call those two places A & B.

Your friend Maria is again standing at the bus stop as the bus goes by. Her position is right between points A & B, that is, the two places where the lightning has struck. Remember: She is standing still. You are moving at the speed of the bus.

Which of you is more likely to say the two bolts of lightning struck at the same time? Defend your answer.

STEP 3: Remind students that in the performance they will soon see, George (as Einstein) will present his own understanding of relativity as a scientific concept and will use some of the same examples as in this pre- activity.

EXTENSIONS: TK

POST-ACTIVITY: *Letter Writing*

LEARNING GOAL: To help students connect Einstein's scientific contributions with the world in which the students live.

MATERIALS/PREPARATION: Paper and writing tool, or computers for word processing

TIME: 30-45 minutes

TIPS FOR THE TEACHER: Remind students that Einstein lived from 1879-1955. He died at the age of 76 and never got to see the many inventions and scientific breakthroughs his ideas inspired.

STEP 1: Ask students to imagine that Albert Einstein could get a letter from each of them. In their letters, they will write to Dr. Einstein about something that they use that was not invented while he was alive.

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STEP 2: With the class, brainstorm ideas such as smart phones, microwave ovens, flat screen TVs, self-driving cars, personal computers, DVDs and CDs, video games, etc.

STEP 3: Now have each child select one invention. In the first paragraph of their letters, coach them to describe what the invention looks like and why it is useful. In the second paragraph, have them teach Dr. Einstein how to use it, perhaps as a series of numbered steps as a way of reinforcing **sequencing**.

STEP 4: When they've finished writing, have students share their letters with a partner, in a small group, or with the whole class.

EXTENSIONS: TK

RESOURCES:

Books:

Berne, Jennifer. *On a Beam of Light: A Story of Albert Einstein.* San Francisco, California: Chronicle Books, 2013.

Calaprice, Alice. *Dear Professor Einstein: Albert Einstein's Letters To and From Children*. Amherst, New York: Prometheus Books, 2002.

Pohlen, Jerome. *Albert Einstein and Relativity for Kids His Life and Ideas with 21 Activities and Thought Experiments*. Chicago: Chicago Review Press, Inc., 2012.

Websites:

Ducksters: Physics for Kids: Theory of Relativity
http://www.ducksters.com/science/physics/theory_of_relativity.php

Trending Sideways: The Theory of Relativity for Kids
http://trendingsideways.com/index.php/the-theory-of-relativity-for-kids/

The Albert Einstein Archives (The Hebrew University of Jerusalem)
http://www.albert-einstein.org/.index.html

ABOUT THE PERFORMER:

George Capaccio lives in Arlington, MA with his wife Nancy, and has been a performer for a pretty long time. He got his start in fifth grade when Mr. Lynch, his teacher, praised the outlandish tall tales George loved to make up and the "mad scientist" plays he and his friend Alex performed for their classmates.

Before becoming a professional storyteller, George acted in many of Boston's theaters, including the American Repertory Theater. For 5 years, he acted with Boston's Museum of Science's Science Theater. He also worked with Boston-based children's theater companies as an actor, writer, workshop leader, and artist educator. Building on this experience, George went on to co-host *The Children's Room*, a nationally broadcast children's TV show. For each episode, he read aloud children's books, giving each character a distinctive voice to help his listeners tell the characters apart.

Besides performing, George is also a writer. He's written over a dozen fiction and nonfiction books for grades 2-8, and recorded children's books-on-tape and CD for major educational publishers.

As an artist educator, George strives to foster the literacy skills of young people by connecting story with curriculum. For a major part of his career, George worked full-time in Boston Public Schools as an artist-in-residence using storytelling to advance literacy and to complement the language arts and social studies curriculums.

His "mad scientist" period may be far behind him but George continues to find new pathways for enriching the educational experience for students of all ages while expressing his own unique talents.

ABOUT YOUNG AUDIENCES

Young Audiences of Massachusetts (YAMA) is the oldest, largest and most utilized arts-in-education organization in the state and one of the largest in a national network of 33 chapters. For over 45 years, YAMA has been serving as a link between teaching artists and the region's school children, providing dance, storytelling, music and theater programs to children in schools, libraries and hospitals in the form of assembly performances, workshops and residencies. The organization's mission is to encourage lifelong engagement with the arts by making them an integral part of every child's education.

MASSACHUSETTS CURRICULUM FRAMEWORKS CONNECTIONS

George Capaccio: *Albert Einstein: Relatively Speaking*

Frameworks: 2008 Technology Literacy Standards and Expectations

STRAND: RESEARCH, PROBLEM SOLVING AND COMMUNICATION
Topic: Problem Solving

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3.6	With teacher direction, use appropriate technology tools (e.g., graphic organizer) to define problems and propose hypotheses.	

Frameworks: 2006 Science and Technology/Engineering

STRAND: EARTH AND SPACE SCIENCE (PREK-8)
Topic: The Earth in the Solar System

13	Recognize that the earth is part of a system called the "solar system" that includes the sun (a star), planets, and many moons. The earth is the third planet from the sun in our solar system.	3-5

STRAND: PHYSICAL SCIENCES (PREK-8)
Topic: Forms of Energy

5	Give examples of how energy can be transferred from one form to another.	3-5

Topic: Light Energy

12	Recognize that light travels in a straight line until it strikes an object or travels from one medium to another, and that light can be reflected, refracted, and absorbed.	

STRAND: EARTH AND SPACE SCIENCE (PREK-8)
Topic: The Earth in the Solar System

8	Recognize that gravity is a force that pulls all things on and near the earth toward the center of the earth. Gravity plays a major role in the formation of the planets, stars, and solar system and in determining their motions.	

Frameworks: 2003 History and Social Science

STRAND: WORLD HISTORY
Topic: World History I Learning Standards

Scientific Revolution and the Enlightenment in Europe

WHI.33 Summarize how the Scientific Revolution and the scientific method led to new theories of the universe and describe the accomplishments of leading figures of the Scientific Revolution, including Bacon, Copernicus, Descartes, Galileo, Kepler, and Newton. (H**)** (8-12)

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Frameworks: 1999 Arts

STRAND: CONNECTIONS
Topic: Purposes and Meanings in the Arts

6.1	When viewing or listening to examples of visual arts, architecture, music, dance, storytelling, and theatre, ask and answer questions such as, *"What is the artist trying to say?" "Who made this, and why?" "How does this work make me feel?"* (PK-4)	

Topic: Roles of Artists in Communities

7.1	Investigate how artists create their work; read about, view films about, or interview artists such as choreographers, dancers, composers, singers, instrumentalists, actors, storytellers, playwrights, illustrators, painters, sculptors, craftspeople, or architects.	PK-4

STRAND: ARTS DISCIPLINES: THEATER
Topic: Critical Response

5.6	Continue to develop and refine audience behavior skills when attending informal and formal live performances.	5-8
5.7	Articulate and justify possible criteria for critiquing classroom dramatizations and dramatic performances.	5-8

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