Playground Physics: Hang in There!

Playing with pendulums and swings can help preschool children find out more about gravity and motion (see Illinois Early Learning and Development Benchmarks 11.A.ECa, 11.A.ECc, 12.D.ECa, 12.D.ECb, and 13.A.ECa). Emphasize safety: An adult should stay close by to make sure children use the pendulum safely. Remove all pendulums, especially the cords, from the playground when you are not supervising their use. Children must not swing on a pendulum or wrap the cord around any part of their bodies.

Make a pendulum—or two.

- Make a "bob" by putting a beanbag or other weight inside a mesh bag or clean sock. Tie the bob to a cord and hang it from a playground structure so it swings freely close to the ground. Tell the children, "This is a pendulum. You can try different ways to make it work."
- After a while, ask questions such as, "Did you notice what happened when Davy released the bob with the cord stretched tight? What happened when Tess threw the bob?" "What can make the pendulum stop moving?" List their observations for later discussion.
- When the pendulum is at rest, invite some children to measure how far the bob is above the ground. Then invite a child to hold the bob and step back until the cord stretches tight. Then ask them to measure again: "Now how far is the bob above the ground?"
- Invite the children to imitate the motion of the bob by moving their hands through the air.
- Let a child release the bob while others count or use a timer to see how long the bob stays in motion.
- Replace the bob with a funnel or a plastic milk jug with a ¼-inch diameter hole in the bottom. Plug the hole with a cork. Lay an old sheet or a board directly under the bob. One child can fill the milk jug bob with sand. Ask, "When we take the cork out and let the bob swing, what do you think might happen?" Let them try it, then revisit their predictions.
- Set out plastic bowling pins so children can take turns aiming the pendulum bob to knock the pins over. Or put a foam ball in a mesh bag and hang it so it is about waist-high to most of the children. They can play catch by swinging it to each other.
- If your playground has swings, invite children to observe the swings while they play. In what ways are the swings like pendulum bobs? In what ways are they different?

Talk about pendulums.

- Introduce the idea that gravity is an invisible "natural force." It has the power to make hanging things come to rest instead of swinging back and forth forever. That's why it takes effort to make something swing for a long time.
- Ask, "How would you describe a pendulum to a person who has never seen one?"

For related Web resources, see "Playground Physics: Hang in There!" at http://illinoisearlylearning.org/tips.htm.

Illinois Early Learning Project

29 Children's Research Center
University of Illinois at Urbana-Champaign
51 Gerty Dr. ● Champaign, IL 61820-7469
Telephone: 217-333-1386 ● Fax: 217-244-7732
Toll-free: 877-275-3227
Email: iel@illinois.edu
Internet: http://illinoisearlylearning.org

Illinois State Board of Education

Playground Physics: On a Roll!

Many preschoolers like to play with things that roll. Rolling activities can be opportunities to explore principles of science and engineering. Children can investigate rolling objects on inclines such as sliding boards, ramps, chutes, and hillsides at a playground or park. The following activities can help address Illinois Early Learning and Development Benchmarks 11.A.ECc, 11.A.ECd, 11.A.ECg, 12.D.ECa, and 12.D.ECb.

Let children play outdoors with rolling objects.

- Offer a selection of objects that roll. Try a variety of balls, tubes, hoops, discs, marbles, and small wheel toys. Include some natural objects—pinecones, acorns, and small pebbles.
- Suggest rolling the objects down hills, sliding boards, chutes (enclosed slides), and ramps at the playground or park. Ask provocative questions such as, "Do you think the ball will stop at the bottom of the hill or will it keep rolling?" "What do you suppose will land first: an acorn that drops from the top of the slide or an acorn that rolls down the slide?"

Help children set up an outdoor physics lab.

- Provide items for building ramps, chutes, and slides. Include blocks, planks, lengths of plastic gutter, long tubes, flexible toy track, and large pieces of cardboard.
- Suggest some experiments: "What could Tae do to find out if marbles roll faster down the slide or down his ramp?" "Who would like to help Lola see how far these things will keep rolling after they come out the chute?"
- Ask children to make predictions. For example, "Winona is holding a tube at the top of the ramp. Omar is holding a soccer ball. If they let go of their objects at the same time, which one do you think will roll to the bottom first?" Ask children to explain their predictions: "What makes you think so?"

Talk with children about their rolling activities.

- Explain that slides, ramps, chutes, and hillsides are "inclines" (or "inclined planes"). An incline is a surface that has one end higher than the other.
- Use objects and book illustrations to help explain words like tilt, level, wedge, steep, angle, slope, slanted, and path.
- Ask children what they have noticed about inclines. "Which is easier—rolling things on level ground or on an incline?" "If you want things to roll very fast, what sort of incline would you make?"

Suggest some rolling games.

- Let a child try rolling an object down an incline to another child at the bottom. Or let children set up plastic bowling pins to knock over.
- Encourage children to race various objects down inclines. "Let's see which one crosses the finish line first—Marina's ball or Kevon's tube."
- Invite children to make wheel toys for rolling races and other games.

For related Web resources, see "Playground Physics: On a Roll!" at http://illinoisearlylearning.org/tips.htm.

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Making and Tinkering:

Supporting Teachers' Use of Children's Literature as a Springboard for STEM/STEAM Design Engineering

Booklist

A Chair for My Mother
A Good Day Fishing
A Home for Dixie
Adventures With Jonny: Let's Go Fishing
Ah, Music!
Are You My Mother?
Awesome Dawson!
Bartholemew and the Oobleck
Before You Were Mine
Big Anthony: His Story
Bubble Trouble
Bubble, Bubble
Caterina and the Lemonade Stand
Clancy and Millie and the Very Fine House
Create with Maisie
Curious George and the Roller Coaster
Don't Throw That Away!
Dreaming Up
Extra Yarn
First Shapes in Buildings
Goldilocks and the Three Bears
Harold and the Purple Crayon
I Face the Wind
If I Built a Car
Iggy Peck, Architect
Just How Long Can a String Be
Kid Paper Airplane Book
Lemonade for Sale
Mama Built a Little Nest
Max Has Two Sticks
Mr. Gumpy's Outing
My Little Car
Not a Box
Nuts to You!
Olivia Forms a Band
Olivia Opens a Lemonade Stand
Olympig
Otto: The Boy Who Loved Cars
Pete the Cat and I Love My White Shoes
Peter's Chair
Piggy and Dad Go Fishing
Pop's Bridge
Rapunzel
Robots, Robots, Everywhere!
Roller Coaster
Roller Coaster Kid
Shoes, Shoes, Shoes
Simon and the Catapult Man's Perilous Playground Adventure
The 3 Billy Goats Gruff
The 3 Little Pigs
The 3 Pigs: An Architectural Tale
The Best Nest
The Boy Who Harnessed the Wind
The Bubble Factory
The Dark
The Great Paper Caper
The Robot Book
The Secret Lives of Squirrels
The Shoemaker and the Elves
The True Story of the 3 Little Pigs
The Very Busy Spider
The Wind Blew
The Wonderful Towers of Watts
Those Darn Squirrels!
Toy Boat
Twenty-One Elephants and Still Standing
Who Sank the Boat?
Whoosh! Easy Paper Airplanes
Yoda: The Story of a Cat and her Kittens

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COMMENTARY

STEM Education Must Start in Early Childhood

By JD Chesloff

According to a **2010 survey** by Change the Equation, a nonprofit, nonpartisan corporate initiative to further math and science learning, nearly one-third of Americans would rather clean their bathrooms than do a math problem. In a globally competitive economy, with employers of all shapes and sizes increasingly seeking workers skilled in science, technology, engineering, and math, this is humorous and more than a little troubling. Investing to ensure a pipeline of workers skilled in STEM competencies is a workforce issue, an economic-development issue, and a business imperative. And the best way to ensure return on these investments is to start fostering these skills in young children.

It is becoming increasingly difficult to define a STEM "job." Regardless of the industry—manufacturing, utilities, construction, technology, financial services—employers are looking for a talent pipeline that can produce workers proficient in the STEM disciplines. Concepts at the heart of STEM—curiosity, creativity, collaboration, and critical thinking—are in demand. They also happen to be innate in young children.

As employers look at the workforce pipeline over time, they ask themselves a simple question: Where are we going to find workers?

There is cause for concern:

• According to a **2010 study** from Georgetown University's Center on Education and the Workforce, about 76 million baby boomers will soon retire, and only about 51 million people are in line to replace them, creating a "worker gap" of 25 million.

• This past summer, the Center for American Progress and the Center for the Next Generation released a joint report showing that more than half of U.S. postsecondary students drop out without receiving a degree.

• And perhaps most alarming of all, of the 39 million young adults in the United States ages 17 to 24, the Pentagon reports that **75 percent** do not qualify to join the U.S. military because they cannot meet the physical, behavioral, or educational standards for service—standards that are similar to those many industries use in hiring.

When it comes to STEM jobs, the pipeline issue is complicated further. The U.S. Department of Commerce **projected** that in the decade leading up to 2018, STEM occupations would grow by 17 percent, compared with 9.8 percent growth for all other occupations. Across the country, across all occupations, there are 3.6 people for every one job. In STEM fields, there is one person for every 1.9 jobs. Employers can't find the talent to fill these jobs, which is even more surprising considering that the U.S. Census Bureau **recently reported** that the median salary for engineering majors was the highest of any profession.

—Illustration by Kali Ciesemier

Supply is low and demand is high. There is a mismatch between projected future jobs requiring STEM skills and the projected supply of qualified workers to fill them.

In 2009, at the urging of the Massachusetts Business Roundtable and a coalition of business leaders working closely with the state's lieutenant governor, Tim Murray, Gov. Deval Patrick created the Governor's STEM Advisory Council to develop a state STEM plan that would ensure that the education pipeline—from pre-K through higher education—is producing workers who are skilled in STEM competencies. The implementation strategy has a component focused on pre-K. Both the plan and the implementation are now national models.

There are many ideas about the most effective entry point in the education system for making an impact on student interest and achievement in STEM. Some say high school. Some say that's too late. Some say middle school. Some say 3rd grade. The Raytheon Co., one of Massachusetts' leading employers of STEM professionals, **conducted a survey** of 1,000 middle school students across the country and asked them if they preferred doing math homework or eating broccoli. The winner, with 56 percent of the vote was ... broccoli.

It is my feeling that you can't start early enough: Young children are natural-born scientists and engineers. Like STEM, investment in early-childhood education is a workforce-pipeline issue. Research has shown that high-quality pre-K cuts the rate of children being held back a grade in half; decreases juvenile arrests by a third; and increases high school attendance by a third, college attendance by a whopping 80 percent, and employment by 23 percent. High-quality early-learning environments provide children with a structure in which to build upon their

natural inclination to explore, to build, and to question.

There is an exciting and powerful link between STEM and early childhood. Research confirms that the brain is particularly receptive to learning math and logic between the ages of 1 and 4, and that early math skills are the most powerful predictors of later learning.

Research from the University of California, Irvine, confirms that early math skills are a better predictor of later academic success than early reading is. The study found that in a comparison of math, literacy, and social-emotional skills at kindergarten entry, "early math concepts, such as knowledge of numbers and ordinality, were the most powerful predictors of later learning."

If math skills are such an important component of academic success, but people would rather be cleaning their bathrooms or eating broccoli, I'd say we have a problem. Math skills and other STEM competencies are important to the country's long-term competitiveness because today's young children are tomorrow's workforce. Workers who are fluent in these competencies will be more prepared and qualified to fill the jobs that our innovation economy demands.

"If math skills are such an important component of academic success, but people would rather be cleaning their bathrooms or eating broccoli, I'd say we have a problem."

This concept is integrated into the Massachusetts education system, beginning at the earliest stages. The **strategic plan** of the Massachusetts Department of Early Education and Care officially recognizes that "inquiry and exploration are foundations for math and science and are also the foundations for early learning." The department's commissioner, Sherri Killins, has made remarkable strides in linking STEM and early childhood by encouraging STEM professional-development opportunities for early-childhood educators, aligning state standards and frameworks by ensuring a pre-K component to math and science standards, and intentionally integrating STEM into daily activities with students through curricula and quality measurements through the state's Quality Rating and Improvement System.

Massachusetts has engaged in productive partnerships with the private sector as well, including tens of thousands of dollars in donated hardware and software from IBM to support the state's implementation of its Race to the Top Early Learning Challenge grant from the federal government. Other companies, like National Grid, John Hancock, and JP Morgan Chase are also supporting efforts in the state to explore innovative ways to bolster the early childhood workforce.

And why wouldn't they? International competition for talent is getting stiffer. As the Center for American Progress and the Center for the Next Generation study points out, "half of U.S. children get no early-childhood education, and we have no national strategy to increase enrollment," while China, for example, has plans to enroll 40 million children in preschool, an increase of 50 percent, by 2020. Just for some context, there are a total of about 24 million children from birth to age 5 in the United States. By 2030, China will have 200 million college graduates, more than the entire U.S. workforce.

Which gets back to the original point: Where are employers going to find workers? To remain

competitive in the global economy, investment is needed to ensure a workforce pipeline that would rather engage in science, technology, engineering, and math than cleaning bathrooms and eating broccoli. And the best way to shore up that pipeline is to start investing in it early.

JD Chesloff has served as the executive director of the Massachusetts Business Roundtable since 2011. He is the chair of the Massachusetts Board of Early Education and Care and also chairs the executive committee of the state governor's stem advisory council.

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