

LET IT ROLL



Exploring motion with young children

By Kathy Cabe Trundle and Mandy McCormick Smith

A toddler tosses a crayon from his high chair and watches curiously as it rolls under the stove. He seems to wonder why the spoon, which he tosses next, behaves differently. Some of children's earliest explorations focus on movement of their own bodies. Quickly, children learn to further explore movement by using objects like a ball or car. They recognize that a ball moves differently than a pushed block. As they grow, children enjoy their experiences with motion and movement, including making objects move, changing movements, and recognizing differences in how objects move.

Young children usually have a multitude of tools available to them, from ramps to race cars. These everyday tools help facilitate their motion investigations. Preschool and kindergarten science content standards suggest that young children should explore how things move and how this movement can change. Children are also expected to make predictions and formulate conclusions based on their observations.

We used various science investigations to engage preschool and kindergarten-age children with explorations of motion and provided opportunities for them to develop their basic inquiry skills. Using everyday toys and objects is a realistic and captivating way to help young children understand the basics of motion. Read on to learn how to incorporate motion in your early childhood classrooms!

Ideas About Motion

In exploring motion, ramps are everywhere in a young child's world and imagination. Given an opportunity, books, blocks, and a hoisted table all become the needed ramp for car races. Children often think the steeper the ramp or slope, the more effect it will have on the cars. On a basic level, children's interpretations of this general observation is accurate. A common misconception stems from overgeneralizing this basic trend and not recognizing that an angle eventually becomes too great to continue this correlation between the angle of the ramp and the distance or speed that a car travels.

Exploring Mass

In thinking about motion, mass is often one of the first concepts students love to think about and explore. When asked to predict and compare the motions of a thrown watermelon to a tossed apple, our children painted a wonderful scene of the heavier, awkward watermelon smashing to bits on the ground and the lighter apple sailing effortlessly through the air stopping with a nice bounce and a bruise. Then we asked them to transfer these observations to two toy cars on a ramp, one lighter and one heavier. Given what they imagined with the watermelon and the apple, they said the lighter car would travel faster and farther. Children's conceptual thinking about mass can be likened to cartoon images. When asked, they elaborated on extreme scenarios that included elementary ideas on gain, loss, and transfer of momentum and energy, which often ended in loud crashes. We always encourage these ideas and support the inquiry that follows.

Drawing on their scenarios we were able to suggest reasons other than mass that may lead to traveling faster and farther. First, we provided them with toy cars of different masses and noted their observations. One student remarked that the "low-riding cars" were "super fast," whereas "monster trucks are too high to spin fast." We allowed their comments to guide the inquiry by next looking at the shape and aerodynamics of the car, followed by wheel size and circumference, both of which influence the rotational inertia or the object's "laziness" to gaining or losing speed. Both children and adults often attribute speed differences solely to differences in mass, but physicists would tell us that mass alone does not affect speed down a ramp. As teachers we can aim to show the students there are a number of factors that affect an object's rotational inertia and therefore its speed.

Verbalizing Ideas

Materials and how they affect motion are among the better understood concepts related to motion. Although a child might generally conceptualize what is happening, she may have trouble verbalizing her ideas. Our students are usually able to predict that a slick, smooth ramp will make a car roll faster or farther than a carpeted one, but they cannot explain the reasoning behind their predictions. Children observe and inquire about different tactile surfaces and list their observations about touch, but translating sensory information into motion usually proves difficult. Often, young children link information that is not scientific. For example, when a group of our students predicted that the smooth ramp would make a car roll farther than the carpeted one, they reasoned that "hard surfaces are colder, which make a car roll farther." Some of their rationales are scientifically accurate whereas others, like this example, are not. It is important to note that the intent of instruction is not to discourage children's nonscientific ideas. Rather, we provide opportunities for children to test their ideas against the evidence they gather using their science process skills.


Guided Inquiry Activity

In our planning for young preschool and kindergarten children, we always begin the learning through play, which provides opportunities for "incidental learning" in which children are engaged with materials that we purposefully select and place in the classroom or playground. Our placement of the materials depends on the type of objects and the concepts being taught. During this incidental learning time, we listen to and identify things about which children are curious and the questions children ask. Children's talk during play helps us identify their current understandings about related science concepts. We begin to focus children's observations by asking productive questions that children answer through their own explorations and observations: "What do you notice about...?" or "What happens when you...?"



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Preschoolers at play.

During the incidental play phase of the instruction for motion, we place motion-related materials in the block area or center. These materials include flat, smooth surfaces children use to make ramps (e.g., pieces of cardboard, Styrofoam, or foam board) and objects children use to explore motion (e.g., cars, balls/spheres of various sizes and masses, balls with different surfaces, cylinders of different diameters, and objects with irregular shapes). We always remind children about the safe use of materials. Our classroom expectations include keeping objects on the floor or ramp, away from our faces and our friends. We also caution children to keep their fingers and toes away from the bottom of the ramp. Heavy objects might hit the bottom of the ramp with enough force to injure a child's fingers or toes. 

Through their play explorations, children observe that when objects are placed on a ramp, some roll, others slide, and some do not move at all. Some objects even behave as "rollers" at times and as "sliders" at other times, depend-



Rolling toy cars down a ramp.

ing on how the child releases the object on the ramp. We encourage exploration by asking questions like “What happens when you turn that object sideways before you release it?” and “What kinds of objects are good rollers and which ones are good sliders?” We often get responses that link the shape of an object to rolling or sliding: “Flat sides are sliders and circle shapes are rollers” or “Toys with wheels are built for rolling.” Through their play and incidental learning, children begin to learn that the shape of an object affects how it moves.

Intentional Learning

After children have had time to play with materials related to motion, we move the instruction from incidental to “intentional learning” in which children are making and recording observations, looking for patterns in their data, answering questions, and asking new questions. During intentional learning, the targeted concepts emerge through the investigations as we continue to ask productive questions to focus children’s observations and the analysis of data. We also scaffold the inquiry process and scientific language for children. For example, we only introduce new science vocabulary after children have had opportunities to observe and describe the phenomenon with their own choice of words and language.

We begin the intentional learning for motion by stacking two books on the floor and leaning one end of a foam board on the books with the other end on the floor. Next, children roll a car down the ramp and mark with masking tape where it stops to indicate how far it travels. Then we ask them to compare releasing the car with no push to releasing the car with a push. Which rolls farther? This exploration provides an opportunity to introduce the concept of a fair test. Next they compare a ramp built with two books to one built with four books (changing the angle and the incline of the ramp). Children predict which ramp will make a car travel a greater distance after it rolls down the ramp. Then they test their predictions by adding

the extra books and rolling the car down the ramp again, releasing the car with no push. Children begin to learn that the steepness of the ramp affects how far the object will roll. We encourage children to test this concept by asking them “What could you do to the ramp to get the car to roll even farther?” and “What happens when you make a very steep ramp?” Students note that very steep ramps “create places at the bottom which make crashes.” Through this investigation children begin to see that the angle of the ramp affects how far or fast a car can roll. As the angle of the ramp increases, the height of the ramp also increases. This increase in height increases the object’s potential or stored energy. The more potential energy the object has the faster and farther it will roll. This relationship holds true until the angle is too great and the object can’t roll, resulting in a crash at the bottom of the ramp.

Additional Investigations

Additional investigations include changing the surface of the ramp and the mass of the car. We ask children: What happens when you add a piece of carpet to the ramp? How far does the car roll? How does that distance compare to the distance when using a ramp without the carpet? After investigating with the given materials, students will make general connections about surface types, friction, and distance. For example, they will note that rough surfaces, like carpet, will make a car go slower and in turn not travel as far. We measure the mass of the car. Then we add weights to the car (metals washers or pennies bound together with rubber bands) and measure the total mass again. What happens when you roll the heavier car down the ramp? How does the distance the unweighted car travels compare to the distance the weighted car travels? Which rolled farther? These investigations allow children to begin to understand that the surface of a ramp as well as shape and size of the object affect how fast and far an object can travel down a ramp. In addition, students are testing their original ideas on mass being the greatest influencer of speed. After investigating, the students will see that although mass is related to speed, it is not the sole factor. They will note that other factors such as wheel size, surface type, and mass distribution affect the speed of the vehicle. Friction is the force that results when any two objects are in contact, and friction works against the motion of an object. In general, the smoother the surfaces, the less friction there will be. By reducing the friction, the object will travel faster and farther. Conversely, an increase in friction from a surface such as carpet increases friction, which decreases the motion. Students are often surprised to find their data do not support their original ideas regarding mass. In terms of mass, rotational inertia depends on mass, but it is the object’s distribution of mass which is important. We aided our students’ understanding of this relationship by having them walk on a

low balance beam, keeping safety precautions in mind, with their arms at their sides. Next, we had them walk the same beam with their arms out to increase the mass distribution. By distributing the mass we are increasing the rotational inertia or allowing them to better resist rotational change. (For more on how mass is distributed, see Science 101 on p. 62.) Inertia is an object's resistance to change. If an object is already at rest, it will want to stay at rest. If it is in motion on a path, it will stay on that path. Both of these statements are true until the object is acted upon by a force. By increasing the students' rotational inertia they will have a greater ability to stay on the path of the beam.



We allow children to test their own ideas by building different ramps and using different kinds of objects. We also have children look at how these variables (ramp angle, ramp surface, mass of the object) affect the objects' speed by setting up rolling races with a finish line. We set up two ramps at equal distances from the finish line and children release the objects at the same time. It's important to talk about a fair test and make certain that they are only testing or changing one variable (e.g., ramp height, object mass, or ramp surface) at a time.

Formal Assessment

There are several learning outcomes for students with this guided inquiry activity. At the end of this lesson the students will be able to:

- Describe the motion of objects.
- Relate materials/objects to types of motion (sliders and rollers).
- Predict and evaluate what types of motion will result from a given setup.
- Compare motion outcomes from different designs.
- Design their own motion investigations using everyday materials.

To encourage children to apply their learning and to provide an opportunity for formalized assessment, we ask them to set up a ramp, based on all of their tests, that will make the object roll as far as possible. "How will you set up your ramp?" "If you wanted to make the car roll slower, what would you do to the ramp?" and "If you wanted to make the car roll faster, how would you change the ramp?" The children's responses included making the slope less steep "like a hill, not a mountain, will make things go slower" or by placing an "up ramp at the bottom of the down ramp," which can slow an object down. We encourage children to make connections with what they are learning by asking them to think of times when we would want to change ramps to slow things down (wheelchair ramps) and speed things up (in-line skate parks or waterslides).

To make the learning relevant to the classroom community, we walk around the school and identify ramps and how we use them to do work. For example, we have a ramp at one entrance to our school building, which makes it easier for friends who use a wheelchair or stroller to get in and out of our building. Workers who deliver supplies to the school often use ramps to unload heavy boxes, and most sidewalks include ramps at intersections. Children also collect three objects from home that they predict will be rollers and three others that will be sliders. Then, they test their predictions using their ramps in the classroom or on the playground slide.

A Foundation of Knowledge

Students enjoy the success and experience of learning from their trials as well as being engaged in the fundamentals of scientific design and inquiry. The motion investigations described in this article elevate children's awareness of the physics around them, including materials and motion and mass and motion, as well as ramp design. Together these concepts provide a foundation of knowledge that inspires curiosity upon which children eagerly build more advanced concepts in later years. ■

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Print Resources

- Cowen-Fletcher, J. 1993. *Mama zooms*. New York: Scholastic.
- Dahl, M. 2006. *Roll, slope, and slide: A book about ramps*. Minneapolis, MN: Picture Window Books.
- Waring, G. 2006. *Oscar and the cricket: A book about moving and rolling*. Cambridge, MA: Candlewick Press.
- Whitehouse, P. 2003. *Rolling*. Chicago: Heinemann-Raintree Classroom.

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades K–4

Standards B: Physical Science

- Position and motion of objects

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academies Press.

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