

Explorations



Math Moves!

Experiencing ratio and proportion



Inquiry and prolonged engagement are essential to math

Science centers are known for promoting active, “hands-on” inquiry in science. Mathematics can also involve active questioning, constructing, manipulation of objects, and experimenting. Try multisensory active math in Math Moves! Engage your students in curriculum-related, exhibit-based learning, integrating the motivation and energy of free-choice investigation, the fun of discovery and personal meaning-making. Enacting math can be a powerful tool for exploration and understanding.

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In This Guide

Math Moves! Experiencing Ratio and Proportion provides rich, engaging experiences that:

- Encourage children to acquire deep understanding of math concepts.
- Make the practice of math skills surprisingly enjoyable
- Help children identify success with math as personally relevant and rewarding.

The content focus is the broad topic of ratio and proportion, including fractions and the geometric concept of similarity, with exhibits that are:

- **open-ended** to encompass several ways visitors may interact and often more than one math problem to explore
- **conversational** to encourage children and adults to talk with each other about the exhibit activity.
- **accessible** by incorporating audio and written labels in English and Spanish.

Math Core Partners, Project Leaders & Advisors

Explora
 Museum of Science, Boston
 North Carolina Museum of Life + Science
 Science Museum of Minnesota
 San Diego State University's Center for Research in Mathematics and Science Education
 Selinda Research Associates
 TERC

Funding information – if you do not have this, it will come from J. Newlin

Thanks to teacher advisors: Joe Chan, Courtney LaRoche, Beth Lescenski, Marcia Lunsford, Amy Nolte, Chris Robinson, Erica Schaps, Melissa Sloneker, Michael Stoesz

When you visit the Math Moves! exhibition:

- Share expectations, plans and schedules for the visit with students and chaperones. Give chaperones copies of any materials given to students. Give chaperones copies of any activities students will do. A chaperone guide (pg. xx) provides guiding questions for chaperones to use with Kindergarten through grade 5 groups. This may also be used to supplement student pages for grades 4–5.
- Encourage students and chaperones to have exploration time at each exhibit. “Play with the exhibit. What do you notice? What are you learning about? What would be interesting for others to do here?”
- Do some preparation activities before your visit. Use suggestions in this guide and the resource list for more ideas.
- Divide your class into small groups (3–4) to work together in the exhibition. For large groups, schedule time in other parts of the museum so each student has access to the exhibits.
- Review this guide for connections to your curriculum. Choose the activities that meet your needs best. Assign groups to different exhibits to gather information and share back in the classroom. Give student groups one or two exhibit pages to complete, then share information about “their” exhibits back at school.
- There are two versions of student pages: Level 1 (grade 4–5) and Level 2 (grade 6–8). Review each to see which ones would be most appropriate for your classroom.
- Exhibits are not sequential. You can have students work at one or two of the exhibits or all of them.
- Add your own page(s) or thinking prompts. Use journals or composition notebooks if you use these in classroom work. Bring sturdy cardboard to write on if you plan to use single pages for students.
- Other exhibits about ratio and proportion, besides the ones shown in this guide are also in this area. Ask students to try one of these and report back to the rest of the group about their choice.

About This Topic

Math Moves! is about experiencing ratio and proportion. Allowing students to play with ideas of ratio and proportion in tangible ways provides a physical memory and background as a basis for developing abstract patterns, associations, and concepts. This qualitative sense of ratio and proportion can support quantitative competence when they encounter ratios in classroom work.

WHAT IS RATIO?

A comparison of two things. Ratios can also be expressed with fractions, decimals, percents, or words. Ratios also can be written with a colon between the two numbers being compared.

Example: One chaperone is required for every ten students, so for 100 students on the 4th grade field trip, how many chaperones are needed? 10 chaperones for 100 students is the same as 1/10 or 1:10 or one to ten.

WHAT IS PROPORTION?

Proportions are statements that two ratios are equal. Understanding relationships between ratios is known as proportional reasoning. Proportional reasoning is considered the gateway to higher math, including algebra.

In proportion problems there are *two things* that both change at the same rate. If a student knows the amount of dollars & gallons in one situation (e.g., 2 gallons cost \$5.40), and either the dollars or the gallons of another situation (\$2.70 or 3 gallons), using proportional reasoning allows them to figure out the other quantity (1 gallon or \$8.10).

Tables like the ones below help clarify proportional comparisons.

Miles	60		180			
Hours	1	2	3	4	5	

Dollars		3.30				
Pounds	1	2	3	4	5	

Adapted from:

www.homeschoolmath.net/teaching/proportions.php



One of 21 mathematical “Big Ideas” identified by math education researchers includes ratios.

Fractions, Ratios, & Percent

- A comparison of a part to the whole can be represented using a fraction.
- A ratio is a multiplicative comparison of quantities; there are different types of comparisons that can be represented as ratios.
- Ratios give the relative sizes of the quantities being compared, not necessarily the actual sizes. Rates are special types of ratios where unlike quantities are being compared. A percent is a special type of ratio where a part is compared to a whole and the whole is 100. The probability of an event is a special type of ratio.

Journal of Mathematics Education Leadership, vol. 7, #3, 2005

CONNECTING WITH THE CLASSROOM**Before Your Visit**

Share your expectations with students regarding what they will be doing at the museum. If you plan on using student pages, review the pages with students before the field trip. Clarify any questions students may have.

If you want to use your own guiding questions or have students develop their own questions or activity challenges, use the attached exhibition floor plan (pg. xx) and student pages (pg. xx) to inspire or develop questions.

Before or After Your Visit

These activities allow students to experience ratios with their bodies in the classroom. These are appropriate for all grade levels, and can be done before or after your visit to Math Moves!

WHOLE & HALF

Have students work in pairs. One student will be “whole,” the other is “half.”

WHOLE holds their hands apart (can be horizontal or vertical—try both). HALF puts one hand half-way between WHOLE’s hands. WHOLE can move hands together and apart and HALF needs to adjust accordingly. Switch roles.

Variations:

WHOLE holds hand above floor. HALF places hand between hand and floor.

WHOLE walks along a set distance (about 5 feet), HALF walks half as fast. For an extra challenge, have one person move one quarter as fast or one third as fast.

If you have access to a digital camera, try capturing pairs on video to analyze movements. How close did they come to the goal?

Discuss as a class:

Which partner had to move farthest? Fastest? Explain your thinking.

MOVING TWICE AS FAST

Have students work in pairs. Put 2 pieces of masking tape parallel on the floor, 6–10 feet long. Several pairs can do this concurrently if there is space.

Ask each pair to walk along the taped lines at the same rate. Then student A uses the same rate, but student B needs to walk half as fast, then twice as fast. Switch roles.

Discuss as a class:

How can you tell how fast you were moving? How did you know if you were moving half or twice as fast? What would help you do this?

RATIO HUNT! (For grades 3 and up)

Ask students to quietly move around the classroom to find objects that meet the description given below. How do they know when they have chosen a correct-sized object?

- + Find something that is 3 times longer than your thumb.
- + Find an object that has 2 times the circumference of your arm.
- + Find something that is $\frac{1}{2}$ as wide as a piece of paper.
- + Find an object that is 10 times longer than your foot.

Tricky tasks:

- + Find an object that is 1 times longer than your hand.
- + Find an object that is 4.5 times longer than your pinkie.
- + Find an object that has $\frac{1}{2}$ the circumference of your head.
- + Find an object that is as big as you.

MATH TALK

Practice “math talk” in daily classroom work. These prompts are excellent for facilitating student interactions at museum exhibits too.

What did you notice?

How are these similar?

How are these different?

What is common?

What is the relationship between _____ and _____.

How are they alike?

What do you see?

What else do you see?

What else?

(Press for details!)

After Your Visit

Review student pages in small groups, then as a whole class. Sharing data and perceptions is important for students to identify patterns in the activities that go beyond individual experiences. Conversations also allow students to process and clarify their ideas. "Compare with another person in your group. How are their choices like yours?"

1. SHADOW FRACTIONS

- + Make your own shadow table with a flashlight and lined paper. Mark measurements on table and perpendicular endpaper.
- + Where do you need to put an object to make its shadow twice as big as the object?
- + Is it the same for all sizes?
- + Share challenges students created at the museum. Do they work on your shadow table?
- + What patterns do students notice?



2. SCALING SHAPES

- + Review the patterns students found, i.e., original number of blocks and number of blocks in a doubled form.
- + What does "doubled" mean when discussing a 3-dimensional form?
- + Brainstorm some ways this information would be useful in life outside math class.



3. BALANCE AND IMBALANCE

- + Ask students to compare their rules about making the bars balance. What similarities do they find?
- + In this activity, students use a lever. Have students make their own levers to investigate the ratios using load and distance from the fulcrum. <http://www.msichicago.org/online-science/activities/activity-detail/activities/simple-machines-build-a-lever/browseactivities/0/>
- + Making a simple lever with a ruler and paper cups.



4. SENSING RATIOS

- + If students have experience with a piano, or if you can demonstrate with a keyboard or piano, they will notice the same pattern of black and white keys repeating sound patterns as the notes become higher or lower in pitch. What is the pattern? How is this like a musical scale?
- + Investigate what frequencies humans can hear, and what kinds of pitch ratios make up harmonious sounds in music. <http://www.musicmasterworks.com/WhereMathMeetsMusic.html>
- + A mathematical explanation of why some notes sound good to the human ear. <http://en.wikipedia.org/wiki/Harmony>
- + Short explanation about how harmony is defined, and history of harmony in Western music.
- + Explore how different ratios of notes sound.



5. PARTNER MOTION

- + There are 6 different prompts on the graphing screen and **xx** images to try out along side the screen. Discuss your students' experiences by using the appropriate discussion prompts below.
- + What did the graph look like on the screen when you and your partner were moving? What was the x-axis (*distance from the sensor/screen*)? What was the y-axis (*showed time elapsed*)?
- + Describe where you and your partner were standing when the *graph lines crossed*. OR describe what you had to do to make sure the graph lines *did not cross*.
- + How does the graph show that you were moving *twice as fast* as your partner?
- + How did you move to *make mountains*? Why are some more steep than others?
- + What shapes/animals did you make? Why are some shapes impossible to make?
- + Ask students to find graphs in the newspaper or on-line that show change over time and discuss them.



6. COMPARING FORMS—CHAIRS

- + What was it like to sit in the large chair? Middle size? Small chair?
- + How did you measure the chairs? What did you find out?
- + If you were building the next size chair larger or smaller, how big would it be? Explain your thinking.



7. COMPARING FREQUENCIES

- + There are numbers on the wheels and on the big circle. What did students notice about the way they worked together?
- + Watch the classroom clock (analog). When the second hand moves around the face, what does the minute hand do? The hour hand? What is the ratio represented on the clock?
- + How does this photo show ratio? Or Which wheel goes around more times?



8. FRACTION TREASURE HUNT.

Discuss:

- + Which exhibits did students find that represent $\frac{1}{2}$? How did they show $\frac{1}{2}$? Did anyone try to make $\frac{1}{4}$ or $\frac{1}{3}$? How did they do that? Ask students to compare their findings.

Chairs	Shadow Fractions
Balance and Imbalance	Scaling Shapes
Sensing Ratios	Comparing Frequencies
Partner Motion	

9. CELEBRATE CURIOSITY!

- + After the museum visit, ask students for their ideas about the exhibits in **Math Moves!**
- + Brainstorm: What other kinds of exhibits would help kids "move with math?" How would they design an exhibit to teach math ideas using movement?
- + If you are already teaching about ratio and proportion, ask students what other kinds of activities would they include to help people *experience* ratio?