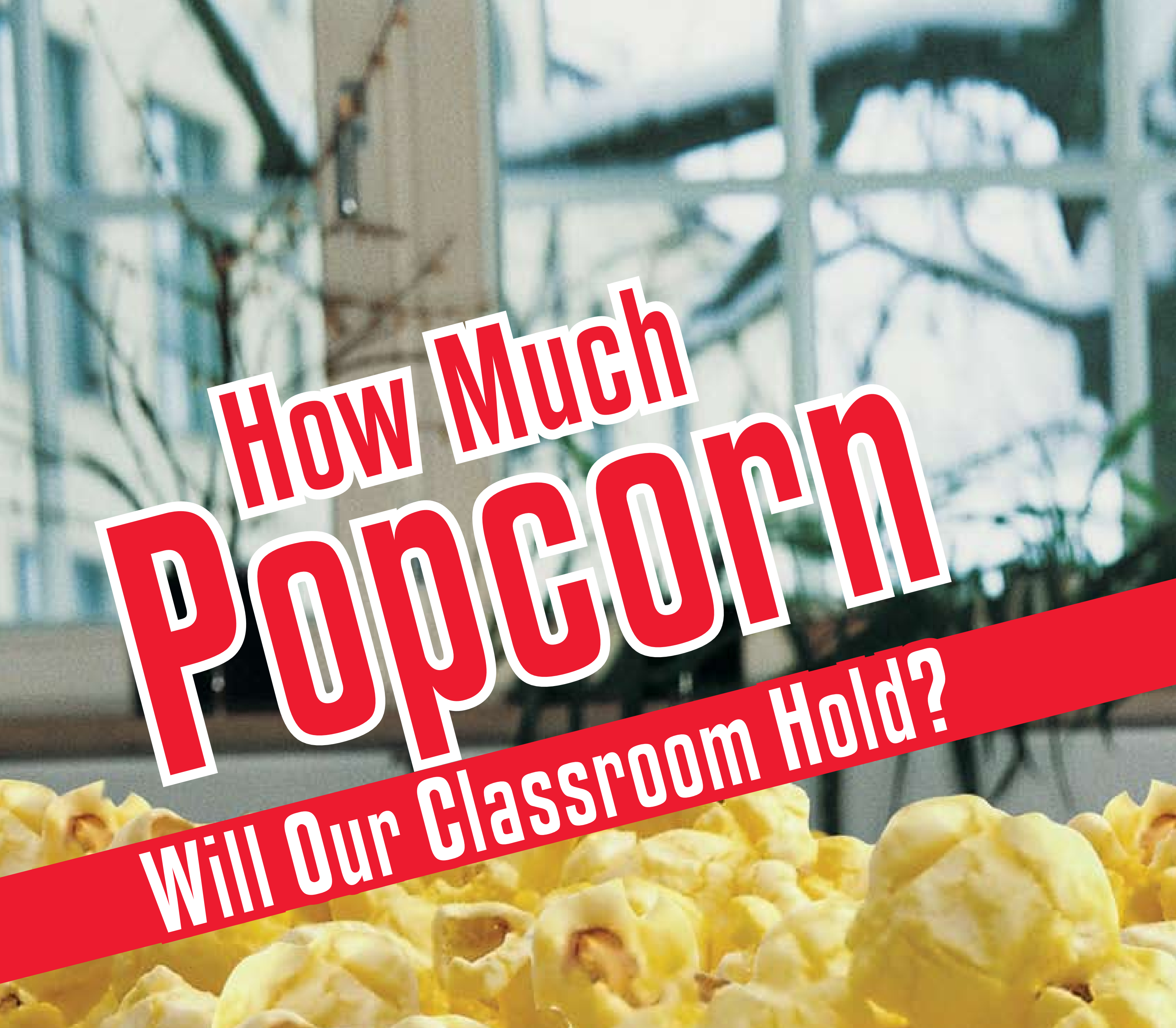

# How Much Popcorn Will Our Classroom Hold?

*Challenging upper elementary students to find the volume of their classroom creatively combines math and science.*

By Katie Rommel-Esham

*How much popcorn will our classroom hold?* This intriguing question sparked a terrific integrated science and math exploration I conducted with fifth- and sixth-grade students. In the process of finding the classroom's volume, students developed science-process skills (e.g., developing a plan, measurement, collecting and interpreting data, prediction, inference, communication, and using number relationships) and applied mathematical processes (determining an estimate, using benchmarks, measuring, mapping, etc.) in a meaningful way—getting an authentic glimpse of how these two subjects are inextricably linked.

## Popcorn Party

Even at upper elementary levels, many students hold fond memories of Frank Asch's Bear stories. Thus,

starting the lesson with a read-aloud of the Bear story *Popcorn* was appropriate here, even though it lies below students' targeted reading level. In this story, Little Bear's parents leave him home while they attend a Halloween party. Bear decides to have a party of his own to which all of his friends bring popcorn. As the characters pop all of the popcorn they have brought, it gradually fills each room of the house until the entire house is filled with popcorn. At the conclusion of the reading, I asked students how much popcorn would be needed to fill their bedrooms at home. "A lot," "tons," and "a whole bunch" were common responses.

Then, I presented students with the problem that was the focus of this investigation: How many liters of popcorn do you think it would take to fill our classroom?

The discussion that followed was important, as it forced students to think about what "a whole bunch" really means. I guided students to use benchmarks as they estimated. For example, I provided various medium-sized boxes (boxes such as those in which reams of paper come are ideal), one- and two-liter bottles, and other containers for students to use during the discussion. Appropriate guiding questions included:

- "How many liters of popcorn might fit in this box?"
- "How might we determine that without having enough popcorn to actually fill it?"
- "How many of these boxes might then fit in our classroom?"
- "How could we use this information to figure out how many liters of popcorn we would need to fill

our classroom?"

- "What kinds of processes and procedures do you think we would need to follow to determine that?"
- "What information would we need?"
- "How could we get that information?"

I recorded students' thoughts and estimates on chart paper so they could return to them throughout the investigation. We used adhesive-backed chart paper so the charts could be moved around the room as needed and updated as their investigations progressed.

Students' suggestions ranged from logical but not feasible (e.g., spreading a layer of popcorn all over the floor and seeing how many layers would be needed to fill the classroom) to plausible (e.g., filling smaller containers and measuring the number of liters of popcorn in the filled containers, then using that information to calculate how much would fill the classroom), but their numeric estimates of the number of liters of popcorn needed to fill the classroom, which ranged from 1,000 to 150 million, revealed a lack of understanding of large numbers.

## Establishing Ground Rules

Following these brainstorming activities, I divided the class into groups of five to six students each and challenged them to develop a plan to find out the number of liters of popped popcorn that our classroom would really hold. I reminded students to think about the issues we had discussed and to come up with a reasonable way to proceed.

Next, I established the ground rules for the investigation, which involved numerous considerations, such as: During the process of determining the volume of the classroom, will students be required to find the area of the exact footprint of the room, especially if it is not rectangular? Will the area inside of closets be included or excluded? Window ledges often block out space from the window to the floor—what will the considerations be for this space? Decisions regarding these matters can be left to the discretion of the teacher after careful consideration of the developmental levels of the students.

For our classroom investigation, students were required to find the area of the footprint of the room, with all its irregularities. They could, however, assume for the purposes of our investigation that there is no furniture in the room, and they could ignore the space inside the closet. To establish a benchmark by which to evaluate students' progress, prior to presenting this problem to the students, I measured the actual rectangular footprint of the classroom using the trundle wheel and the floor to ceiling height in meters to determine my own estimate of the volume.

## Developing Their Plans

Each team was responsible for determining an estimate of their own and outlining a written plan—a list of steps—for how they will proceed. I encouraged students to do this on notebook paper and in pencil to allow for editing should their approach change as they worked.

As students developed their plans, I circulated among the groups to respond to questions and offer guidance. Approval of students' plans provides an opportunity for "troubleshooting" and discussion about data gathering procedures. While I did not want to allow only one procedure, I also did not want students to be too far off base. For example, when one team decided to line up a row of popcorn along their meterstick to see how many pieces were in a linear meter, I questioned them about their understanding of the difference between linear measure and square measure (area) to redirect their thinking and problem-solving approach.

This particular group of students was thinking more in terms of the number of *pieces* of popcorn rather than in terms of volume—they were missing the connection that while the number of pieces is certainly related to the volume, it was the volume that was of importance here. The group also did not have a clearly defined plan for how to proceed from this measurement phase.

We discussed the difference between linear and square measure by talking about *perimeter* and *area*—in the first case, you measure *around* the floor in the room; in the other, you are *covering* the floor. Then, we marked off an area of one meter squared. Students knew the formula to find the volume of an object is *length* × *width* × *height*, so they knew that they could square the amount of popcorn lined up against the meter (a one-meter length of popcorn) to get the amount of popcorn required to cover a square meter, and then multiply by the height to get the amount of popcorn required to fill a volume of one-meter cubed. Talking together allowed us to work through the problem and extend their thinking.

## Finding the Volume

Each team of students needed access to various materials to carry out the investigations, including:

- Metersticks and/or trundle wheels (rolling measuring devices useful for measuring long distances or other distances not easily measured using a meterstick or measuring tape);
- String;
- Scissors;
- An ample supply of 10 cm × 10 cm squares cut from card stock (from which students can build cubes should they desire);
- Measuring cups;
- One- and two-liter bottles and containers;
- Masking tape;
- Calculators; and, of course,
- 2–3 L popped popcorn (which allows some for measuring and some for snacking—at a later time).

Some students immediately saw the value in building 10 cm × 10 cm × 10 cm cubes in order to determine how much popcorn they will hold—in earlier lessons, students had previously learned the relationships among meters, liters, and cubic centimeters so they knew that a 10 cm × 10 cm × 10 cm cube was equal to one liter. Others preferred finding the dimensions of the classroom using string, metersticks, or trundle wheels, and then calculating the volume.

Students worked for two to three days determining their estimates, recording their measurements and procedures (including all calculations) along with their results. All students in each group participated in each phase of the investigation, but the problem-solving approach allowed students to work within their respective strengths. In some groups, tasks were divided such that some members focused on developing the initial plan, others on measuring the classroom, others on completing the calculations, and others writing up results. In other groups, tasks were divided differently, for example, some members began doing calculations (like finding the area of the floor) while others finished measuring the floor-to-ceiling height.

Students were encouraged to think about potential sources of error inherent in their investigations and how such error might affect their results. For example, while human error certainly plays a role here, using different measurement tools will yield slightly different results due to the accuracy with which they can be used in the physical space of the classroom. The containers each group chose to use presented some challenges. While the 10 cm × 10 cm × 10 cm cubes provided an easy conversion, some of the larger boxes (one held 2.5 L) made the math more difficult and yielded a slightly different estimate.

After they calculated their estimates, students were required to produce a written report detailing their investigation and results. This written report served dual purposes—it acted as a summative activity for the students, allowing them to pull together all the processes used during the investigation of the problem, and it provided me with a tangible record of student work for assessment purposes.

## The Results: A Lot of Popcorn

Once the reports were completed, we held a class discussion on the similarities and differences in plans, materials, procedures, and the results of each of the groups. Each group shared their procedures and talked about what, if anything, they would do differently next time. Students commented on the need for making observations of the physical space of the classroom in order to determine a course of action; devising a plan; recording the steps used so that the plan could be either replicated or modified; communicating clearly with each other; "walking" through the plan before beginning to troubleshoot potential problems; gathering and interpreting their data, and drawing conclusions from the data.

During the discussion, I emphasized the math connections in the experience, pointing out that estimation is a mathematic concept used in many situations. We also discussed the conditions under which an estimate is appropriate (such as this one) and when an exact measure is necessary (such as when administering medication, for example).

When our discussion concluded, we followed with the moment of revelation—the sharing of each group's estimate for how much popcorn the room could hold. The groups' estimates ranged between 170,000 and 300,000 liters.

Even though the process of developing procedures and processes was really the main purpose of this activity, students were still anxious to know "what the answer was" regarding how many liters of popcorn the classroom would hold. Finally, I revealed the figure I had calculated—the classroom would hold approximately 237,000 liters of popcorn. My process had been to first determine the volume of the room in cubic meters, then convert that value to cubic centimeters (liters) by dividing by 1,000 (1000 cubic cm=.001 cubic m).

Some groups used roughly the same procedure I used but used different materials (e.g., cutting string the length, width, and height of the classroom, then measuring the lengths of the strings and calculating the room's volume that way). One group measured the number of liters of popcorn held in a box (approximately 2.5 liters) then determined the number of boxes that would fill the classroom, an inherently more difficult process. Yet another group used roughly the same procedure in reverse, determining the number of boxes the classroom would hold, then determining the number of liters of popcorn the box held.

## Assessment and Outcomes

Along with the chart paper used for recording and students' final written reports, I also used checklists to assess students' progress throughout the activity. While the written documents provide some insight into student understanding, the checklists allowed for assessment of other important skills, including teamwork, ability to use measuring devices appropriately, interpersonal communication, and leadership style.

In this investigation, students were actively engaged in the processes of science, including observation, measurement, prediction, inference, developing hypotheses, gathering data, and experimentation. An understanding of volume will help students understand that volume can be an important measurement in science. For example, it is critical to the concept of density. It can also be an important variable in many investigations. For example, if comparing how fast two materials heat or cool, the relative volumes must be controlled.

Coupling math and science instruction together in this context provides not only an obvious and authentic use for the mathematics involved but also strengthens the bond between the content and process skills of these two curricular areas. And besides, from the students' points of view, it's just plain fun! ■

## Connecting to the Standards

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

**Content Standards**
**Grades 5–8**
**Standard A: Science as Inquiry**

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

**Science Education Program Standards**
**Standard C**

The science program should be coordinated with the mathematics program to enhance student use and understanding of mathematics in the study of science and to improve student understanding of mathematics.

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### Resources

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