

An Exploration of Hundredths, in Part

Nicholas J. Gilbertson

Teachers have found many different ways to support students who are learning about rational numbers. Some of the most productive ways often involve the use of representations that anchor students' experiences in the quantities being learned. Although almost all representations have their limitations, they also provide opportunities to support students in pressing their understanding of

rational numbers. In this article, I share an activity motivated by a discussion that occurred during one of my seventh-grade classes. We used a hundredths diagram, in which the area of the large square represented 1 unit (for other

interesting uses of this diagram, see Scaptura, Suh, and Mahaffey 2007 and Cramer et al. 2009).

The students had vast experience with this diagram, especially when operating on rational numbers and

converting among percentages, fractions, and decimals. Students were given an assignment to shade the appropriate number of squares to represent $1/2$ percent. I anticipated that this problem would be unproblematic, and I was surprised to see how difficult it was for many students to solve. Many students felt that one-half of the large unit square should be shaded (focusing on the " $1/2$ " part), whereas many others felt that one-half of a small 0.01 square should be shaded. (Olson et al. 2010 referred to this issue as the "percent predicament." They noted how students confused $5/7$ and $5/7$ percent.) The ensuing discussion was quite rich, but it failed to create a consensus within the class. Realizing that there was something missing in students' understanding, I gave students the **Percentage Art activity sheet**.

LEARNING TARGETS

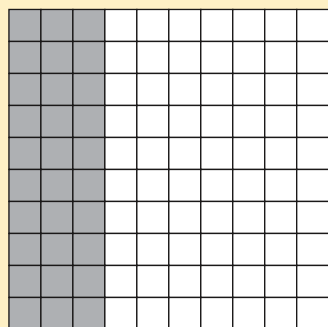
The main purpose of this activity is for students to be able to represent noninteger percentages. Many students view percentages, decimals, and fractions as unique representations. These different representations cause confusion when students are asked



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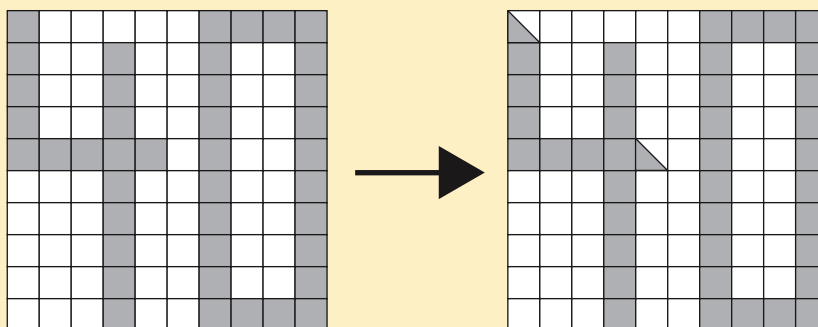
Edited by **Rebecca Damas**, rdamas@trevor.org, who teaches at the Trevor Day School, New York, New York. Readers are encouraged to submit manuscripts through <http://mtms.msubmit.net>.

Fig. 1 A hundredths grid is shaded, in part, to show various quantities.



The shaded region represents 30 percent = $30/100 = 0.30$.

Fig. 2 Half squares are in play to adjust the image's percentage.

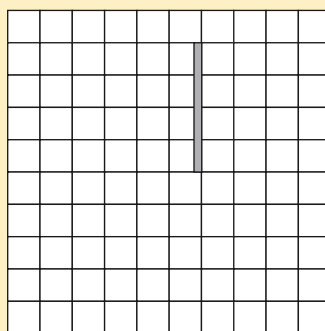


41 percent

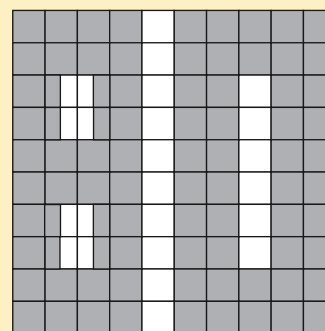
40 percent

to reason using a value such as 0.5 percent. Yet we see these types of percentages all the time in the real world, from population growth rates to auto loan interest rates. This activity supports the Common Core's Standard for Mathematical Practice "Attend to precision" (CCSSI 2010, p. 7) because students have to accurately represent the values in the hundredths diagram (see **fig. 1**). It also furthers their development of "a unified understanding of number, recognizing fractions, decimals . . . , and percents as different representations of rational numbers" (p. 46).

Fig. 3 Representing both small and large percentages often causes difficulties for students.



1 percent



80 percent

STUDENTS' EXPLORATION OF THE TASK

In question 1 of the activity, students may need several tries before creating a correct image. Numbers close to 1 (those greater than about 0.80 or 80 percent) and numbers close to 0 (those less than 0.15 or 15 percent) are quite challenging because either of these extremes produce large numbers of shaded or unshaded squares. Numbers between 0.20 and 0.50 seem much easier to create, with students being most successful with quantities between 0.30 and 0.40. Choosing a number that works is an important first

step for students to consider.

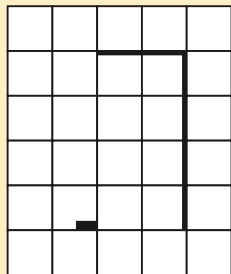
Many students will likely be unsuccessful in their first few attempts. This activity works well in small groups of two to four students, specifically because failed attempts can elicit discussion about how to tweak the image so that it meets the criteria of the problem. For example, in **figure 2**, the student used 41 squares to create the number 40, but with two slight modifications the image only used 40 squares, which was the intended value.

A good way to break up the activity in class is to have a brief discussion after question 1. This gives students

an opportunity to see how other students are solving the task and may highlight some interesting points for the class to discuss. For example, in **figure 2**, one could ask students what value they would give the small triangular piece in the figure (1/2 percent, 0.005, or 1/200), which can help students think about how to accurately represent noninteger percentages.

With questions 2 and 3 on the activity sheet, students explore further how to structure the space in the hundredths grid to make small and large numbers. Students will likely find that working with large amounts of

Fig. 4 One way to represent 0.7 percent is shown on a partial grid.



white or shaded space is challenging as well as engaging. **Figure 3** shows two examples of these extreme values, 1 percent and 80 percent.

In question 3, students consider the possibility of drawing a number that is less than 1 percent. Students may think that this is impossible because they are used to filling in full squares; they will also think that representing a quantity less than 1 percent will use less than a full hundredth square. If the small triangle (from **fig. 2**) appeared previously, this would be a good opportunity to remind students that it is possible to shade in values for less than 1 percent. **Figure 4** is an example of how a student might represent $7/10$ percent. Each segment (and the decimal point) represents $1/10$ percent.

LESSON TAKEAWAYS

After students have had the opportunity to explore and share their solutions, they should have a better sense of how to represent noninteger percentages using the hundredths diagram. In my own class, this activity seemed to be eye-opening for many students in that they had not considered these important rational numbers and how they could use their existing representations in new ways. The hundredths diagram has shown its usefulness in supporting student understanding of representing rational numbers and has many creative uses as students explore this often

challenging content of middle-grades mathematics.

REFERENCES

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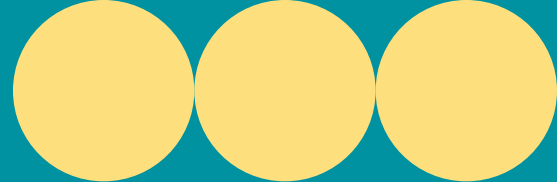
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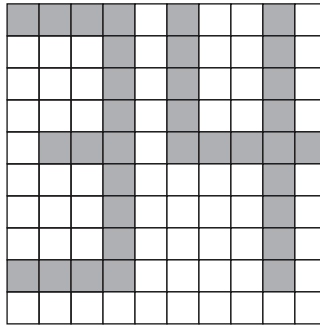
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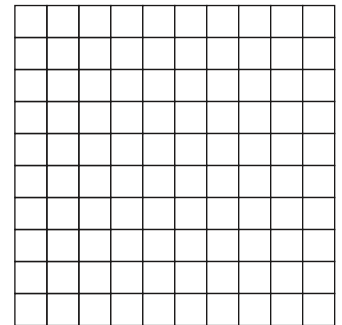
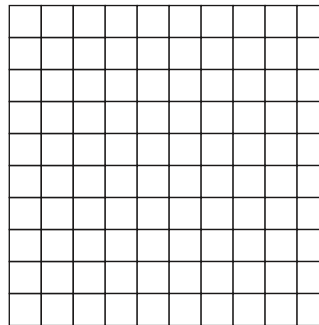
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PERCENTAGE ART

In the figure at right, what percentage of the unit square is shaded?



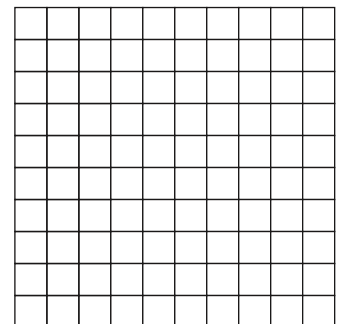
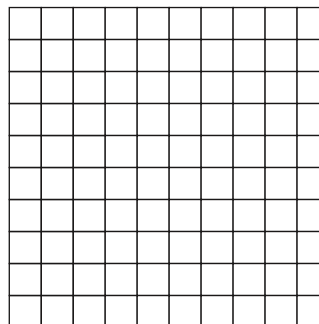
1. Using the hundredths grids at right, represent a number that corresponds to the percentage of the unit square that is shaded, as shown in the example above.



2. What are the smallest and largest numbers you can represent on the hundredths grid? Represent these two numbers at right.

Smallest

Largest



3. A student from another class claims he or she can represent a number that is smaller than 1 percent (but greater than 0 percent). Is this possible?

