FOLDING FUN

1. Fold a sheet of paper in half hamburger style.
2. Direct students to sketch what the paper will look like when it is opened.
3. With the paper folded, make cuts on one or two sides. For example, cut out shapes/ make notches on one or two sides, cut off corner(s).
4. Show the folded paper to the students. (Place on a document camera or overhead so they can easily see it.)
5. Ask the students to sketch what the paper will look like when you open it.

This activity may be repeated with more complexity by folding the paper more than once, making more cuts when students are ready. Be sure that students can see the folds you make so they can determine which edges are folded and which are "open".

The important part of this activity is the discussion of how they arrived at their answers and the questioning by the teacher to foster deep thinking, application of language, etc. Some sample questions might include: How did you draw your picture? What did you draw first?

Students will draw their figures in many different ways. For example, some will draw the folded paper and then iterate it the appropriate number of times, rotating and reflecting as needed. Others will start with a draw of the whole paper open and then draw in each cut as they imagine it to be.

The important component of the discussion is the focus on visualization and language as the conversation unfolds. For example, a student might say that they "drew the opposite of the shape because it was on the other side of the fold." This is an opportunity to use the term reflection and discuss reflection across a line of symmetry. If the paper is folded into four parts, then one part may be a rotation and reflection of the folded piece that was shown.

During early conversations students will use informal, everyday language ("I turned it."), but as they discuss, should begin to be more precise in their use of mathematical language. The terms "sometimes", "always", and "never" become important. One or two attempts that support an argument are not enough to prove it is always true unless there is a way to logically demonstrate that it will always work. They also need to realize that just one counterexample disproves an "always" statement.

Hearing other classmates share strategies allows students to think about different ways to visualize and they may begin to try each others' strategies as

the folds and cuts become more complex. If a group is struggling, one way to scaffold the more complex folds is to unfold part and allow students to revise their drawing before the whole paper is revealed. If this scaffolding is used, and important part of the discussion will be centered around how the drawings changed as the folds were revealed and what they noticed that helped them make those changes. This supports the notion that mathematics is a process that can be revised as more information is available and patterns are noticed.

Once the paper is completely unfolded a part of the discussion might include what kind of symmetry the shape has. Does it have line symmetry? Will it always have line symmetry? Why or why not? Does it have rotational symmetry? Will it always have rotational symmetry? Why or why not? Students may try to test their conjecture by attempting to create a counterexample. For example, if a student asserts that the paper will always have rotational symmetry, they would try to make one that does not.

Does the shape of the paper make a difference in the answers to these questions about symmetry? What about the number of folds? If I fold in thirds or sixths, will that make a difference?

As an extension, move from a rectangular piece of paper to other shapes (circle, triangle, etc.)

Another extension is to have students draw what they want the paper to look like when it is unfolded first and then try to fold and cut the paper so that it will match their drawing.

Work on this activity and similar ones should be conducted throughout the year. Children can begin to challenge themselves and others. For example: I challenge you to make 2 folds and 2 cuts to make a design that will have rotational symmetry.

Adapted from *Coming to Know Number* by Grayson Wheatley