Straight-Cut Origami

"Success is the ability to go from one failure to another with no loss of enthusiasm."
—dubiously attributed to Winston Churchill

Two 75-minute classes

Activity

Print 1-cut shapes. Distribute many copies and scissors.

Can you fold the paper so that with one straight cut you cut along all the black lines and only along the black lines?

First ones for the class to try: equilateral triangle, square, 2 by 1 rectangle, 2 line segments that make equal angles with a third segment (like a V with a flat bottom instead of a corner).

Harder: the scalene (irregular) triangle, then the irregular convex quadrilateral. (*Give the students lots of time on this: at least 30 minutes*). If anyone can do those, give them the non-convex examples.

Next, get everyone to try a non-convex example or an example they've not succeeded on before. (Ask them what's different about the non-convex examples.) Try to get the scalene triangle and the non-convex quadrilateral demonstrated at every table.

Eric Demaine's theorem: straight-cut origami can produce any finite union of polygons. Idea of proof: types of folds that help are angle bisectors and perpendiculars. In more detail, the fold lines come from the frontier pattern when oil flow from the sides at a constant rate into the interior, with perpendiculars added.

Questions for class

- What hints / strategies can you share with the class? What helps? What have you noticed? What were the "aha" moments? *Lines of symmetry, angle bisectors, "pocket folds."*

- What do you wonder about 1-cut origami?

- Is this math? Why or why not?

- What larger lessons (if any) do you take away from what we did? *Persistence*

- Did you feel frustration? When? How did you react?

References and resources

Book: Art of Mathematics, Art and Sculpture.

Growth mindset quotes: Inspiring Quotes on the Power of Persistence from Faster to Master

The Fold and Cut Problem from Eric Demaine's web site. (This includes an account of the history.)

youcubed.org

Numberphile video: Katie Steckles discusses the Fold and Cut Theorem

Irregular Shapes Worksheet

Notes

This works well as a first activity of the semester.

Encourage students to help each other.

Encourage discussions first around tables, then have the students share these with whole class.

Praise students for stick-to-it-iveness!

Guide them toward the math behind the scenes.

Assignments

Write a brief guide to solving 1-cut origami problems.

Give a diary account of your experience with 1-cut origami in our classes. How did your understanding develop?

Formulate a question you would like to see answered in a research project on 1-cut origami.

Follow-on activities

Pick's theorem

sum of angles of a polygon

scissors congruence