Symmetry as Revision

I built my academic life around words. I studied international relations and political thought in an English-taught programme, then moved into intellectual history, because I wanted to see how arguments hold together, and how a sentence can carry a complicated claim without distorting it. I now teach writing to students who live under pressure: exams, applications, and constant evaluation in a second language.

For years, I treated maths as a separate talent. I could follow procedures, but I did not feel at home. Poetry changed that, not because poems avoid rules, but because poems reveal what rules can do. A strict form does not shrink a poem. It sharpens it. It turns the writer's attention toward what must remain true, even as the surface changes.

I saw the same idea in a story that has followed me since. In a profile of June Huh, I read that he once left school to become a poet, and that he only later found his way into mathematics. That detail mattered to me. It suggested that maths can begin, not in speed, but in attention, and that aesthetic training can become mathematical training.

That is the question symmetry asks. What can change, and what must remain?

Likewise, this essay introduces symmetry as a set of meaning-preserving moves, and it shows how those moves form a "group," a compact piece of mathematical grammar. I will stay concrete. The square will be our text, and rotations and reflections will be our revisions.

What counts as the same

When you revise a line of writing, you often change everything visible while keeping the point intact. You swap a weak verb for a precise one. You change the order of clauses. You cut repetition. The sentence looks different, yet it still says the same thing. In a good revision, the meaning is invariant.

A symmetry is the geometric version of that idea. A symmetry is a transformation that changes an object's position or orientation while preserving the object's essential structure, so the transformed object still matches the original.

Take a paper square. Rotate it a quarter turn (90 degrees) around its center. Every corner moves to a new place, but the square still fits perfectly on top of its old outline. You acted, and you preserved what made the square a square.

Now ask the question that turns symmetry into mathematics rather than decoration.

If I can perform one symmetry, and then another, what is the logic of combining them?

Groups as "legal moves."

A group is a way to describe a set of actions that can be combined consistently. Think of it as a list of legal moves, together with a rule for chaining them. The actions can be physical, like rotating a square, or abstract, like rearranging elements in an equation, but the logic is the same. (This is the standard structure studied in group theory.)

For a set of moves to count as a group, four promises must hold.

Closure: If you perform one legal move and then another, the combined result is still a legal move.

Associativity: If you chain three moves, the final result does not depend on how you group them. You can think "first A, then B, then C" as (A then B) then C, or as A then (B then C), and you end in the same place.

Identity: There is a “do-nothing” move that leaves the object unchanged, and it behaves neutrally in a chain. Doing nothing, then doing a move, changes nothing about that move.

Inverses: Every move has an undo. If a move takes you from the original position to a new one, its inverse takes you back.

These promises describe reliability. They guarantee that you can build long sequences of transformations without losing coherence.

The square’s symmetries

A square has eight symmetries: four rotations and four reflections.

Rotations

- 0 degrees, the identity.
- 90 degrees.
- 180 degrees.
- 270 degrees.

Reflections

- Across the vertical line through the center.
- Across the horizontal line through the center.
- Across one diagonal.
- Across the other diagonal.

Nothing else works. A 45-degree rotation fails because the corners no longer land on corners. A reflection across a random slanted line fails for the same reason. The square is strict about which changes preserve it.

Now watch how the group promises appear.

Closure becomes visible the moment you compose moves. Rotate the square by 90 degrees, then by 180 degrees. The result is a rotation by 270 degrees, which is still one of the square's allowed symmetries. You stayed inside the set.

Identity is rotation by 0 degrees. It sounds trivial, but it matters. If you list symmetries as actions, you need a neutral action so that "no change" counts as a valid state in a sequence.

Inverses show up naturally. The inverse of "rotate by 90 degrees" is "rotate by 270 degrees." The inverse of any reflection is the same reflection, because reflecting twice returns the square to where it began.

Associativity is harder to see with your eyes, but it is built into how actions work. If you rotate, then reflect, then rotate again, the square ends in a definite orientation, and that orientation does not depend on how you parenthesize the sequence.

One more detail gives the square's symmetry group its character.

Order matters, and that is the point

Many people meet symmetry through mirrors and patterns, so they assume symmetry behaves politely. The square disagrees. If you rotate and then reflect, you do not always get the same result as reflecting and then rotating. The sequence matters.

That "non-commutativity" sounds technical, but you already understand it if you understand language. In English, "only" can change meaning depending on where it sits. In poetry, a line break can redirect emphasis. The order is not cosmetic. It is part of the structure.

Here is a concrete version with the square. Let r be “rotate by 90 degrees,” and let f be “reflect across the vertical axis.” Start with a labelled square. If you apply r and then f, the labels land in a different arrangement than if you apply f and then r. Both results are symmetries. They are both legal moves. They are not the same move.

That is why the symmetry group of the square is not just a list. It is a grammar. It tells you which transformations preserve the object and how those transformations interact.

Why does this feel like a poetic form?

Poetic form is not a cage. It is a set of invariants and a set of legal moves. A sonnet allows many sentences, many images, and many tones, but it makes a promise about length and structure. A villanelle demands repetition, but the repetition is controlled variation. Meaning survives because the form forces the writer to treat it with care.

The square does something similar. Its symmetries are the variations that do not break the underlying object. You can turn the square, flip it, and combine those actions, but you cannot treat it arbitrarily. The object insists on invariants, and the group records exactly which changes respect them.

This perspective changes how group theory feels. It stops being “a chapter in algebra,” and it becomes a language for sameness under transformation.

A teacher’s reason for caring

I want my students to preserve meaning when everything else changes, whether that change is a new prompt, a new rubric, or a tighter word limit. In my week, I may move from an AP history essay conference to an Algebra 2 problem set, and the underlying habit is the same.

Maths, at its best, trains the same habit. It asks you to be honest about what must remain true, and then to practice transformations that keep truth intact.

Symmetry is an unusually friendly entrance into that habit, because it begins with a physical sense, "this still matches," and it ends with a precise structure, "these are the moves that preserve, and this is how they combine."

The first time I truly enjoyed symmetry, I did not feel as if I had crossed into a foreign country. I felt as if I had recognised a familiar discipline, one I already knew from poetry: respect the invariants, learn the legal moves, and let structure sharpen attention. That is why I teach math alongside writing now. Both ask the same question. What changes are allowed, and what must remain?

References

Oxford Lifelong Learning, University of Oxford. “Tom Rocks Maths: Essay Competition 2026.” https://lifelong-learning.ox.ac.uk/about/tom-rocks-maths-essay-competition

Cepelewicz, Jordana. “He Dropped Out to Become a Poet. Now He’s Won a Fields Medal.” Quanta Magazine, July 5, 2022. https://www.quantamagazine.org/june-huh-high-school-dropout-wins-the-fields-medal-20220705/

Encyclopaedia Britannica. “Algebra: Applications of group theory.” https://www.britannica.com/science/algebra/Applications-of-group-theory

American Mathematical Society. “Strung Out on Automorphic Forms.” Math Voices (Feature Column), November 1, 2024. https://mathvoices.ams.org/featurecolumn/2024/11/01/strung-out-on-automorphic-forms/