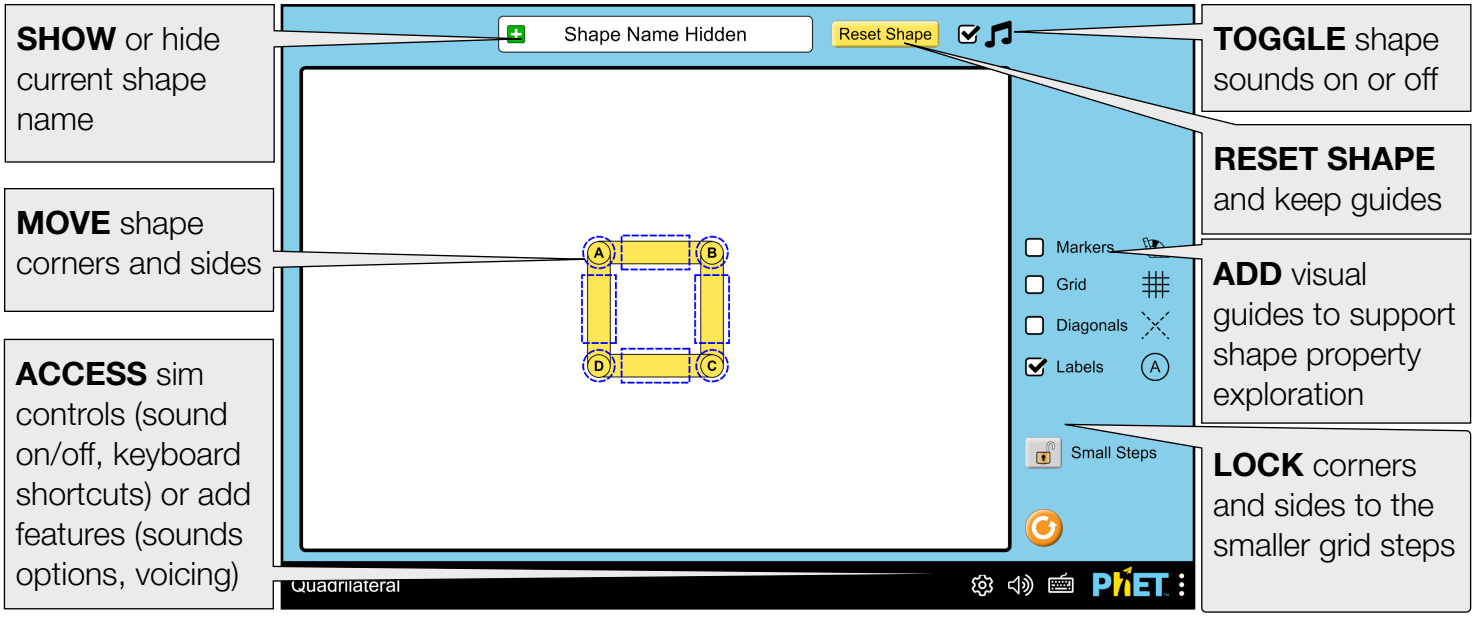
PhET Tips for Teachers — Quadrilateral

In **Quadrilateral** students explore the properties of and relationships between named four-sided shapes.



Model Simplifications

- Only simple quadrilaterals are possible in the simulation. The simulation prevents crossed or complex quadrilaterals and corners or sides cannot be dragged if the next step will produce a crossed shape.
- Not all possible shapes are named in the simulation. We include: Convex, Concave, Dart, Kite, Trapezoid, Isosceles Trapezoid, Parallelogram, Rectangle, Rhombus, and Square. Other named shapes that may be of interest can be explored, but are not explicitly named in the Show Shape Name display, such as: Right Trapezoid, Acute Trapezoid, Obtuse Trapezoid.
- The sim includes the named shape: "Triangle?". The name is included to acknowledge the appearance as a triangle, but the shape still presents with four named vertices and four named sides. Teachers are encouraged to have a conversation with their students on whether it is in fact a triangle or not.
- See the Model Documentation for more details.

Suggestions for Use

Sample Challenge Prompts

- With Shape Name Hidden, discover what happens to the side lengths and angles of the starting shape when moving different corners. What about moving a side?
- What ways can you change a shape that keeps the name of the shape? Can you maintain a parallelogram by moving a side? What about a corner? Is a kite similar or different? Why?
- What is the simplest change you can make to a shape to create another shape? How many shapes can you make with only one corner or side move from the starting shape?
- Is a square a rectangle? Is a rhombus a kite? Use the guides to help find common traits between different named shapes to answer these and similar questions.

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '`?`' to the sim URL, and separating each query parameter with a '`&`'. The general URL pattern is:
`…html?queryParameter1&queryParameter2&queryParameter3`

For example, in Quadrilateral, if you want to mute audio (`audio=muted`) and disable pan and zoom (`supportsPanAndZoom=false`) use:
https://phet.colorado.edu/sims/html/quadrilateral/latest/quadrilateral_all.html?audio=muted&supportsPanAndZoom=false

To run this in Spanish (`locale=es`), the URL would become:
https://phet.colorado.edu/sims/html/quadrilateral/latest/quadrilateral_all.html?locale=es&audio=muted&supportsPanAndZoom=false

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Example Links
⚙ `soundDesign` - set the sound design at sim load, rather than changing in the Preferences Menu. Values are shapeLayers (default) or shapeUnique.	`soundDesign=shapeUnique`
`reducedStepSize` - reduce the step size by 4-fold, allowing more continuous movement of corners and side. NOTE: Finding certain named shapes becomes more difficult with finer movement.	`reducedStepSize`
`inheritTrapezoidSound` - changes the default shapeLayers sound design to include inclusive inheritance of parallel sides (trapezoid to parallelograms) and adjacent angle equivalence (isosceles trapezoid to rectangle/square). Append to add auditory emphasis that parallelograms are a set of trapezoids.	`inheritTrapezoidSound`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=it` (Italian)
`audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`

Device and Input Features

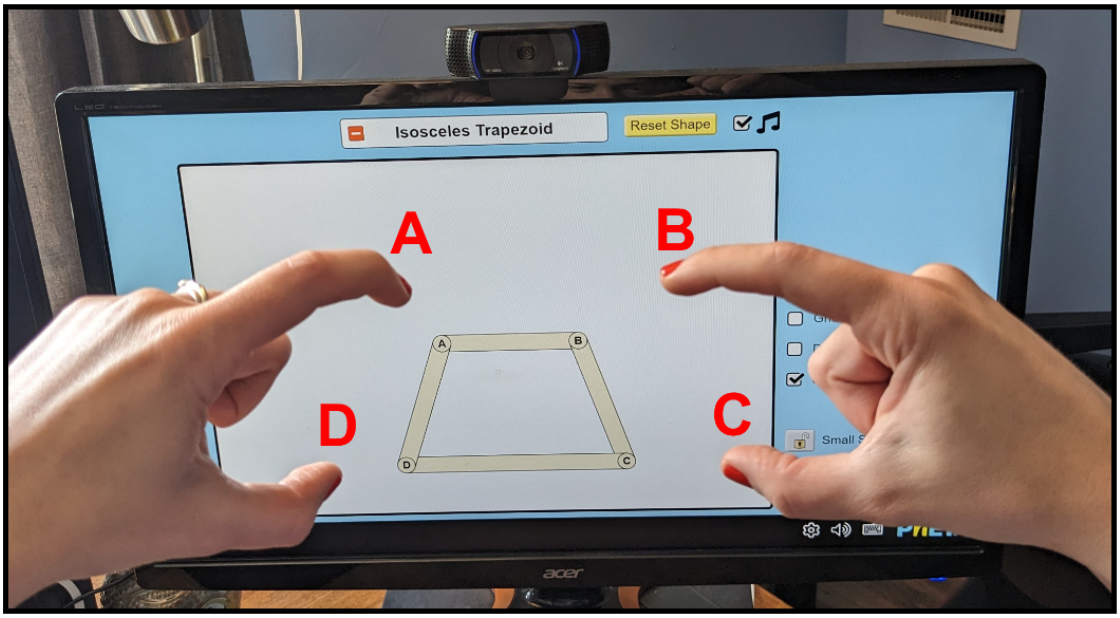
Alternative Input and Touchscreen Devices

- Move the corners and sides with smaller steps by holding the SHIFT key while dragging with a mouse or using the keyboard (Arrow keys/WASD).
- To use small steps when using a touchscreen device, toggle the Small Steps lock button. 
- Quickly reset the shape with ALT/OPTION + SHIFT + R.
- See the Keyboard Shortcuts dialog  in the navigation bar for other helpful shortcuts.

Camera Input: Hands

If a camera (e.g, webcam) is available on your device, you can enable a feature to *detect your own finger positions to move the corners of the quadrilateral*. This feature leverages the computer vision capabilities of the open-source MediaPipe model. It does not collect any data/images.

- Add the query parameter ?cameraInput=hands to the end of the simulation URL.
- The feature requires two hands to be present in the detection window. This can be from two individuals for cooperative exploration!
- The corner to finger mappings are as follow: Corner A: Left Index, Corner B: Right Index, Corner C: Right Thumb, Corner D: Left Thumb (see image below).
- in *Quadrilateral*, this feature assumes the camera is facing you and may not map correctly if the camera is placed elsewhere (e.g., above).



Corner A: Left Index, Corner B: Right Index, Corner C: Right Thumb, Corner D: Left Thumb.

Tips and Disclaimers

- The simulation will take longer to load the necessary resources for real time hand detection.
- This feature is resource intensive and may have poor performance on some devices.
- This feature does not work offline.

- The horizontal and vertical range of the corners are mapped to the upper and lower bounds of your camera window. Try backing away from your camera for more range of motion and to adjust the size of the shape. Add the query parameter &showVideo to the simulation URL for a resizable camera preview for troubleshooting.

Auditory Features

Sound and Sonification

- Shapes with similar properties play the same sound tracks. As you create shapes with more specific requirements, new sounds are layered on while retaining previous sounds to highlight their relationship to other shapes.
- Change the sound design of the simulation to only map a track to each unique named shaped in the Audio tab of the  Preferences menu or use the query parameter list in the Customization Options above.
- A warning sounds plays when the next step of either a corner or side would create a complex/crossed shape.
- See the Sound Features Video for more useful tips on how concepts and sound are integrated in this sim. See the published Sound Design Documentation for more details on all sounds in this simulation.

Voicing

- This simulation features browser-based spoken description through our Voicing feature. Enable Voicing in the Audio tab of the Preferences menu. See the Introduction to Voicing video for more about this feature.
- When the option "Voice object details and changes" is checked, learners have access to specific details about the corners and sides. Delivery of this information varies based on input method. With keyboard use, learners will get information as they move a corner or side in discrete steps whereas mouse and touch users will get information on click/tap, but not during active dragging.
- When the option "Voice surrounding context changes" is checked, the voicing of shape changes is the same for all inputs, but differs depending on whether the “Shape Name Hidden” is toggled to display the current shape name. When left on "Shape Name Hidden", the voicing describes key shape properties of the latest most-specific shape (e.g., "Opposite sides in parallel.", "All right angles."). When the shape name is displayed, the Voicing provides the name of the latest most-specific shape (e.g., "Found a Parallelogram.", "Found a Rectangle."). In both case, the Voicing will also voice consistent property changes as a shape is maintained, (e.g., "Opposite sides in parallel as shape gets smaller.", "All right angles as shape gets bigger.").

See the simulation page for all supported inclusive features.

See all published activities for Quadrilateral here.
For more tips on using PhET sims with your students, see Tips for Using PhET.