Active Learning Through Classroom Applets in Linear Algebra and Geometry

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MAA Ohio Section, March 25, 2022

GeoGebra

- Apps: https://www.geogebra.org/
  - Calculator Suite
  - 3D Calculator
  - CAS Calculator
  - Geometry
  - Graphing Calculator
  - Scientific Calculator
  - GeoGebra Classic
- Resources: https://www.geogebra.org/materials
- App downloads: https://www.geogebra.org/download

Comparison of GeoGebra Apps

apps / features	Scientific	Graphing	Geometry	3D	CAS	Suite	Classic
Numeric calculations	✓	✓	✓	✓	✓	✓	✓
Function operations	✓	✓	✓	✓	✓	✓	✓
Fraction operations	✓	✓	✓	✓	✓	✓	✓
Graphing		✓	✓	✓	✓	✓	✓
Sliders		✓	✓	✓	✓	✓	✓
Vectors & matrices		✓	✓	✓	✓	✓	✓
Table of values		✓			✓	✓	✓
Geometric constructions			✓	✓	✓	✓	✓
3D graphing				✓		✓	✓
Probability Calculator						✓*	✓
Derivatives & integrals				✓	✓	✓	✓
Equation solving				✓	✓	✓	✓
Symbolic calculations				✓	✓	✓	✓
Spreadsheet							✓

Source: https://www.geogebra.org/m/shfwqcpr

GeoGebra subtleties

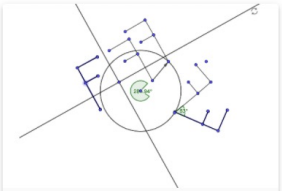
- GeoGebra Classic 5 v. GeoGebra Classic 6
  - Same features, but different graphical user interface (GUI).
  - GeoGebra Classic 6 looks like the online app
  - GeoGebra Classic 5 is preferred by authors who make use of dialog boxes and advanced commands

- GeoGebra file types
  - Activities
  - Books: Collections of activities
  - Lessons: A classroom version of a book or activity

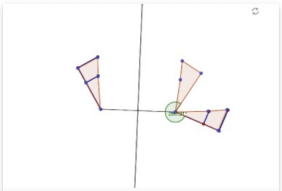
Let’s Try GeoGebra

https://www.geogebra.org/classroom/jzatmp4v

Congruence via Transformations



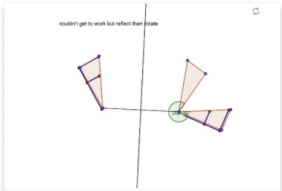
Student 1



Student 2

Task not started yet...

Student 3



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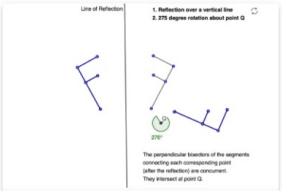

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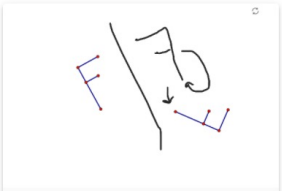

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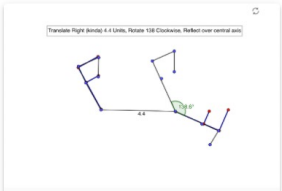
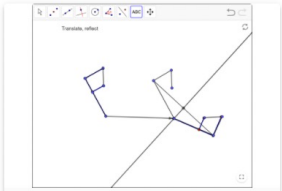
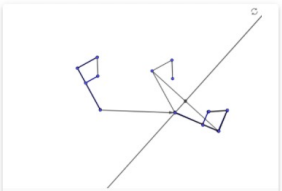


Student 7

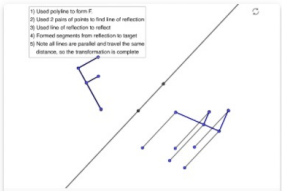


Student 8



Student 9

Student 10



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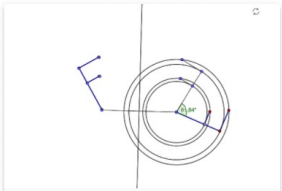
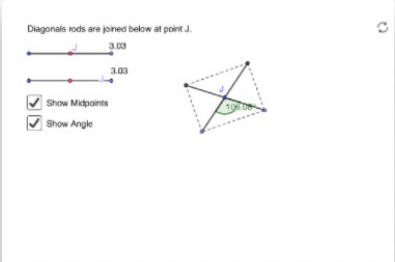


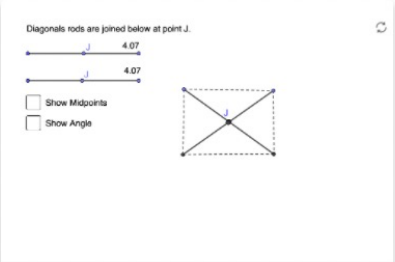
Student 12

Rectangle Diagonals

Determine condition(s) on the diagonals that will guarantee a rectangle.



Student 1



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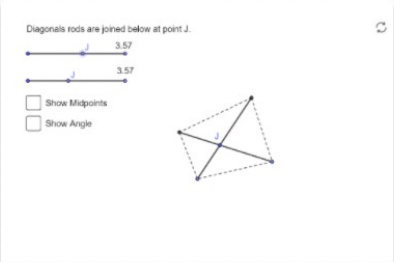
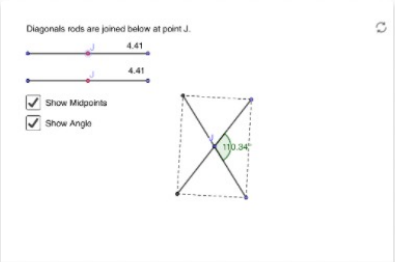


Student 3



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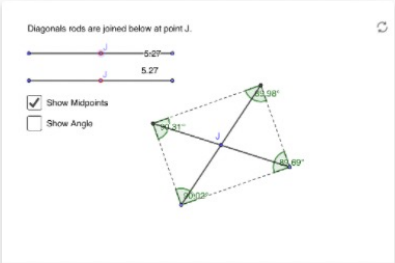
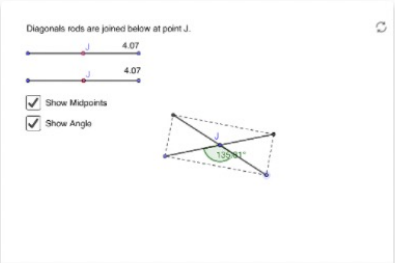


Student 5



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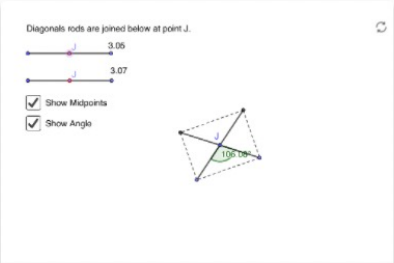
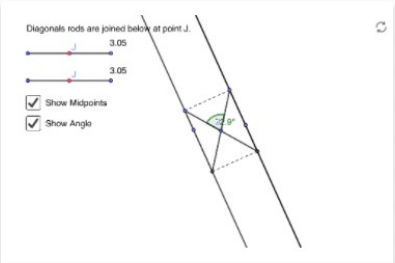


Student 7



Student 8

Rectangle Diagonals Reasoning

What condition(s) **on the diagonals** will guarantee a rectangle?

The intersection must still be at the midpoints of the diagonals but the diagonal lengths must be the same too. **Student 1**	the midpoints of the diagonals have to intersect; the length of the diagonals have to have congruent lengths **Student 2**	Both diagnols are the same length and we get a rectangle. **Student 3**	Diagonal rods are congruent and that the diagonals intersect at the mid point J **Student 4**
Same length diagonals with j being a midpoint **Student 5**	If both diagonals are the same length, than this will guarantee a rectangle **Student 6**	J is the midpoint and the lengths are eqaul **Student 7**	Diagonals must intersect at the midpoints and opposite sides must be congruent **Student 8**
Diagonals intersect at the midpoint and they are congruent **Student 9**	The diagonals intersect at their midpoints. **Student 10**	Both diagonals are the same length and have an intersection at both of the midpoints **Student 11**	Point J is on the midpoint of both segments and the dotted sides equal 90 degrees. Parallel opposing sides **Student 12**

Desmos

- Teacher site: https://teacher.desmos.com/
- Student site: https://student.desmos.com/
- Graphing Calculator: https://www.desmos.com/calculator
  - Also available: scientific, four-function, and matrix calculators
- All of these available via https://www.desmos.com/
- Most featured activities are for middle school through Calculus.
  - https://teacher.desmos.com/search?q=calculus

Let’s Try Desmos

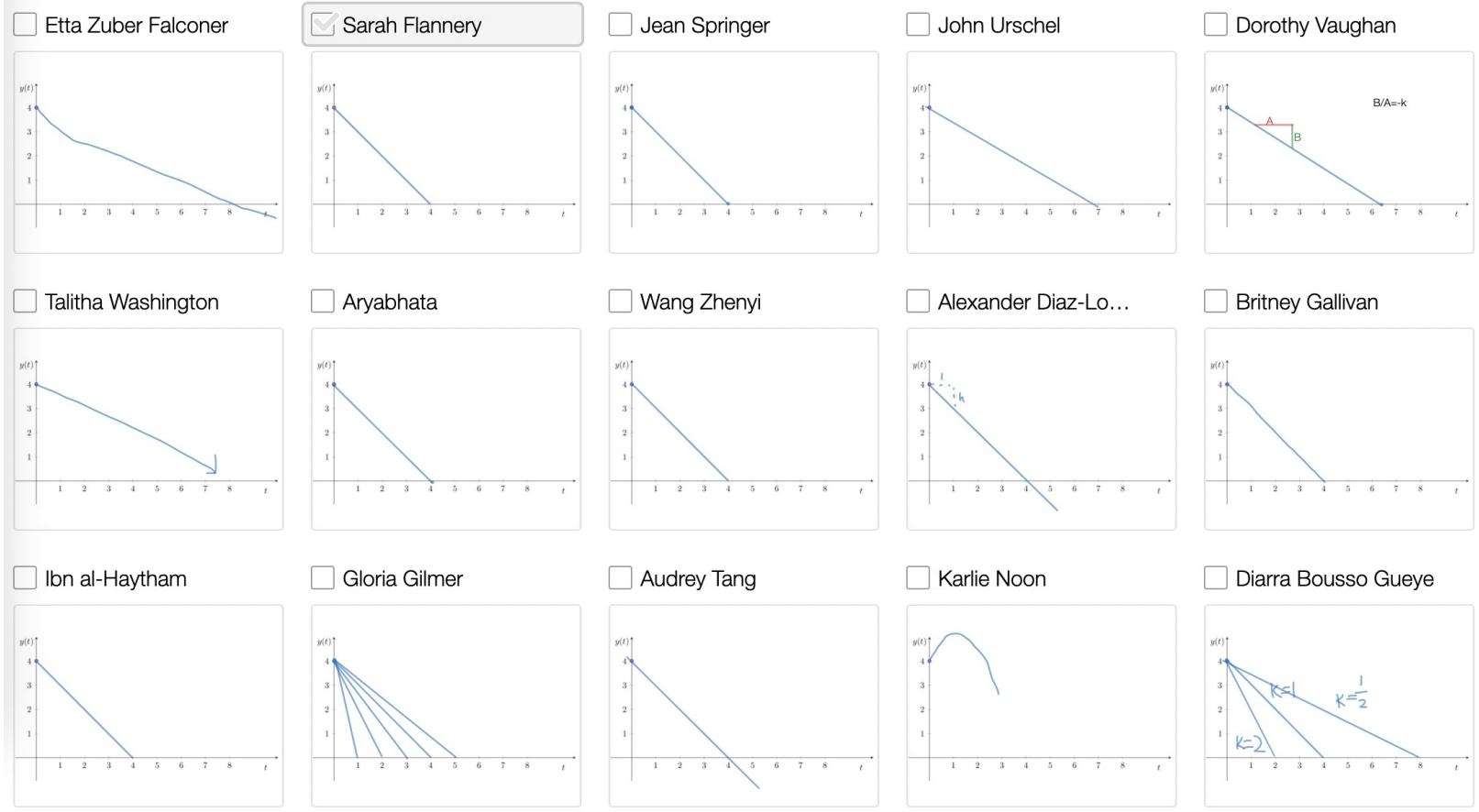
https://student.desmos.com/join/8v8t7q

Solutions to a Differential Equation

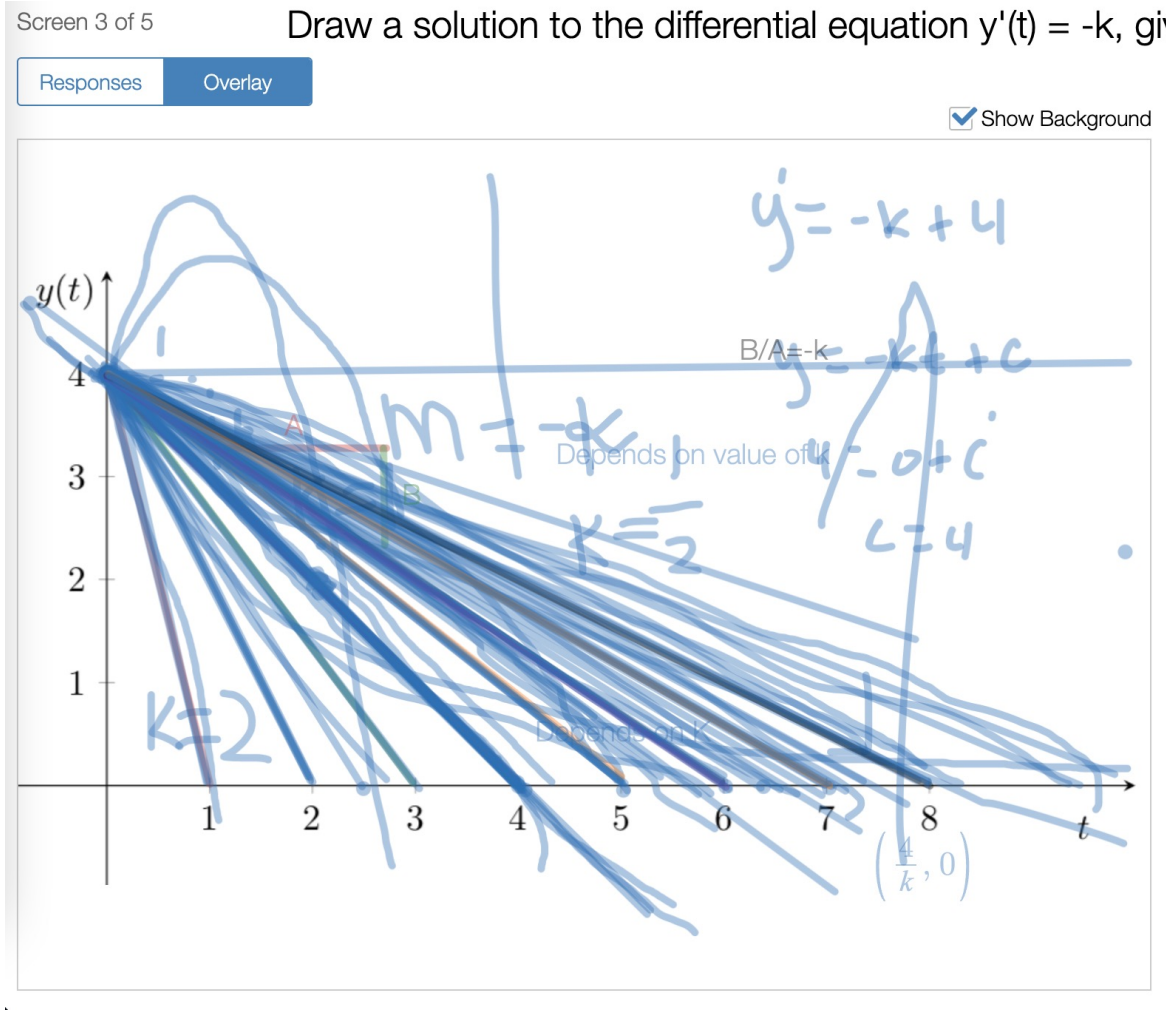
Screen 3 of 5

Draw a solution to the differential equation y'(t) = -k, given y(0) = 4.

Responses | Overlay



Solutions to a Differential Equation, Overlay



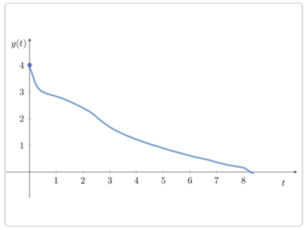
Solutions to another Differential Equation

Screen 5 of 5

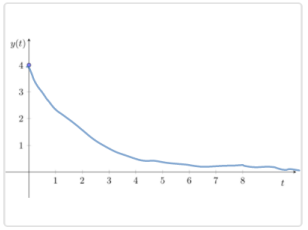
Draw a solution to the differential equation y'(t) = -(k/A)y(t), given y(0) = 4.

Responses | Overlay

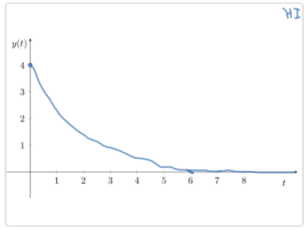
Etta Zuber Falconer



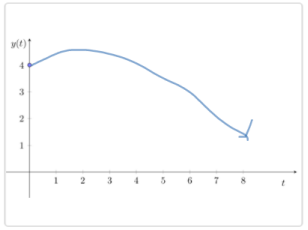
John Urschel



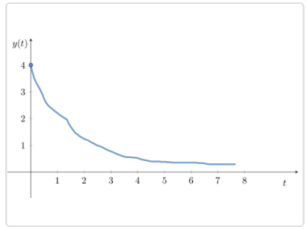
Dorothy Vaughan



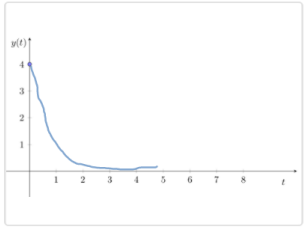
Talitha Washington



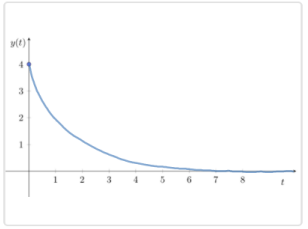
Aryabhata



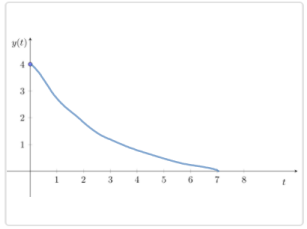
Wang Zhenyi



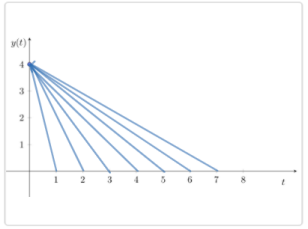
Alexander Diaz-Lo…



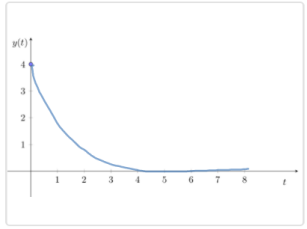
Britney Gallivan



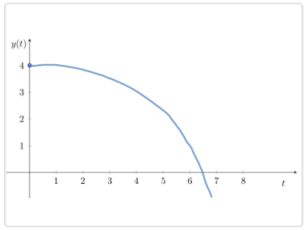
Ibn al-Haytham



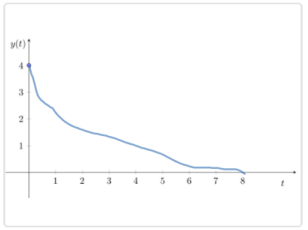
Gloria Gilmer



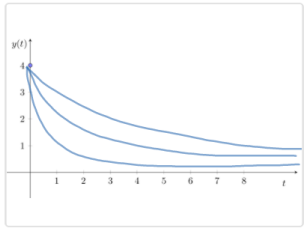
Audrey Tang



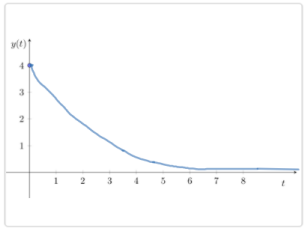
Karlie Noon



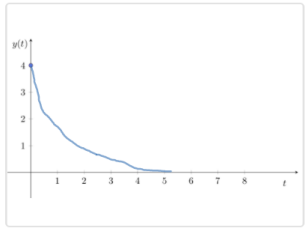
Diarra Bousso Gueye



Margaret H. Hamilton



Gloria Conyers He…



Geometry for Teachers

Write the Pythagorean Theorem.

- [ ] Grace Hopper

if the triangle is a right triangle, then a^2+b^2=c^2

- [ ] Ibn al-Haytham

a^2+b^2=c^2

- [ ] Sophie Germain

a^2+b^2=c^2

- [ ] Hoang Xuan Sinh

a^2+b^2=c^2

- [ ] Kimberly Weems

a^2+b^2=c^2

- [ ] Cynthia Breazeal

a^2+b^2=c^2

Write a definition of rhombus. A rhombus is a quadrilateral ...

- [ ] Grace Hopper

with two pairs of parallel sides, equal length sides, and opposite angles equal

- [ ] Ibn al-Haytham

with opposite equal acute angles, opposite equal obtuse angles, and four equal sides.

- [ ] Sophie Germain

that has 2 pairs of parallel sides and equal side lengths.

- [ ] Hoang Xuan Sinh

and a parallelogram with opposite equal acute angles, and four sides that are equal in length.

- [ ] Kimberly Weems

a rhombus is a quadrilateral with four congruent sides

Trigonometry

Find the sine, cosine, and tangent of an angle θ with a terminal side through (-1,2).

1. Plot the point.
2. Sketch the angle.
3. Sketch the reference triangle.
4. Compute the sine, cosine, and tangent.

Responses | Overlay

☐ Euphemia Lofton Haynes

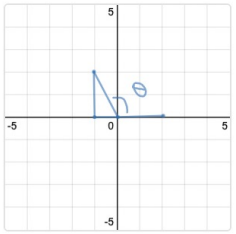
$$\sin(\theta) = \frac{2}{\sqrt{5}}$$
$$\cos(\theta) = -\frac{1}{\sqrt{5}}$$
$$\tan(\theta) = \frac{2}{-1}$$

☐ Alan Turing

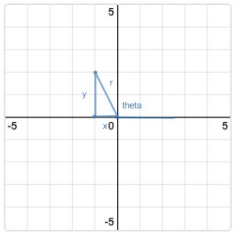
$$\sin\theta = \frac{2}{\sqrt{5}}$$
$$\cos\theta = -\frac{1}{\sqrt{5}}$$
$$\tan\theta = -2$$

☐ Mae Jemison

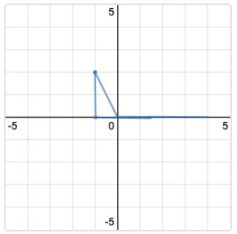
☐ Euphemia Loft…



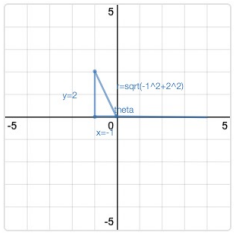
☐ Alan Turing



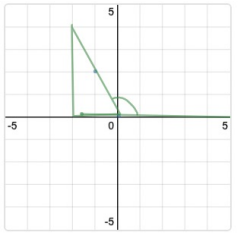
☐ Mae Jemison



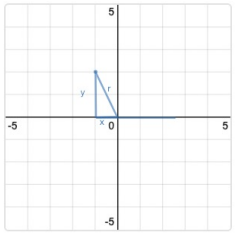
☐ Diana Ma



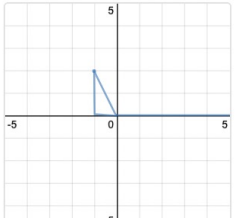
☐ Audrey Tang



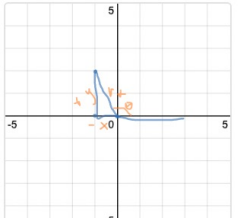
☐ Jagadish Chan…



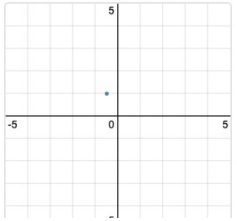
☐ Karlie Noon



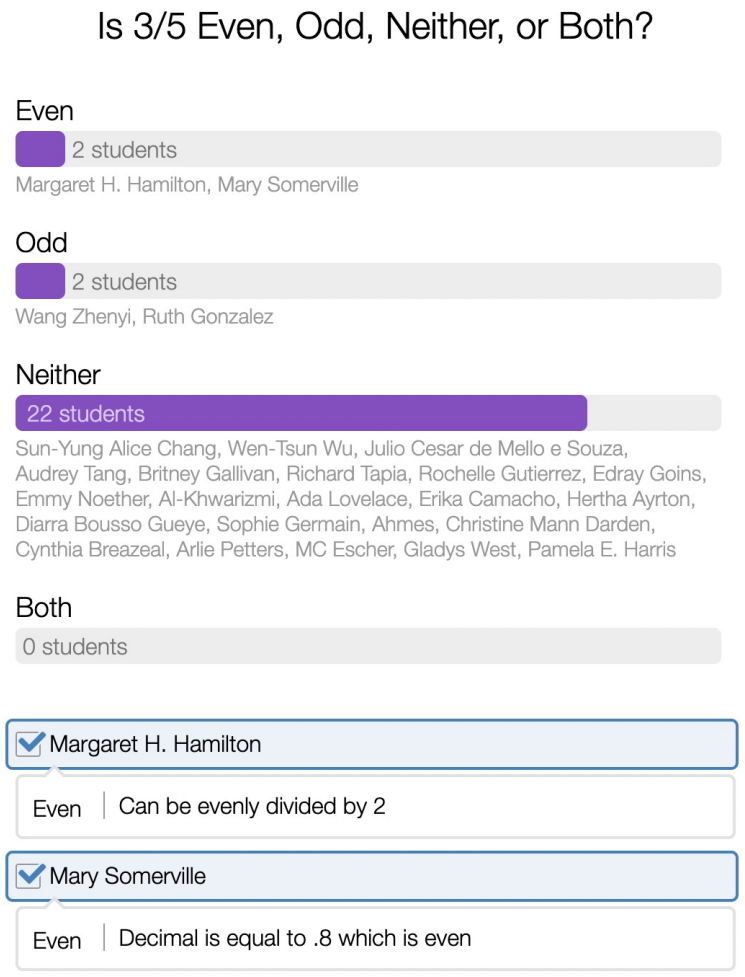
☐ Vi Hart

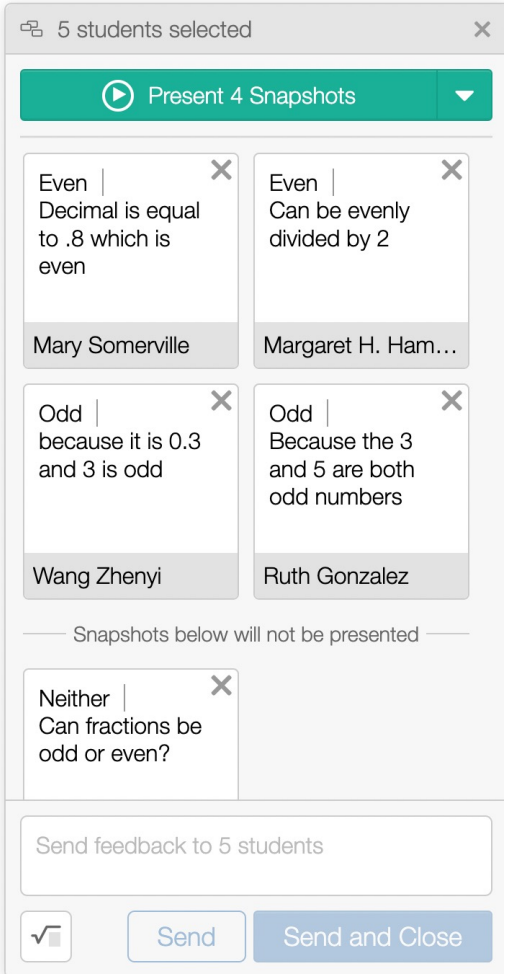


☐ Gloria Gilmer

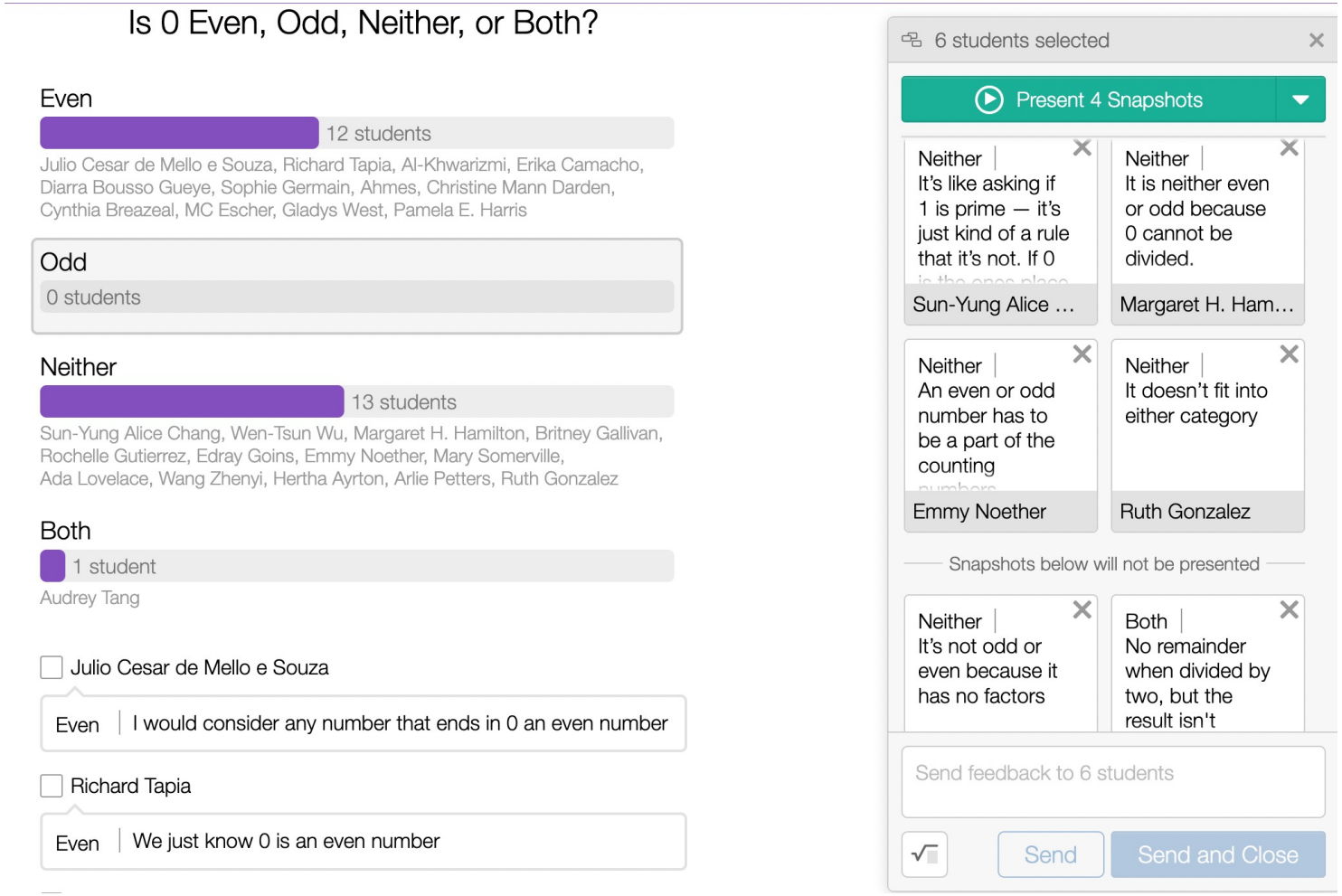


Even, Odd, Neither, or Both





Even, Odd, Neither, or Both



Resources

- My public GeoGebra activities available at
  - https://www.geogebra.org/u/bfindell
- MAA sample activities available at
  - https://www.geogebra.org/m/qprp4rtq
- Desmos MAA sample activities available at
  - https://teacher.desmos.com/activitybuilder/custom/623dc90b257b040a795b401f