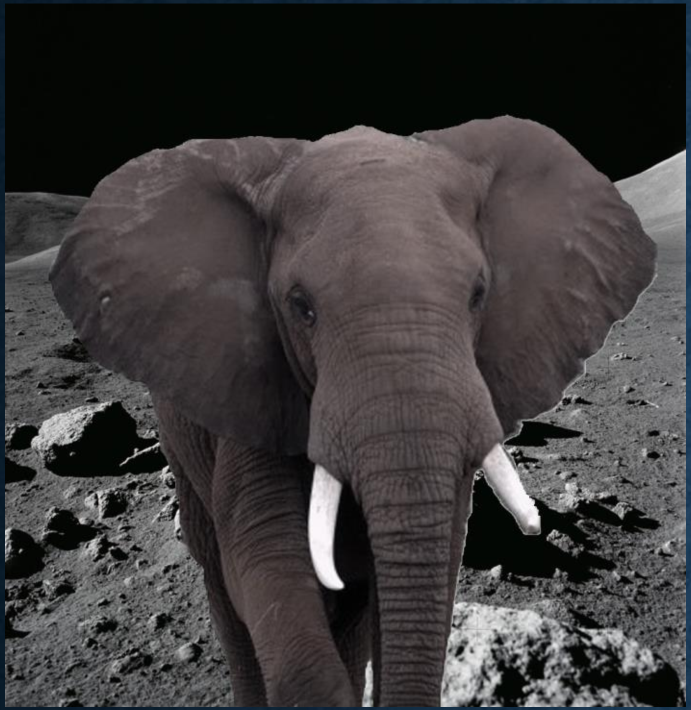
HOW MANY ELEPHANTS CAN FIT ON THE MOON?

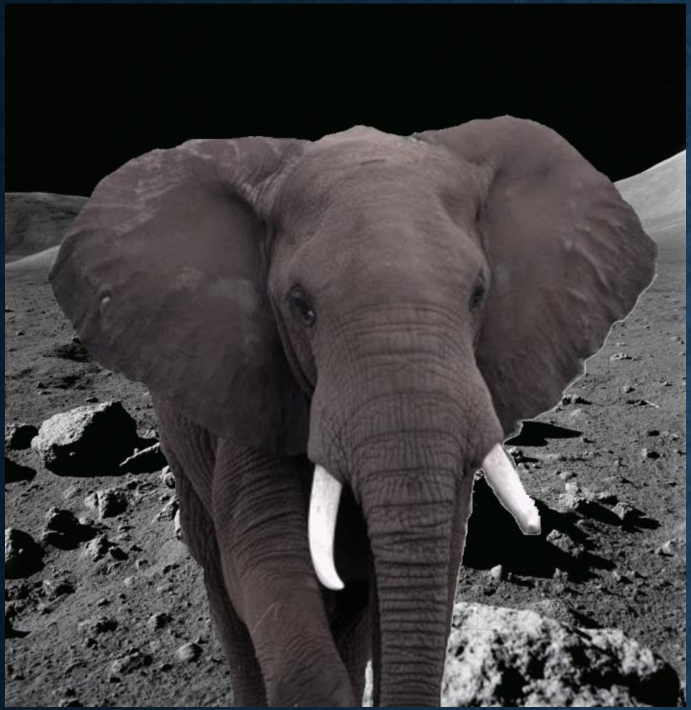
Using technology to address ill-structured questions in the classroom

Christina Watts Lommatsch, Utah State University



HOW MANY ELEPHANTS CAN FIT ON THE MOON?

Take a moment and think about how you would begin to answer this question.



HOW MANY ELEPHANTS CAN FIT ON THE MOON?

Did you ask yourself questions such as:

- What is the surface area of the moon?
- Are the elephants all the same size?
- Are the elephants all one type?
- Are the elephants standing on top of each other?
- Is there any part of the moon elephants can't stand on?
- Are the elephants wearing space suits?

Take a moment and think about how you would begin to answer this question.

HOW MANY ELEPHANTS CAN FIT ON THE MOON?

- These questions are "**ill-structured problems**" meaning that the problem has *unclear goals* and/or *incomplete information* (Voss, 1988).
- Questions less whimsical in nature, such as "How would an architect design a house?" (Simon, 1973) or "Which route should I take to reach my destination fastest?" also fit the "ill-structured problem" definition and are quite similar to those questions we might encounter in everyday life.
- **Technology is a key tool** that can be used to answer these questions and mathematical reasoning is often inherently involved in the problem solving process.

MATHEMATICAL REASONING AND TECHNOLOGY

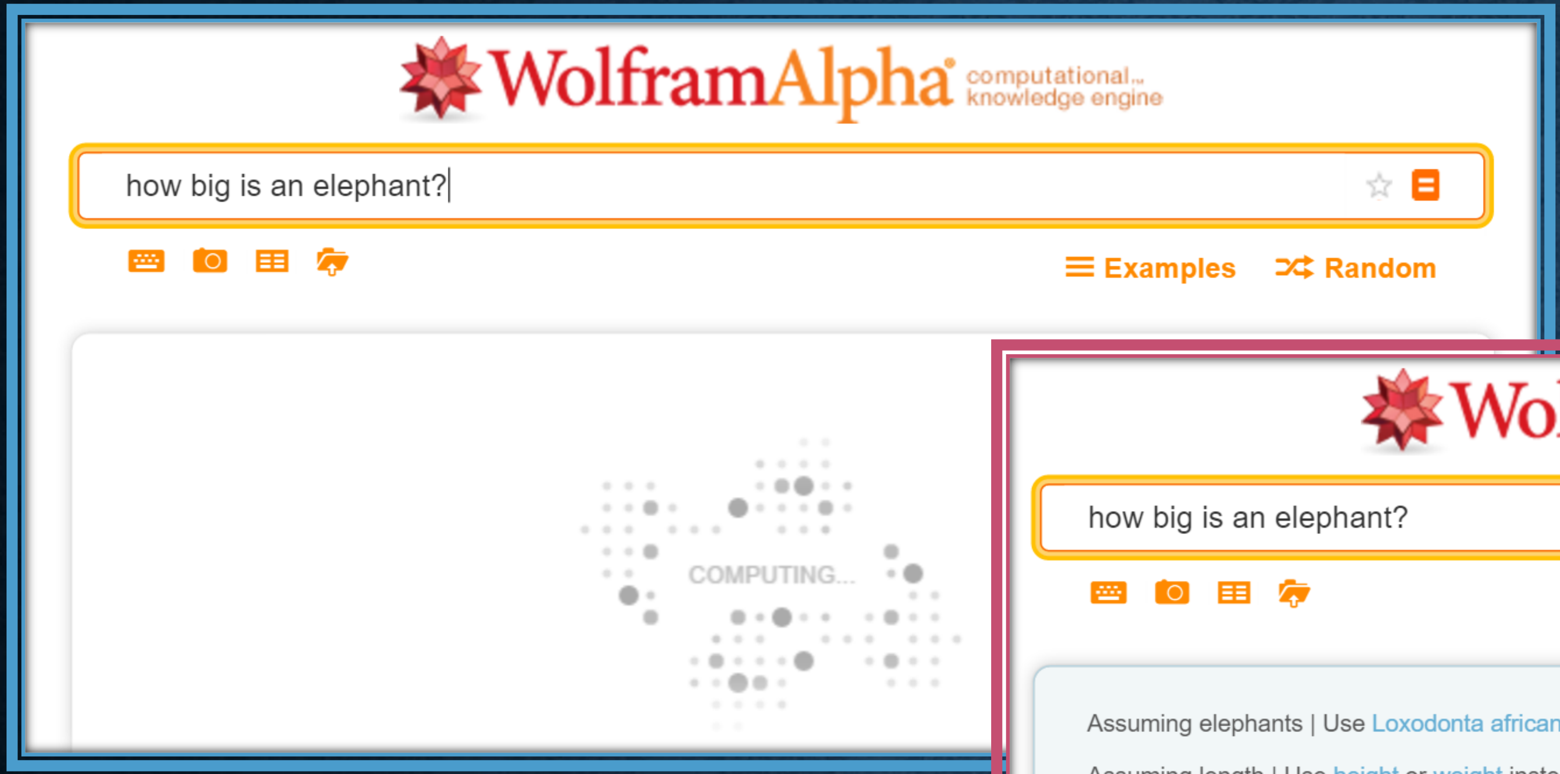
- Contrary to the thoughts of many instructors, technology (such as calculators and computational engines) should not be thought of as the death of mathematical reasoning
- Technology provides a very powerful tool for **scaffolding** students' **mathematical reasoning abilities**.
- This workshop will address the use of two different types of tools: 1) a computational knowledge engine called Wolfram Alpha and 2) an online interactive graphing tool called Desmos.

WOLFRAM ALPHA

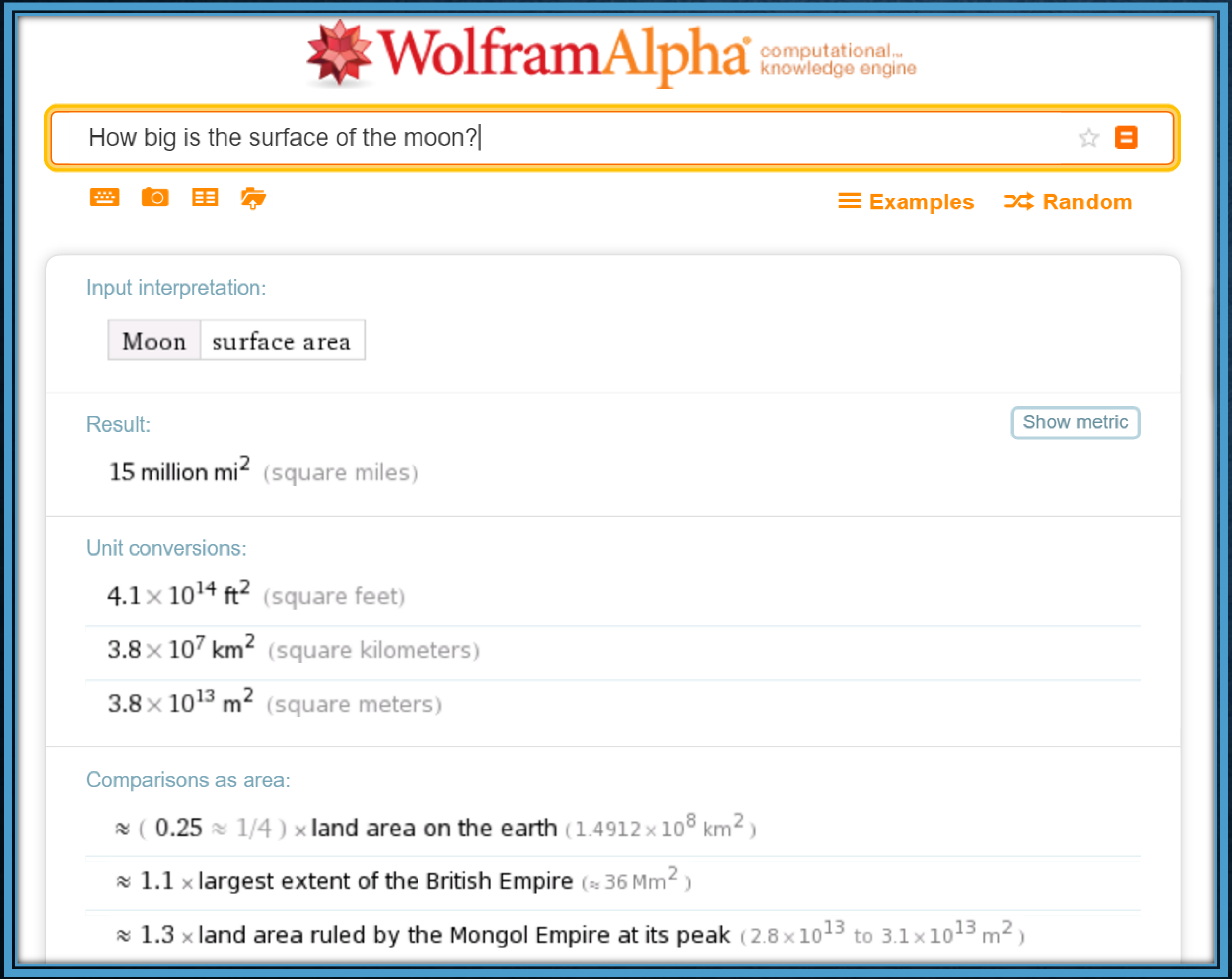
“Making the world’s knowledge computable.”

“Bringing broad, deep, expert-level knowledge to everyone… anytime, anywhere.”

Wolfram|Alpha is an engine for **computing answers** and **providing knowledge**. It works by using its vast store of expert-level knowledge and algorithms to automatically answer questions, do analysis, and generate reports.

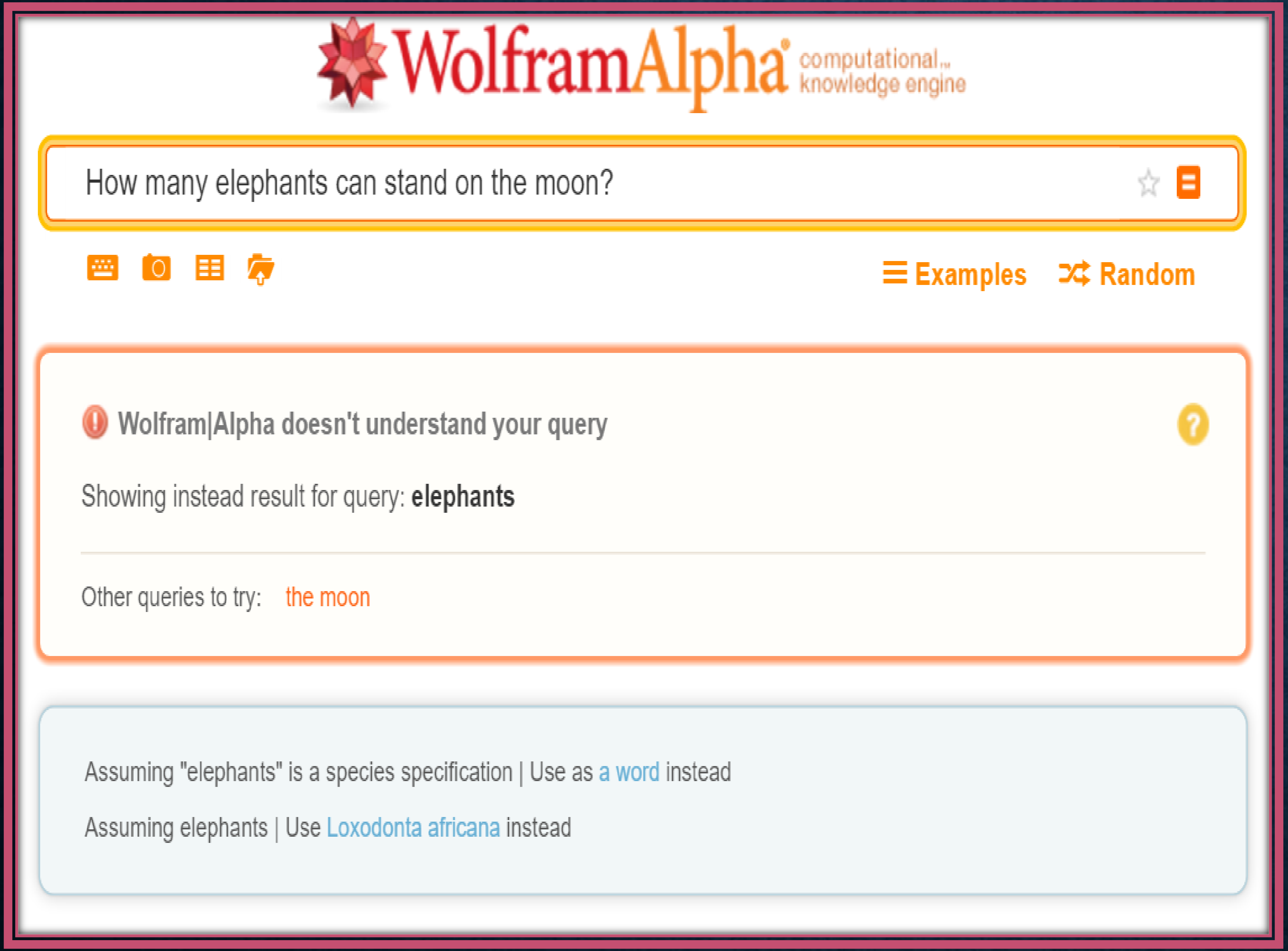


Wolfram Alpha provides a basic **scaffolding** for users to learn how to more accurately **input** their queries into the computational knowledge engine.



Wolfram Alpha also provides a context for the **output** from each query.

Context can deepen understanding and allow students to attach meaning to the associated quantities.



Why don't we just ask the whole question?

- Computational Engines have not quite reached the point where they can "*parse*" (that is, understand the input of) all ill-structured problems.

How many balloons would it take to lift a house like in the movie *Up*?

How many students can name the President and Vice President of the United States?

Questions such as these require you as a teacher to work as a problem solver as well. This provides the opportunity for **cognitive apprenticeship**, that is, modeling of cognitive processes (Collins, Brown, & Newman, 1989).

CONSTRUCT YOUR OWN ILL-STRUCTURED PROBLEM

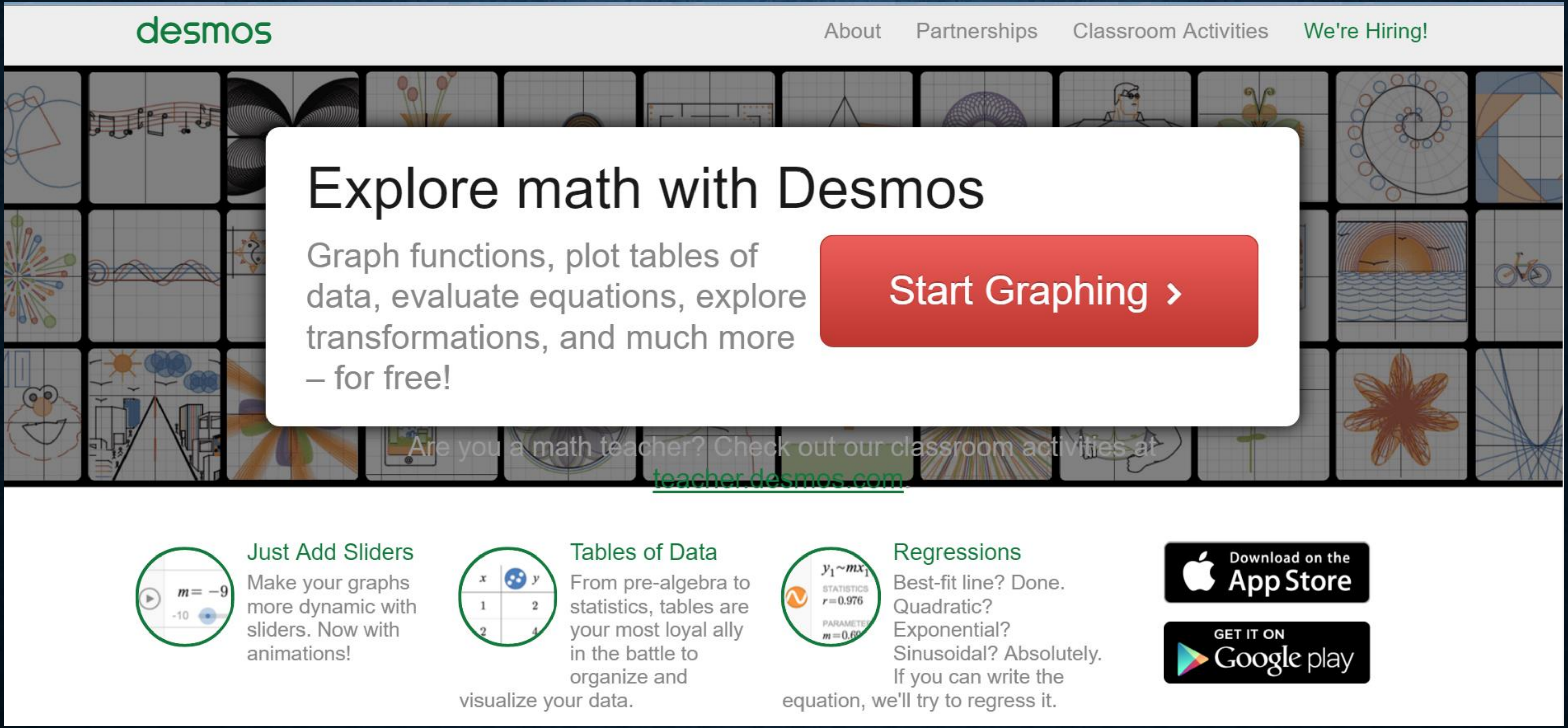
In groups of 2-3, **construct your own** ill-structured problems that will require **mathematical reasoning** to solve.

Recall: an ill-structured problem has *unclear goals* and/or *incomplete information* (Voss, 1988).

PROBLEM SOLVING PROCESS

- **Take a moment and think about what processes you would engage in to resolve your ill-structured problem.**
- Processes such as **refining the questions**, **defining variables**, making appropriate **generalizations** and **assumptions**, defining a **solution process**, outputting a **reasonable solution** are all aspects of problem solving that your students will be learning during this process.
- **What other processes did you identify yourself completing?**

DESMOS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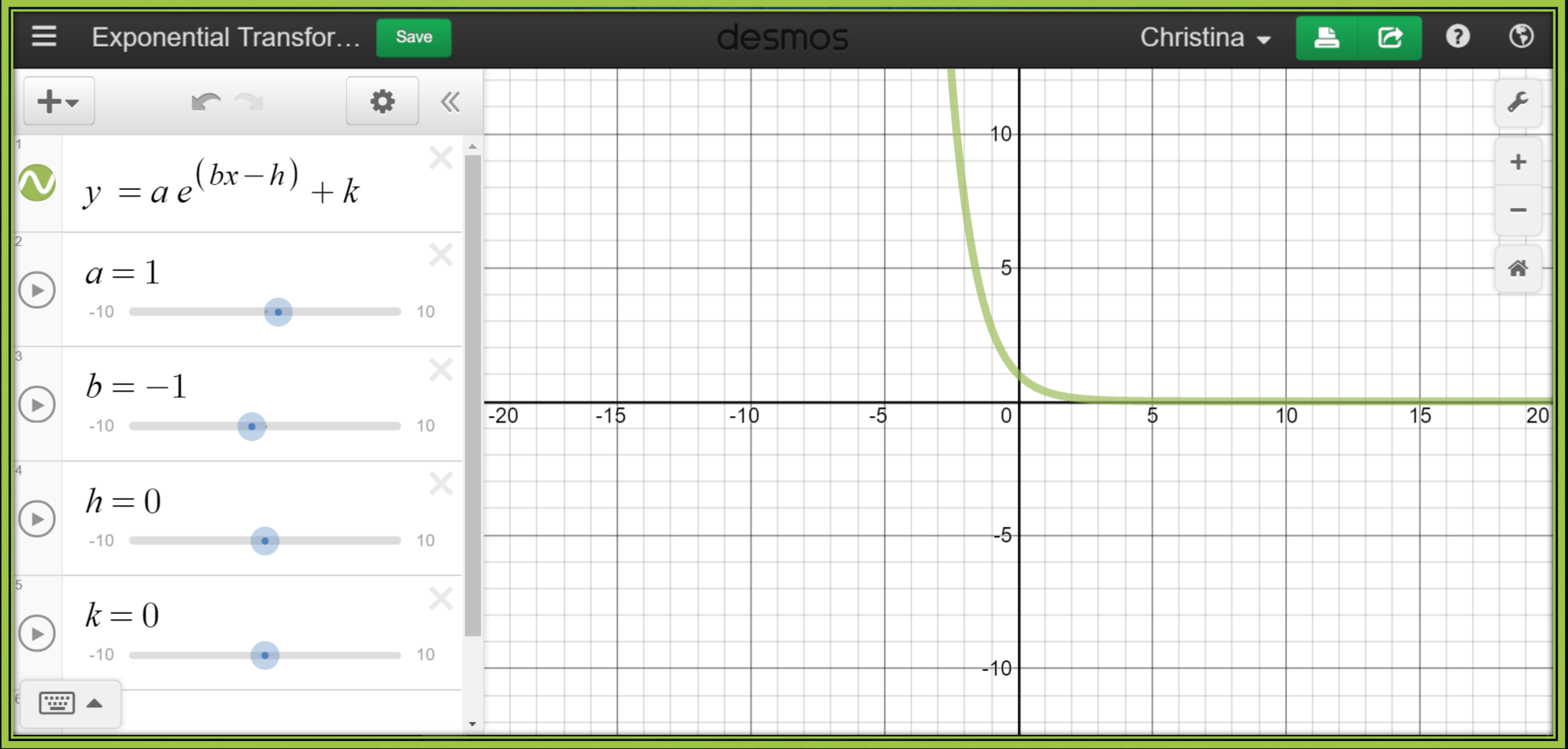

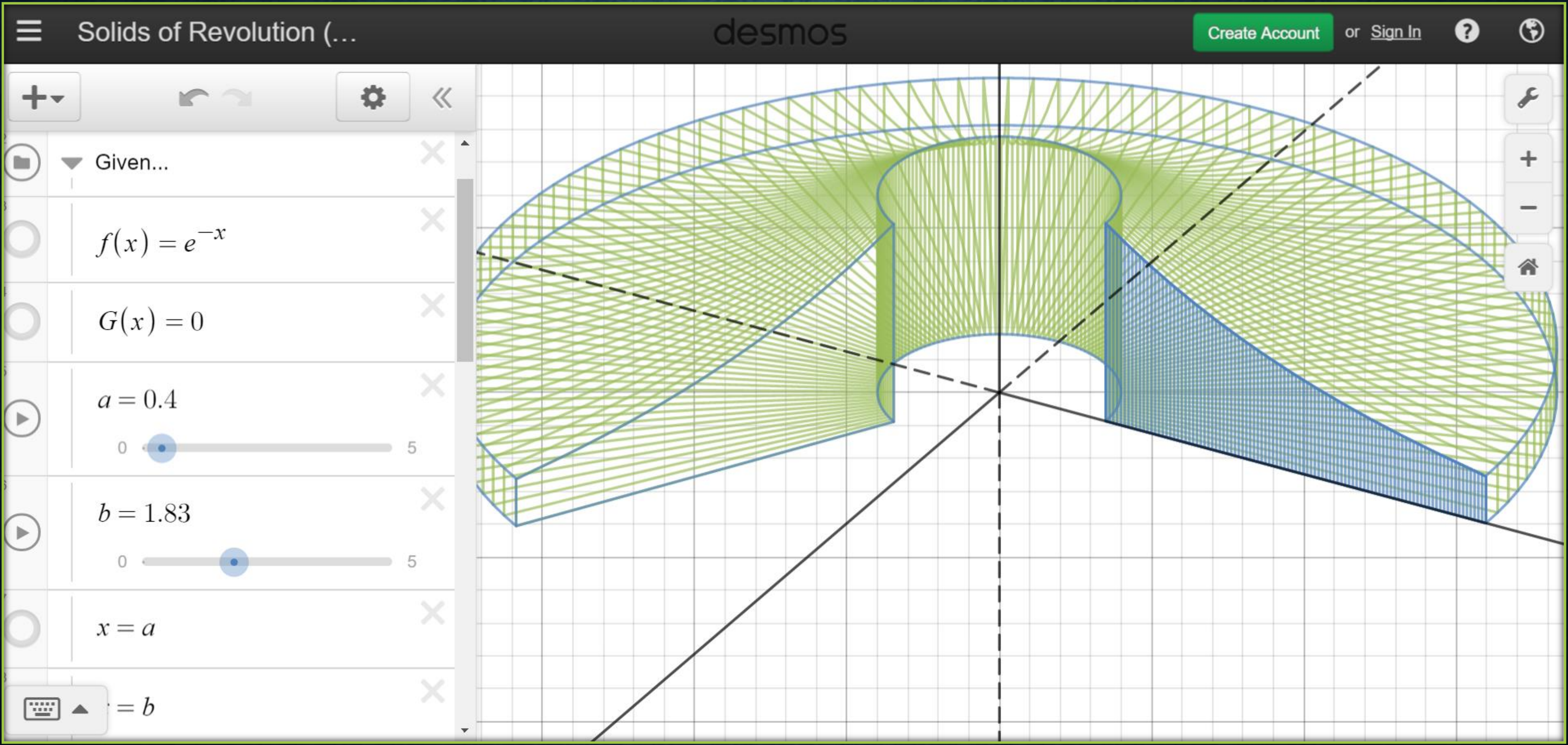
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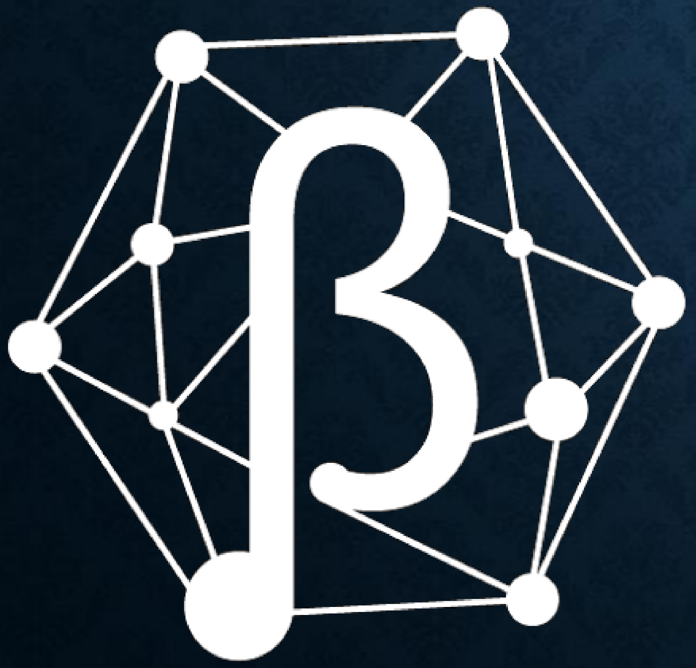
Given...
$f(x) = e^{-x}$
$G(x) = 0$
$a = 0.4$
0
5
$b = 1.83$
0
5
$x = a$
$= b$

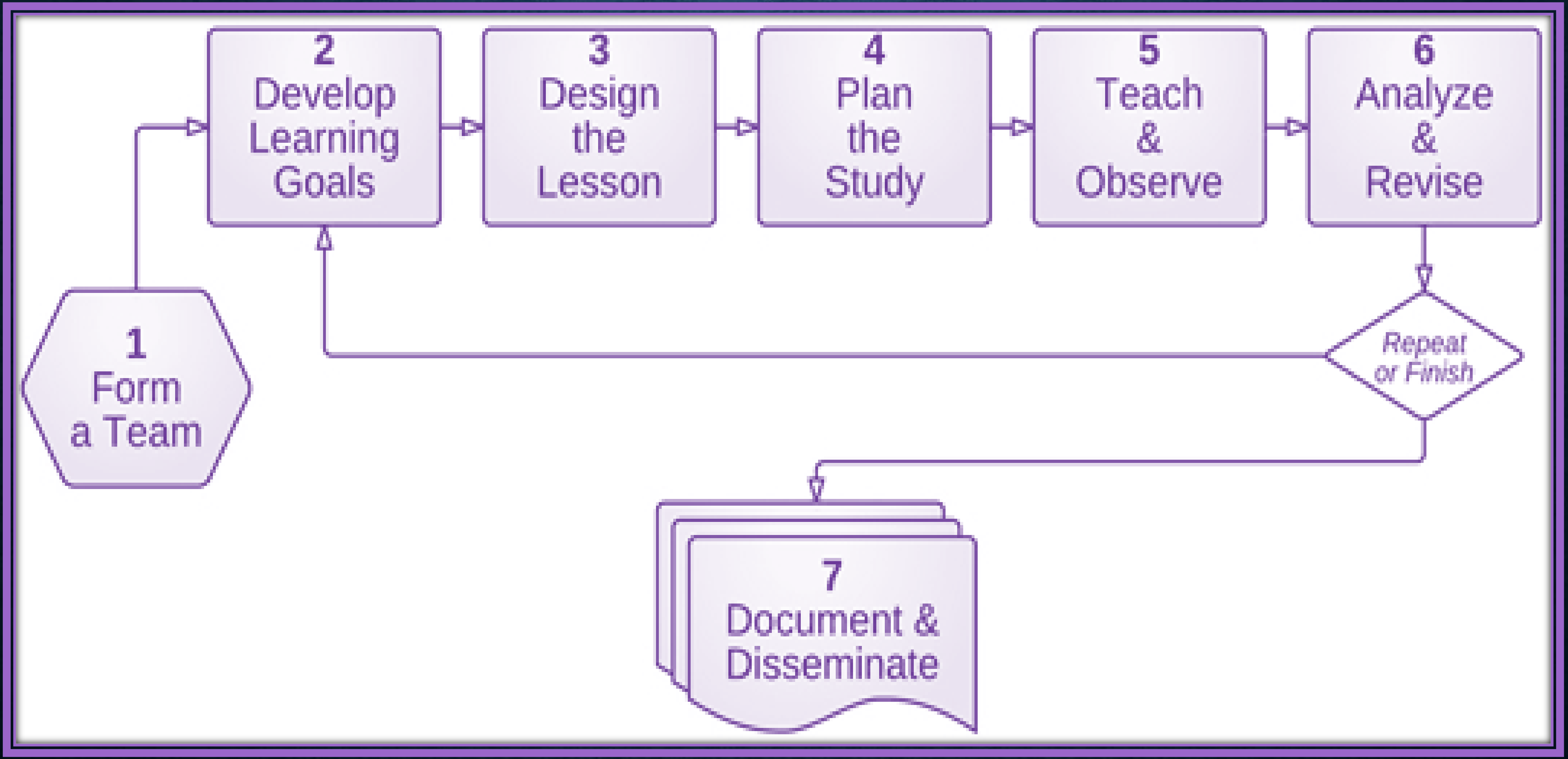
TECHNOLOGY LESSON STUDY AND SHARE

- Technology development goes through many iterations with implementations, critiques, and revisions within each cycle.
- Our teaching should follow this iterative design process too.



- In the world of technology, "beta-testing" is the second phase of software testing in which a **sampling of the intended audience tries the product out**.
- In education, "beta-testing" can be achieved through **lesson study** and the **sharing of lessons**.

LESSON STUDY CYCLE



VIRTUAL TECHNOLOGY LESSON STUDY AND SHARE

https://sites.google.com/site/mathandchristina/

A virtual place to study and share lessons with your peers from today's workshop.

Technology Lesson Study and Share

Welcome to the Lesson Share Section!

If you'd like to share one of your own lessons for the **Lesson Study and Share**, please click here.

Here are the current shared lessons. Please click the lesson you are interested in to evaluate, suggest revisions, or reflect on your own implementation!

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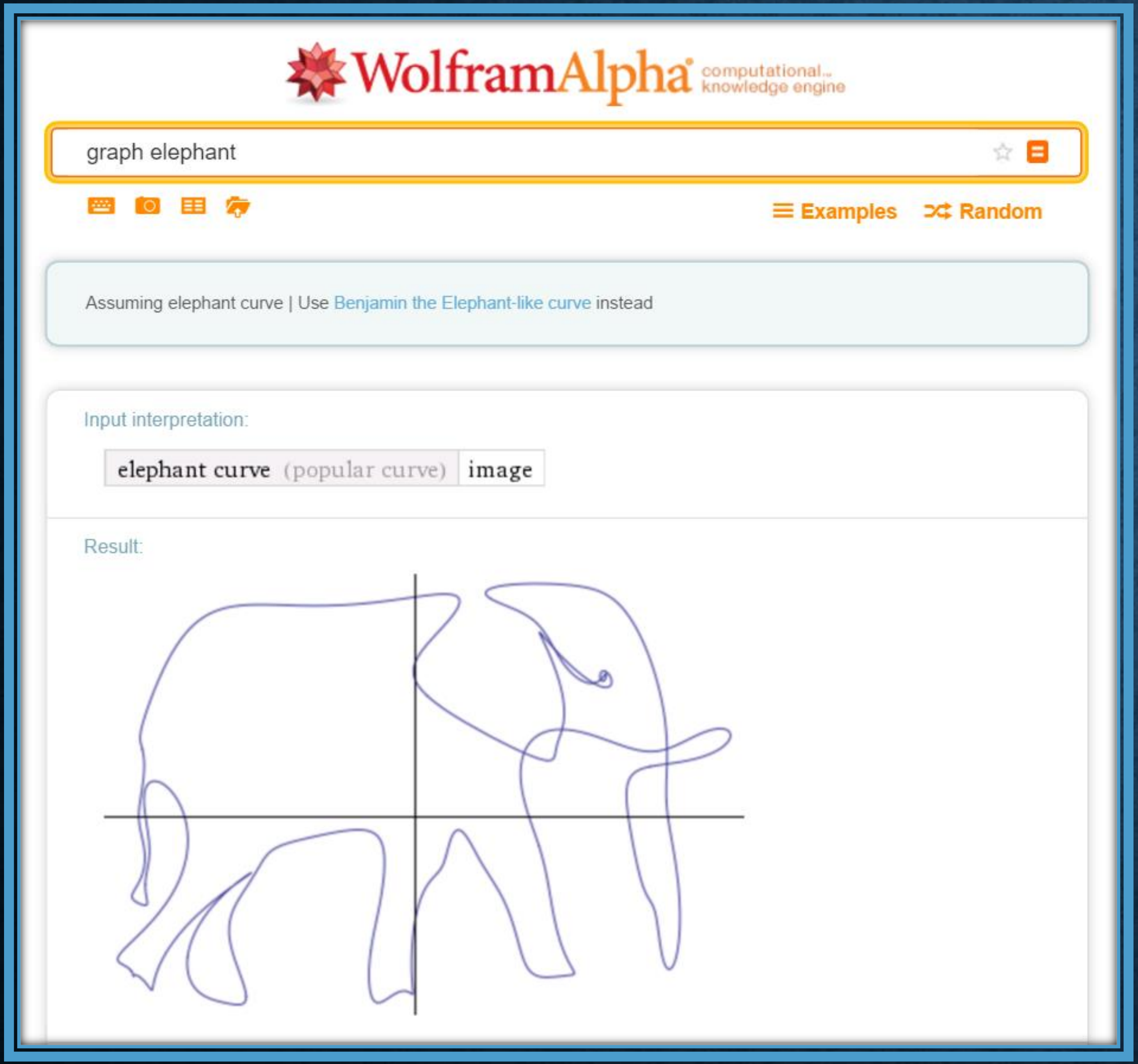

QUESTIONS?

Thank you for your time!

Contact Information:

Christina Watts Lommatsch

https://sites.google.com/site/mathandchristina/

cmw112358@gmail.com

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MY IGNITE TALK & OTHER COOL TECH

UCTM IGNITE 2016 https://youtu.be/iBwKIX3NtBc?t=35

- Base 10 Blocks: http://nlvm.usu.edu/en/nav/frames_asid_154_g_1_t_1.html
- Central Limit Theorem: http://blog.vctr.me/posts/central-limit-theorem.html
- Desmos tangent lines: https://www.desmos.com/calculator/8ubngtz3ei
- GapMinder: https://www.gapminder.org/for-teachers/
- Geogebra Poincaré Disk: https://www.geogebra.org/m/R5e9AggU
- Pokémon Go Tours: http://blog.wolfram.com/2016/08/12/finding-pokemon-gos-shortest-tour-to-compute-em-all/
- Recursive Drawing: http://recursivedrawing.com/
- Sampling Distribution: http://onlinestatbook.com/2/sampling_distributions/SampDist_v1.html#video
- Snowflake Generator: http://www.shodor.org/master/fractal/software/Snowflake.html
- Trig Interactive Unit Circle: http://www.mathsisfun.com/algebra/trig-interactive-unit-circle.html