Tools and Resources for Mathematics and Science/ Engineering Practices

Moving from Standards to Practice Conference

25 February 2013

Ed Dickey
College of Education
UNIVERSITY OF SOUTH CAROLINA

Common Core Standards

- National standards adopted by 45 states
- Based on most recent research regarding students' learning trajectories related to mathematics content
- Includes detailed description of the way mathematics is learned and used by students (Mathematical Practice)

Next Generation Science Standards

- Second Draft under review January 2013
- To be complete by March 2013
- NRC, NSTA, AAAS, Achieve
- 26 States (NC, GA, no SC)
- States review/adopt

CCSSM Mathematical Practices

- Common Core includes a set of Standards for Mathematical Practice that all teachers should develop in their students.
- Similar to NCTM's Mathematical Processes from the *Principles and Standards for School Mathematics*.
- Mathematics Proficiencies from the National Research Council report *Adding It Up*
- Practices MUST be assessed

Mathematical Practices

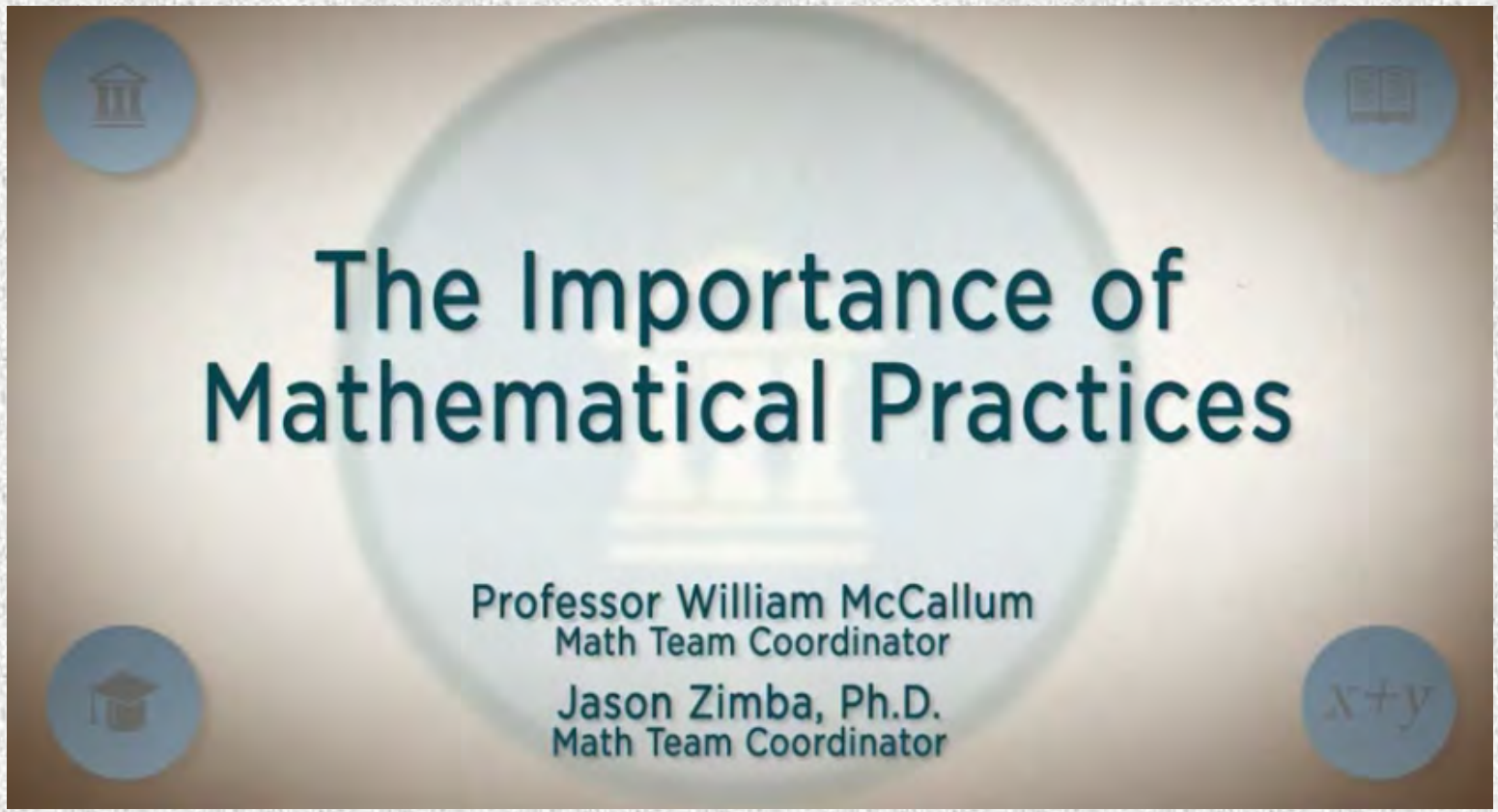
- Expectations that begin with "understand" are especially good opportunities to connect practices to content.
- "Students who lack understanding of a topic may rely on procedures too heavily."
- Understanding standards (intersection of content and practice) "are intended to be weighted toward central and generative concepts.. That most merit time, resources, innovative energies, and focus…"

NGSS Science and Engineering Practices

- "… behaviors that scientists engage in as they investigate and build models and theories about the natural world.
- "… to better explain and extend what is meant by 'inquiry' in science and the range of cognitive, social, and physical practices that it requires.
- … behaviors that engineers engage in as they apply science and mathematics to design solutions to problems."

Importance of Mathematical Practices

- https://www.youtube.com/watch?v=m1rxkW8ucAI



8 CCSSM Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.

8 CCSSM Mathematical Practices

5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

8 Science and Engineering Practices

1. Asking Questions (for science and Defining Problems (for engineering)
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data

8 Science and Engineering Practices

5. Using Mathematical and Computational Thinking
6. Constructing Explanations (for science and Designing Solutions (for engineering)
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

Graphic Organizer

Overarching habits of mind of a productive mathematical thinker

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Seeing structure and generalizing

From Bill McCallum: http://commoncoretools.files.wordpress.com/2011/03/practices.pdf

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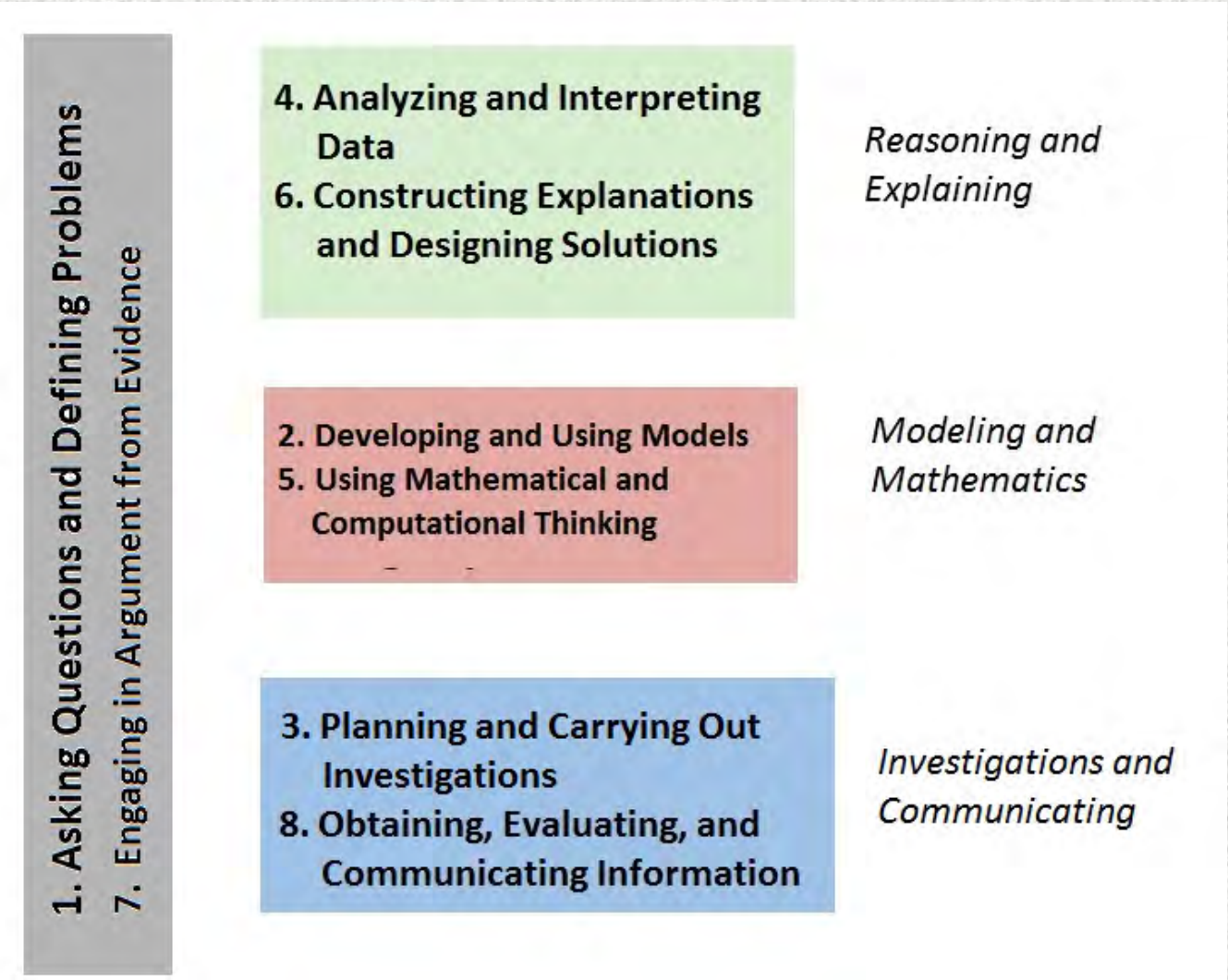
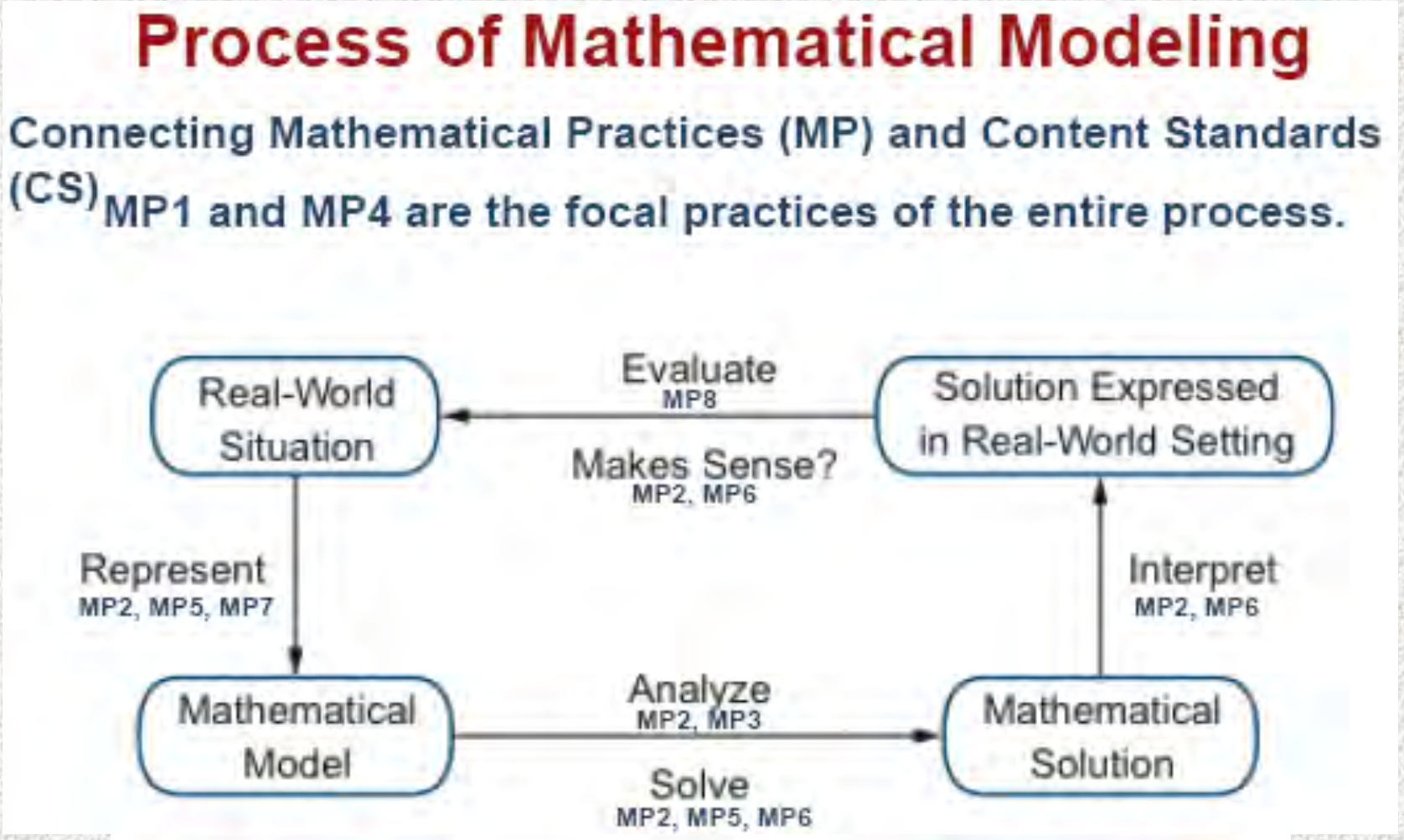
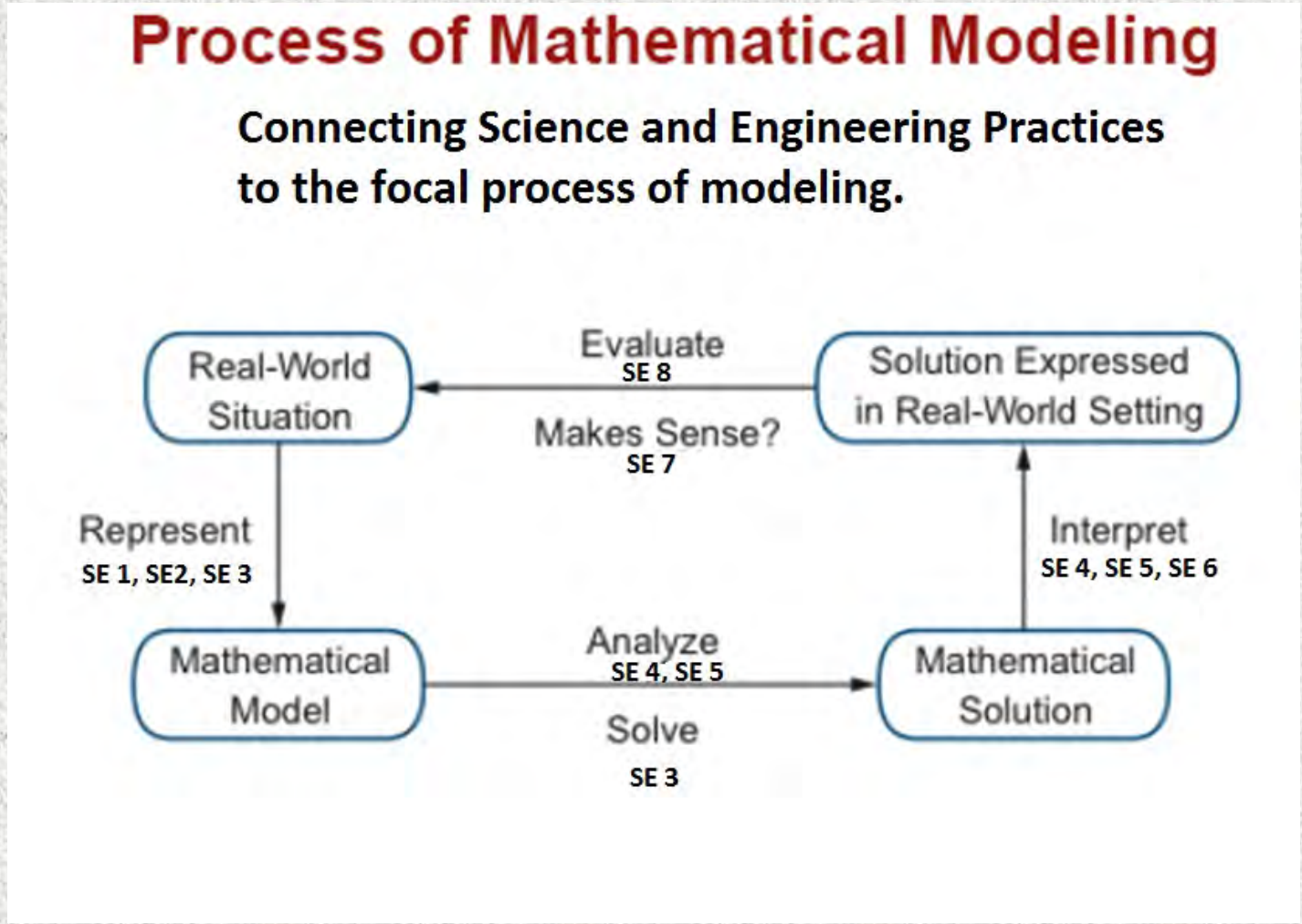


Mathematical Modeling



- Dr. Christian Hirsch, Western Michigan Univ.

Science and Engineering Practices



CAUTIONs from Bill McCallum

- Not intended as free floating proficiencies observed independently of content
  - Blended with content and groups of practices
- Not uniformly applied over all work students do
  - But all practices should be addressed within a school year or high school course
- Must be integrated with content
  - A balanced diet

Plan for this Session

- View a video OR review Common Core tools that I have selected
- Discuss, decide, and share ideas for how the video might be used to address Standards for Practice (math or science/engineering).
- All videos and tools freely available on web and can be captured for use in classrooms (even behind school firewall).

Kylie Minogue

- Come Into My World
- http://www.youtube.com/watch?v=ErU5hKT2KMs

THANKS
to David Masunga
for bringing this
video to my
attention

Music Video: What Practices?

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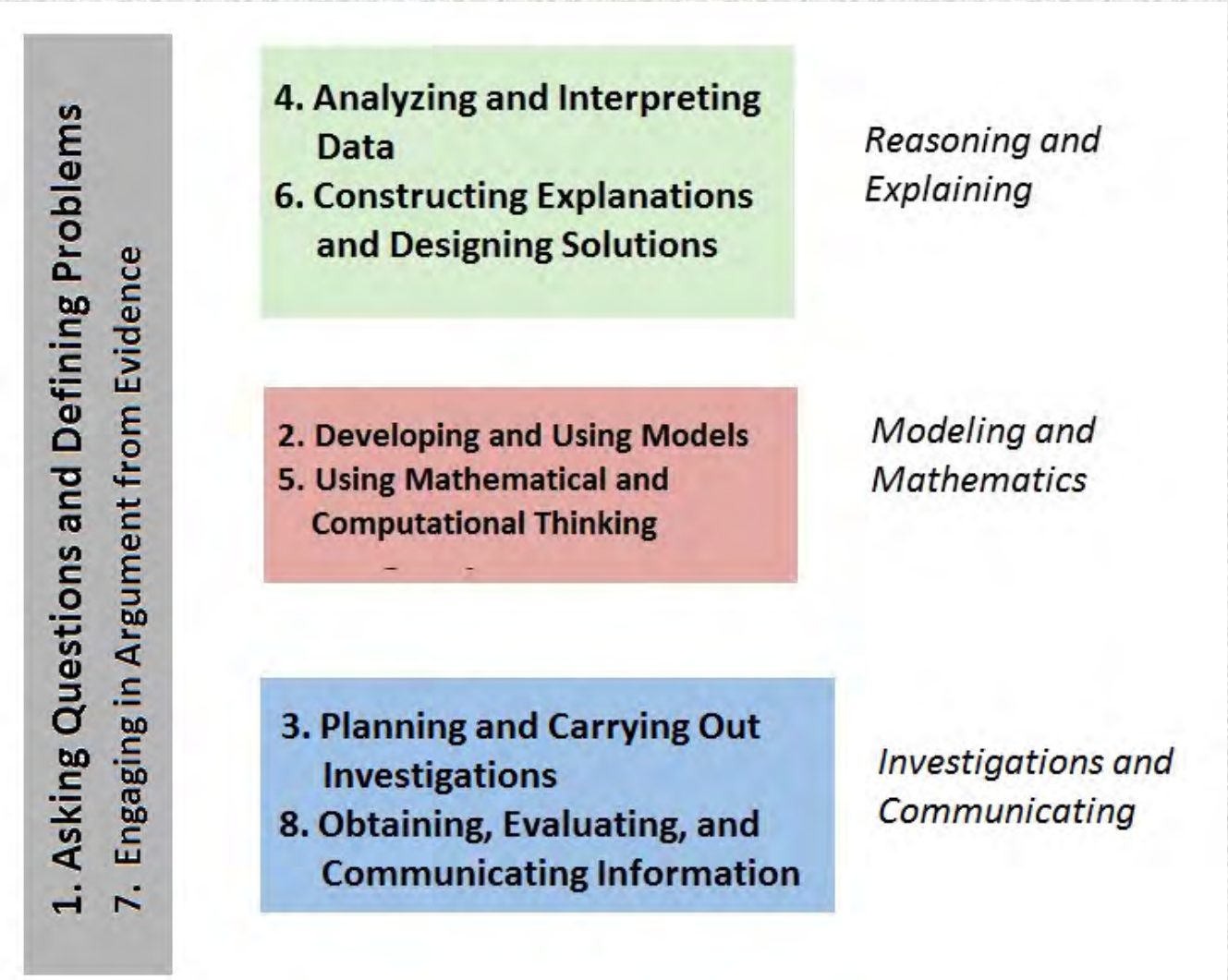
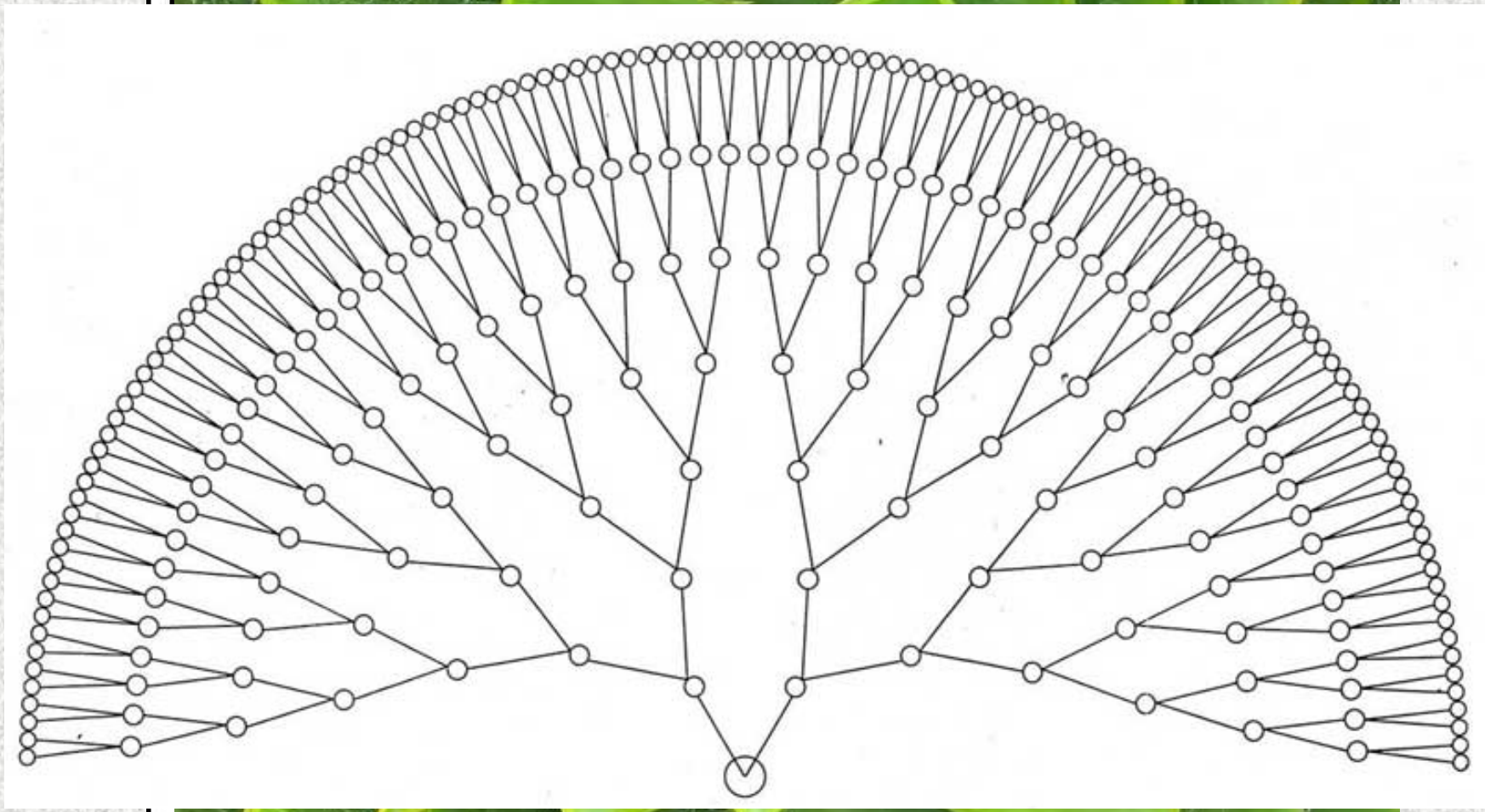
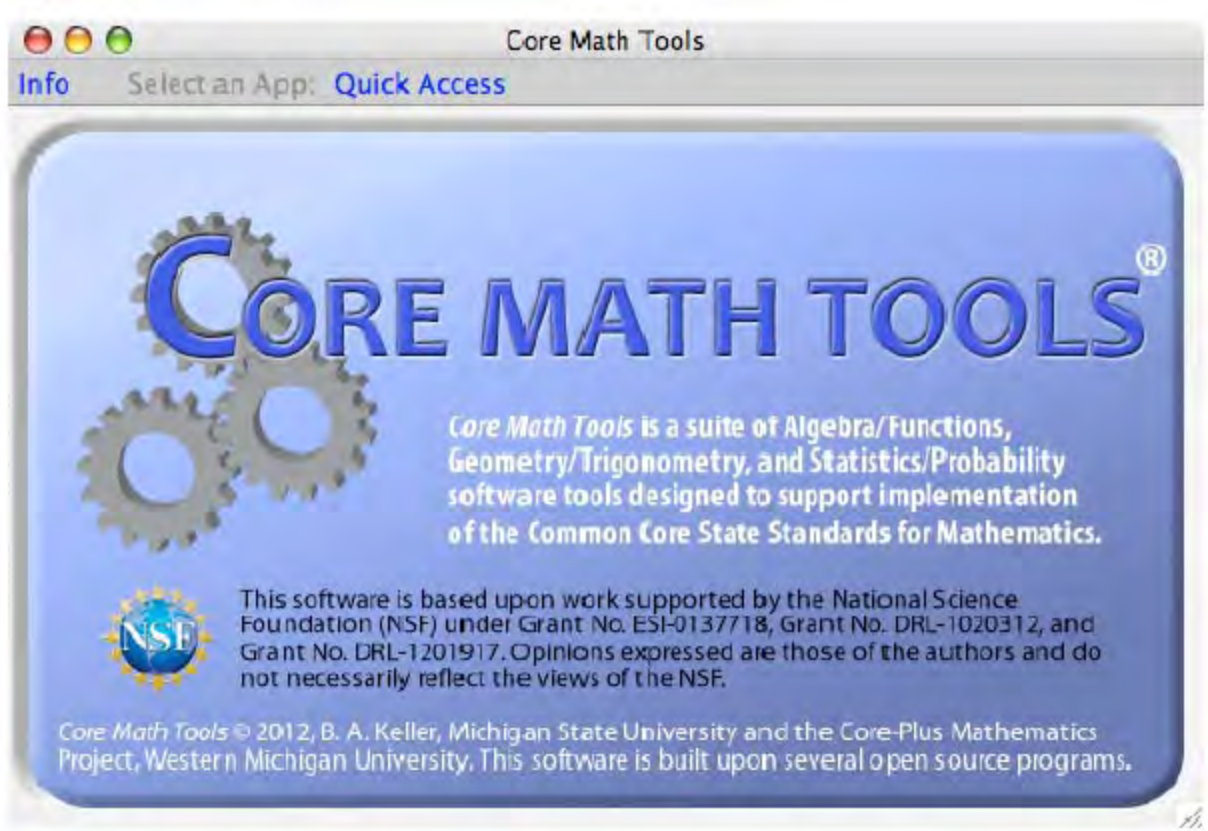


Recursion & Self-Repeating Patterns



Core Math Tools



www.nctm.org/coremathtools

Core Math Tools

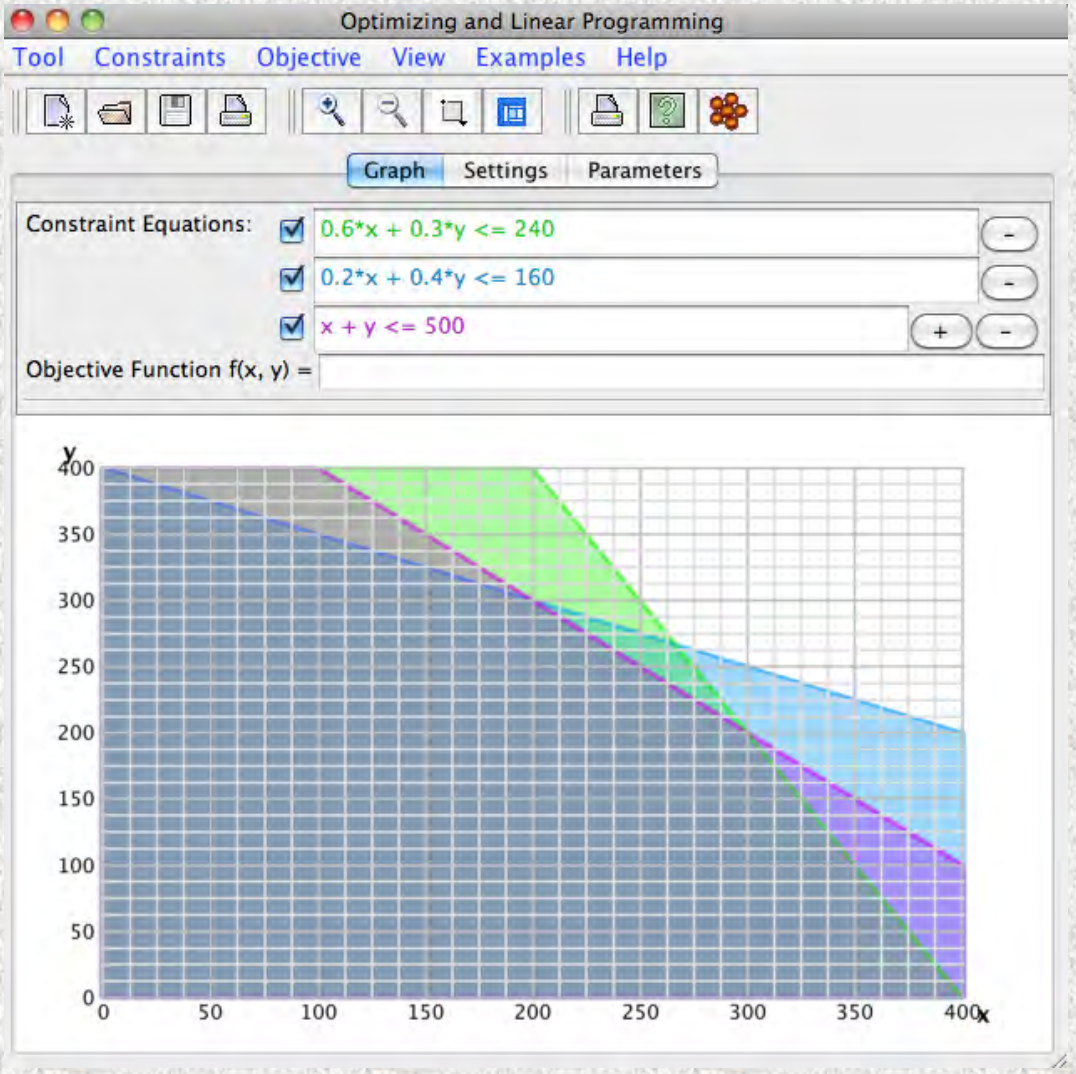
- Core *Math Tools* is accompanied by user support and resources at a CMT portal within the NCTM website.
- Core *Math Tools* is designed for use with *any* CCSSM-oriented high school textbook series.
- Core *Math Tools* is a promising resource for mathematics teacher preparation programs.

Core Math Tools

General Purpose Tools

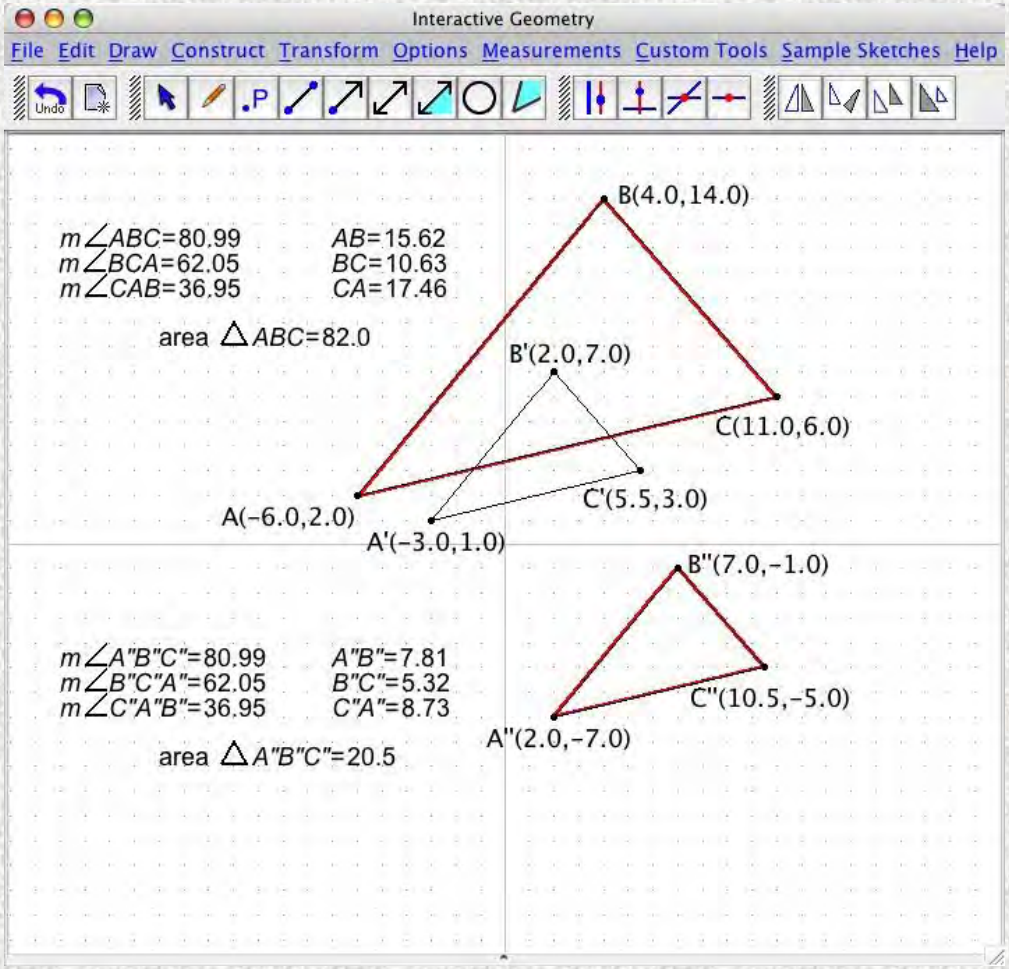
Algebra Tools

- electronic spreadsheet and a computer algebra system (CAS) that produces tables and graphs of functions, manipulates algebraic expressions, and solves equations and inequalities; and modeling.



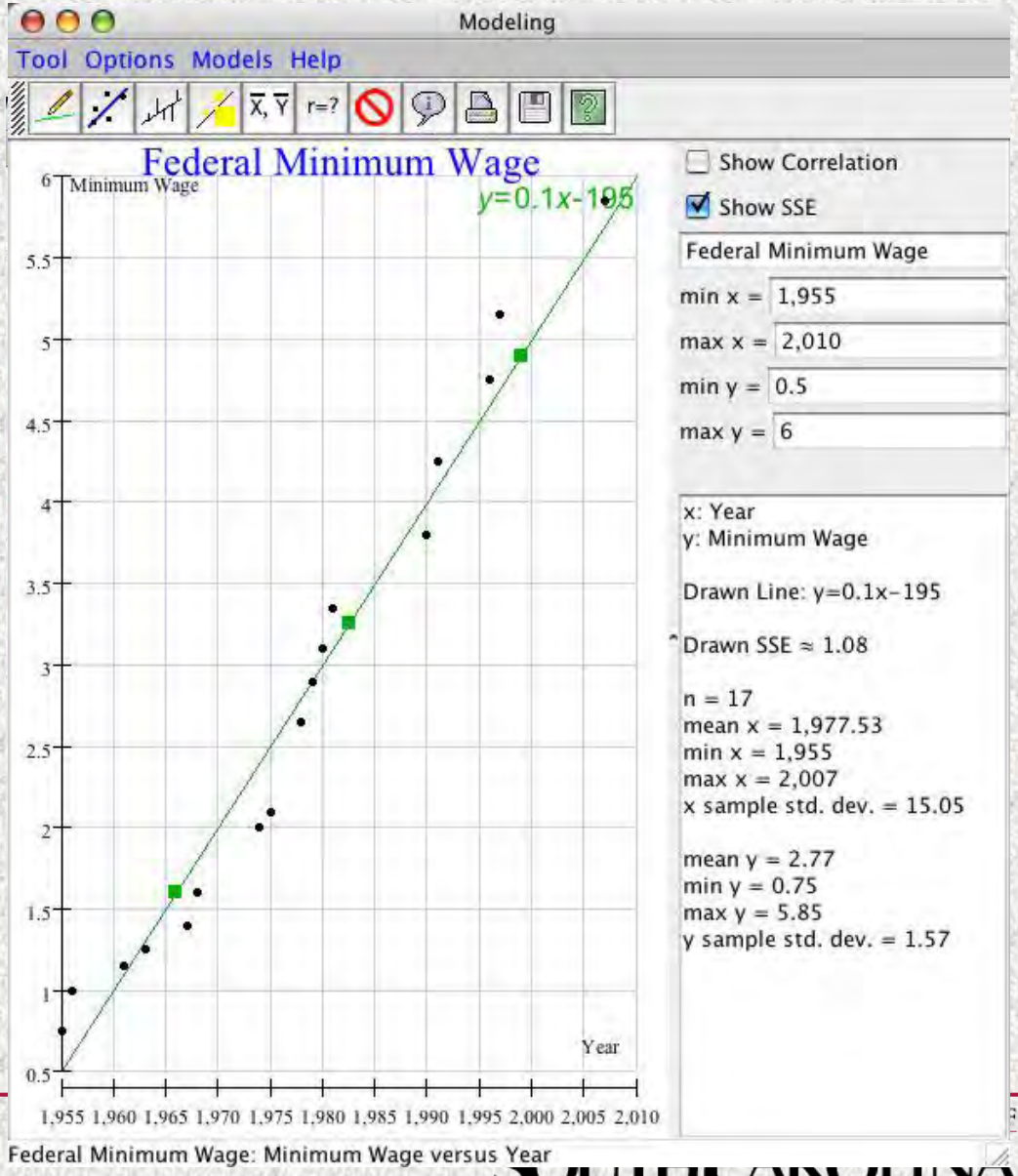
GeometryTools

- interactive drawing tool for constructing, measuring, manipulating, and transforming geometric figures in both a coordinate and coordinate-free environment, a simple object-oriented programming language for creating animations

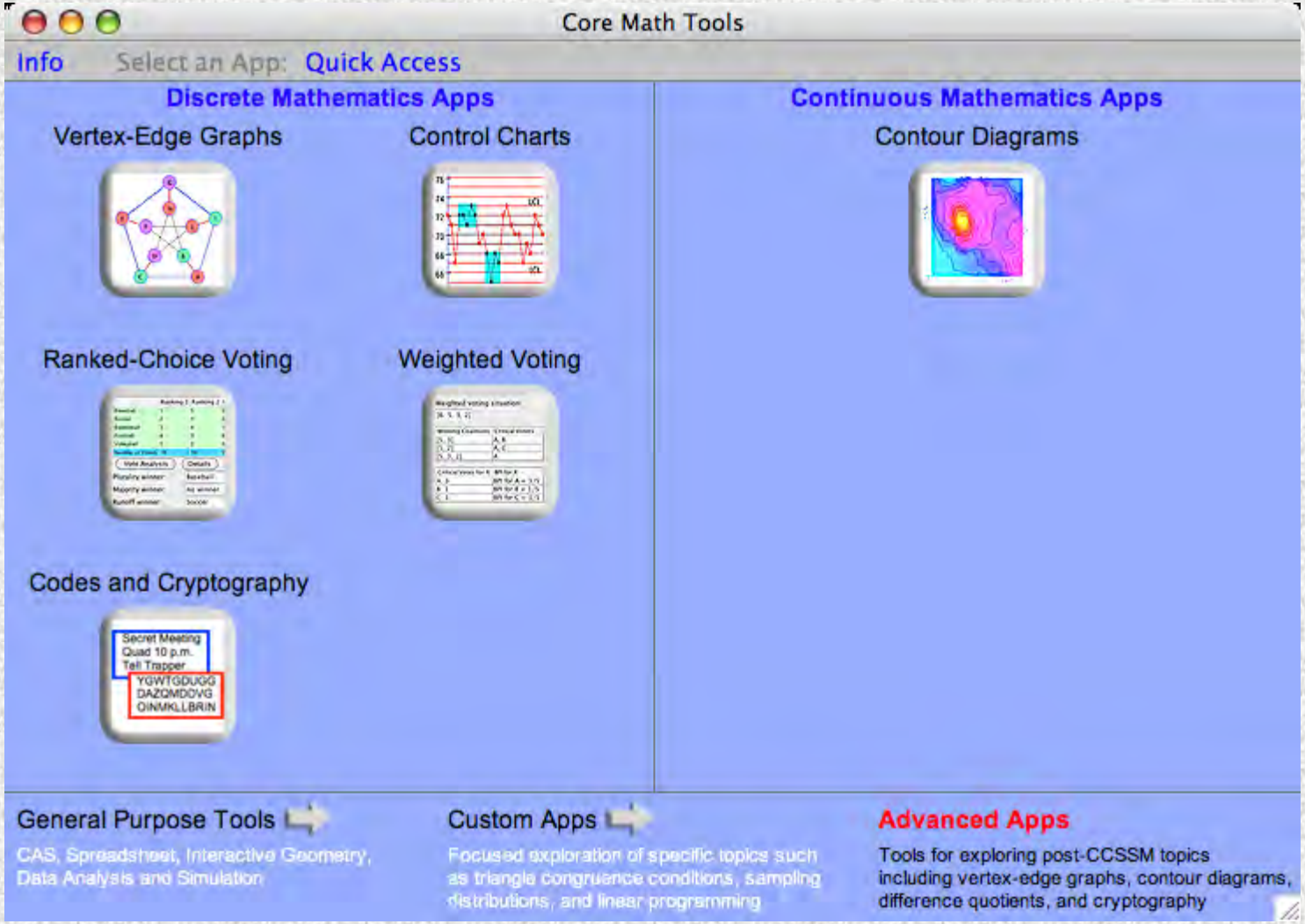


Statistics Tools

- for graphic display and analysis of univariate and bivariate data, simulation of probabilistic situations and mathematical modeling of quantitative relationships. Spreadsheets allow easy insert of class data or data available from other sources. CMT includes pre-loaded data sets for developing key statistical ideas.



Custom Apps


Core Math Tools
Info
Select an App: Quick Access
Discrete Mathematics Apps
Vertex-Edge Graphs
Control Charts
Ranked-Choice Voting
Weighted Voting
Codes and Cryptography
Secret Meeting
Quad 10 p.m.
Tell Trapper
YGWTGDUGG
DAZQMDOVG
OINMKLLBRIN
Continuous Mathematics Apps
Contour Diagrams
General Purpose Tools
CAS, Spreadsheet, Interactive Geometry, Data Analysis and Simulation
Custom Apps
Focused exploration of specific topics such as triangle congruence conditions, sampling distributions, and linear programming
Advanced Apps
Tools for exploring post-CCSSM topics including vertex-edge graphs, contour diagrams, difference quotients, and cryptography

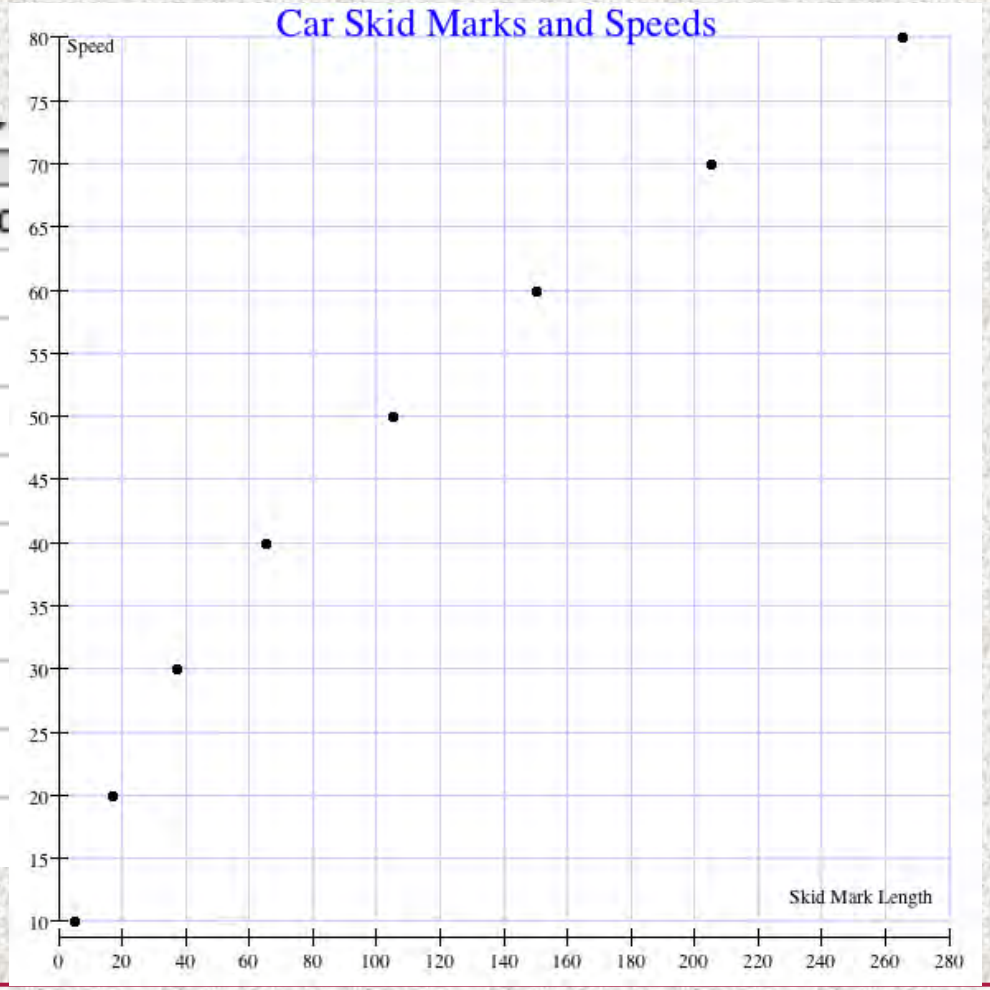
Car Skid Marks and Speeds

- When police investigate the scene of an automobile accident, they look for skid marks and use the length of those marks to estimate the speed at which the car was traveling. The results of experiments with a test car, giving skid mark length (in feet) and speed (in miles per hour), are shown in the next slide.

Thanks to Patrick Hopfensperger, UW-Milwaukee

Skid Marks Vs. Speed

	Skid Mark Length	Speed
1	5	10
2	17	20
3	37	30
4	65	40
5	105	50
6	150	60
7	205	70
8	265	80



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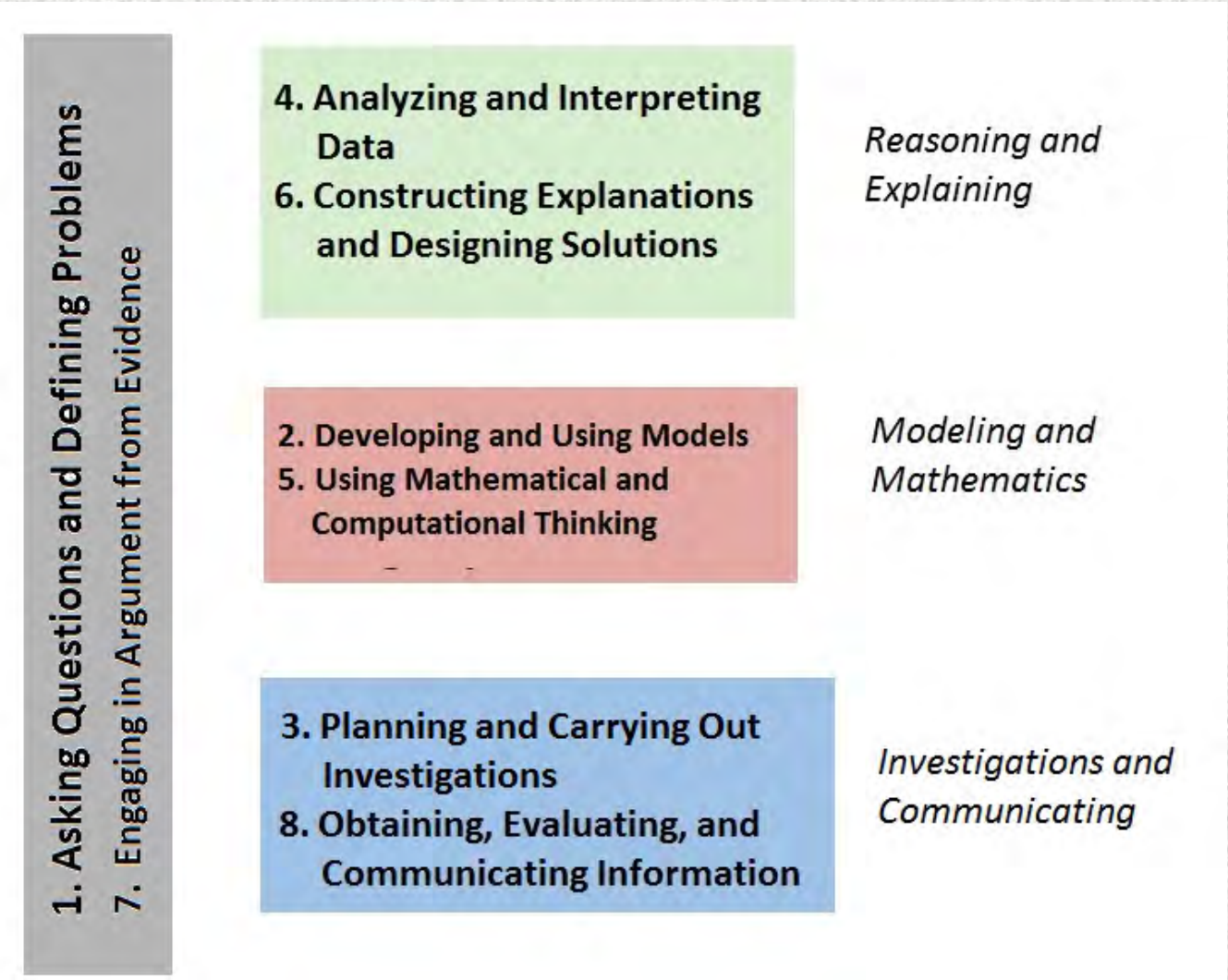


UPS and Girth

- Brian Regan Improv Comedy
- http://www.youtube.com/watch?v=89frRi8GgGA

THANKS
to Tim Kanold for
bringing this video to
my attention!

UPS and Girth

http://www.ups.com/content/us/en/resources/ship/packaging/weight_size.html?srch_pos=3&srch_phr=girth

How To Measure Your Package Size

To measure ground packages use the following formula:

Length + 2x Width + 2x Height

Step 1. Determining Length

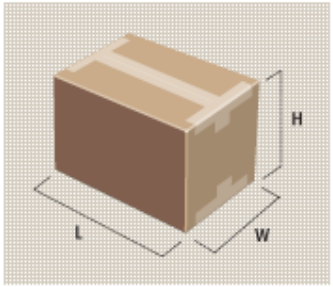
- Measure the longest side of the package, rounding to the nearest inch. This is your length.

Step 2. Determining Girth (2x Width + 2x Height)

- Measure the width of the package, rounding to the nearest inch. Multiply this number by 2.
- Measure the height of the package, rounding to the nearest inch. Multiply this number by 2.
- Add these two numbers together. This is your girth.

Step 3. Add the length and the girth together. This is your package measurement.

Step 4. Weigh the package to obtain its actual weight.



Carry-on Luggage and Girth

Airline	No. of Bags Allowed	Maximum Allowable Dimensions	Max Weight
Air Tran carry-on info	1/passenger	55 linear inches (L+W+H)	-
American Airlines carry-on info	1/passenger	45 linear inches (L+W+H)	40 lbs.
America West carry-on info	1/passenger	51 linear inches (L+W+H)	-
Continental carry-on info	1/passenger	51 linear inches (L+W+H)	40 lbs.
Delta Airlines carry-on info	1/passenger	22" x 14" x 9"	40 lbs.
Northwest Airlines carry-on info	1/passenger	22" x 14" x 9"	40 lbs.
Southwest Airlines carry-on info	1/passenger	24" x 16" x 10"	-
Spirit Airlines carry-on info	1/passenger	22" x 13" x 10"	40 lbs.
United Airlines carry-on info	1/passenger	22" x 14" x 9"	40 lbs.
US Airways carry-on info	1/passenger	24" x 16" x 10"	40 lbs.

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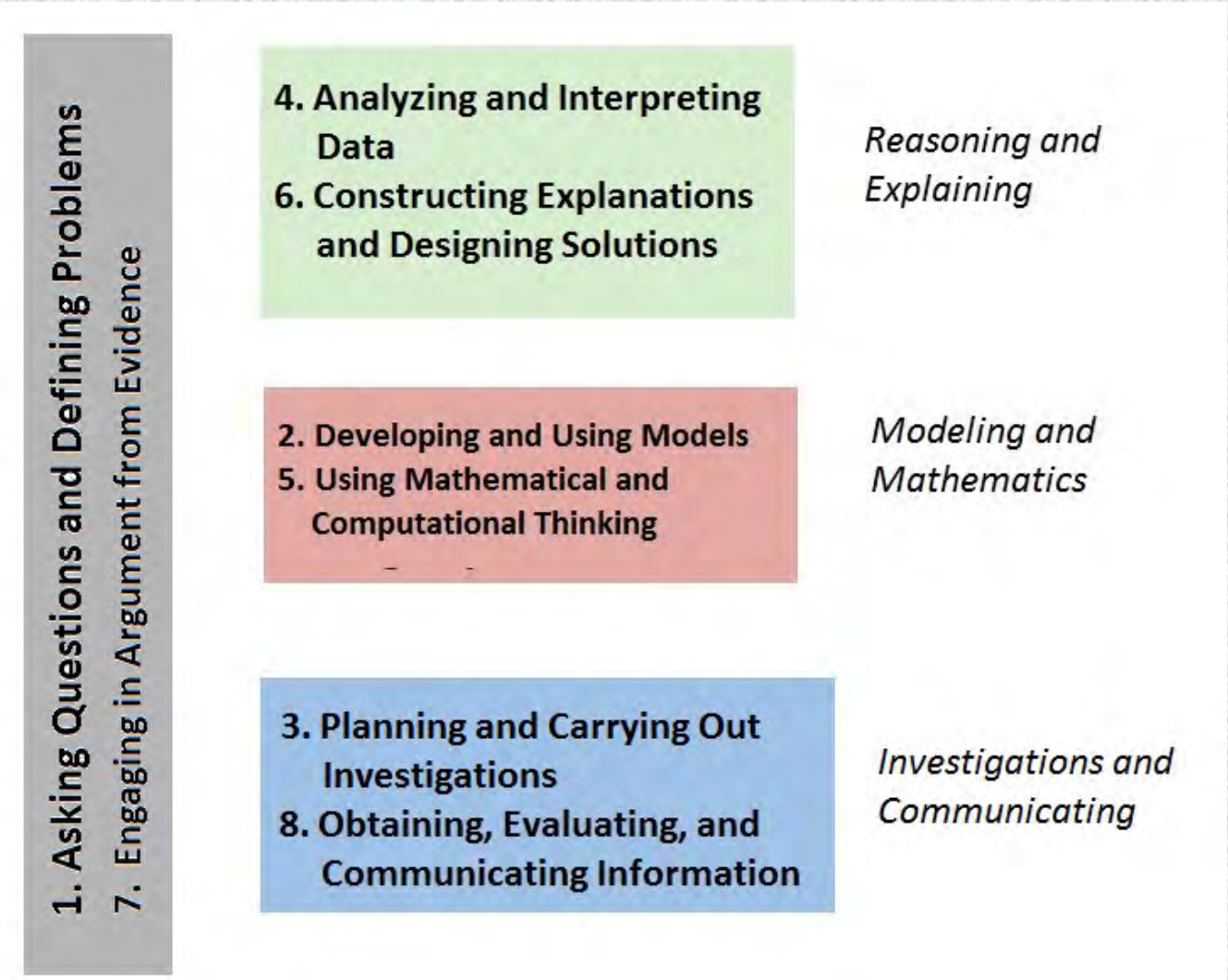
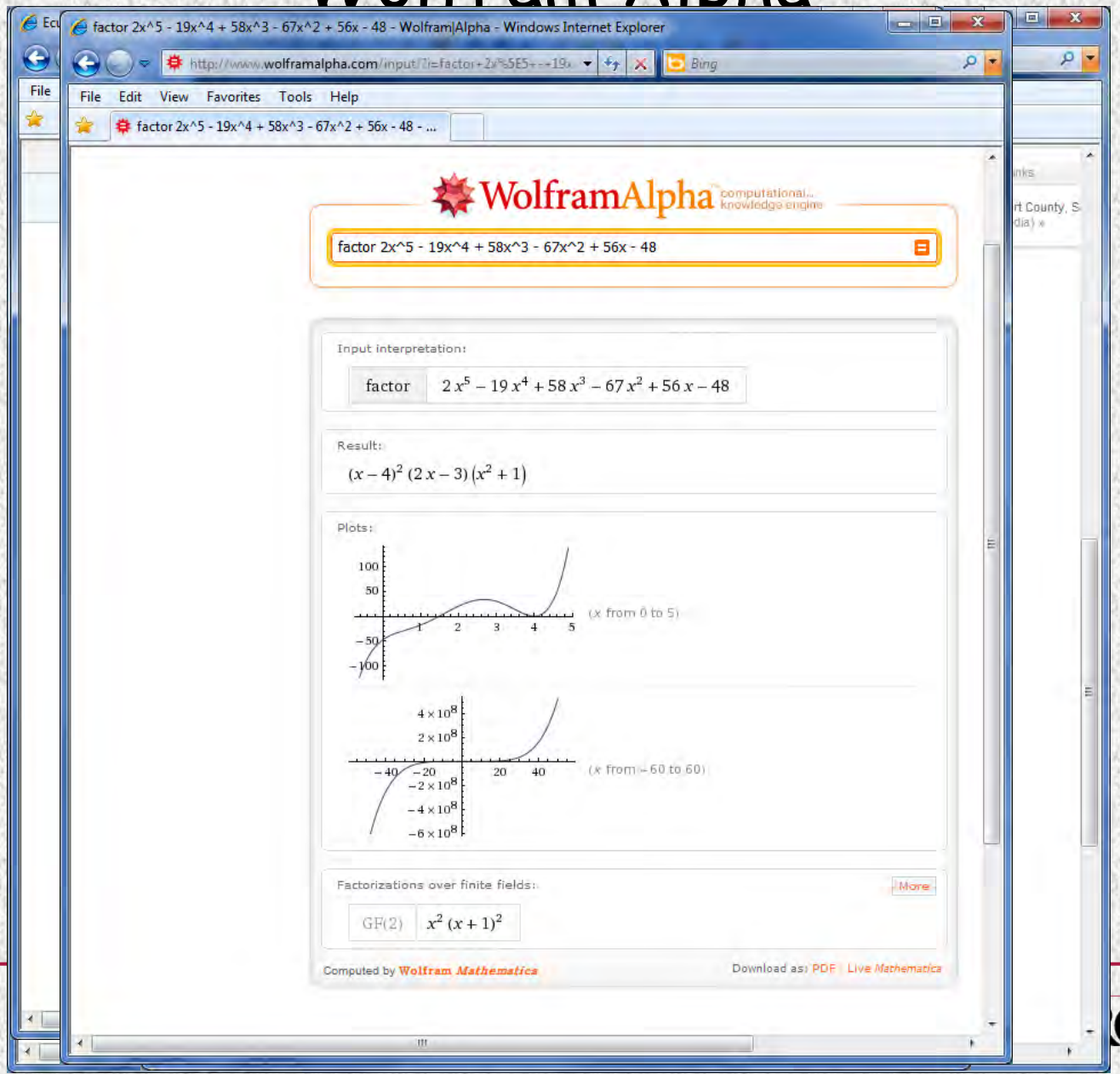


Wolfram Alpha



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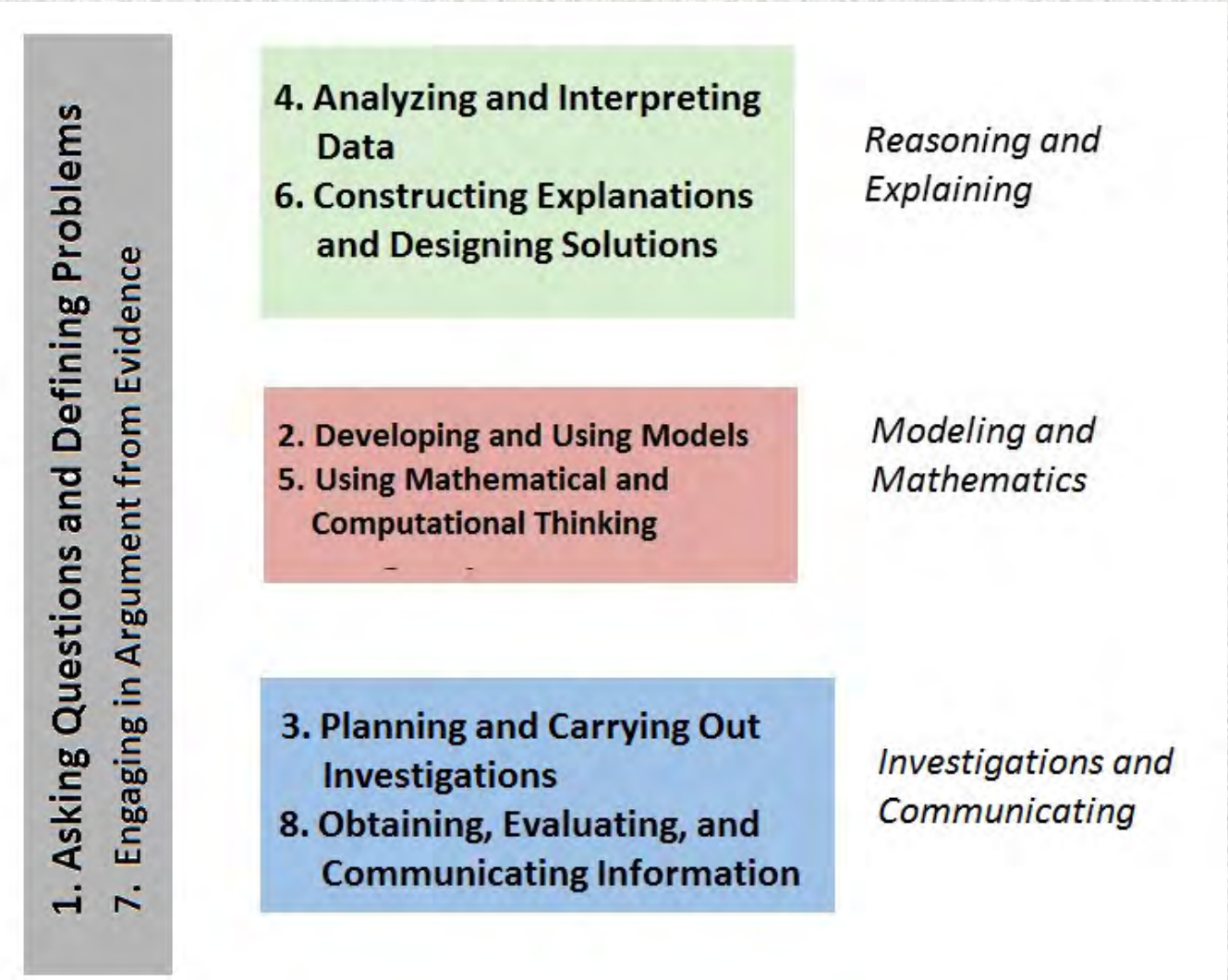


Growing Hair

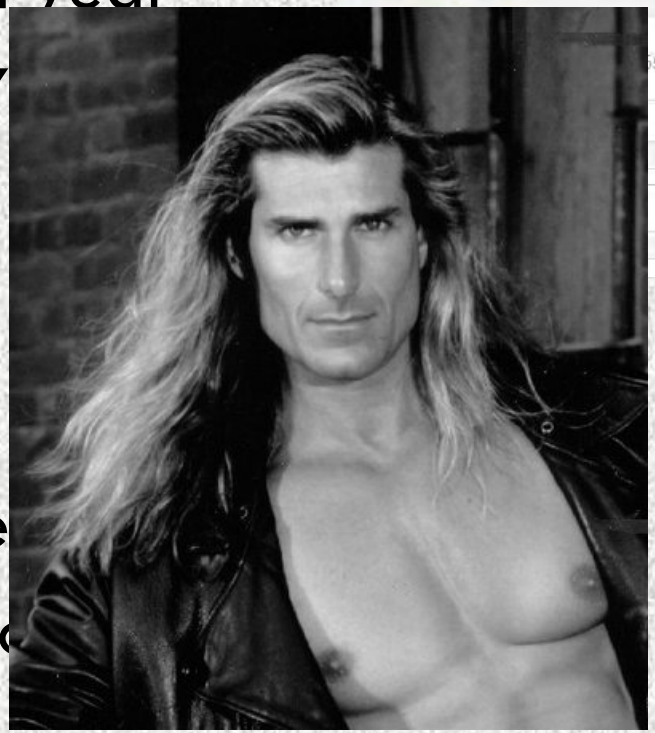
- The Big Bang Theory: Hair Me Out
  http://www.youtube.com/watch?v=iQ3CyK1osY8

Growing Hair

- Sheldon: "… my hair is growing at 4.6 yoctometers per femtosecond…"
- What does that mean?
- Is it accurate?
- Can you re-phrase the growth rate?
- … in centimeter per second, per nanosecond, or other units

Grow Hair: Useful info

- Hair grows at approximately 15 cm per year
- Seconds in year
- Or 31,557
- 1 yoctome
- 1 femtase



seconds in a year

65,000,000 results (0.18 seconds)

10^{-24}	1 yoctometre (ym)
10^{-21}	1 zeptometre (zm)
10^{-18}	1 attometre (am)

3.155

ond

10^{-24}	1 yoctosecond
10^{-6}	1 micrometre (μm)
10^{-5}	10 μm
10^{-4}	100 μm
10^{-3}	1 millimetre (mm)
10^{-2}	1 centimetre (cm)
10^{-1}	1 decimetre (dm)
10^{0}	1 metre

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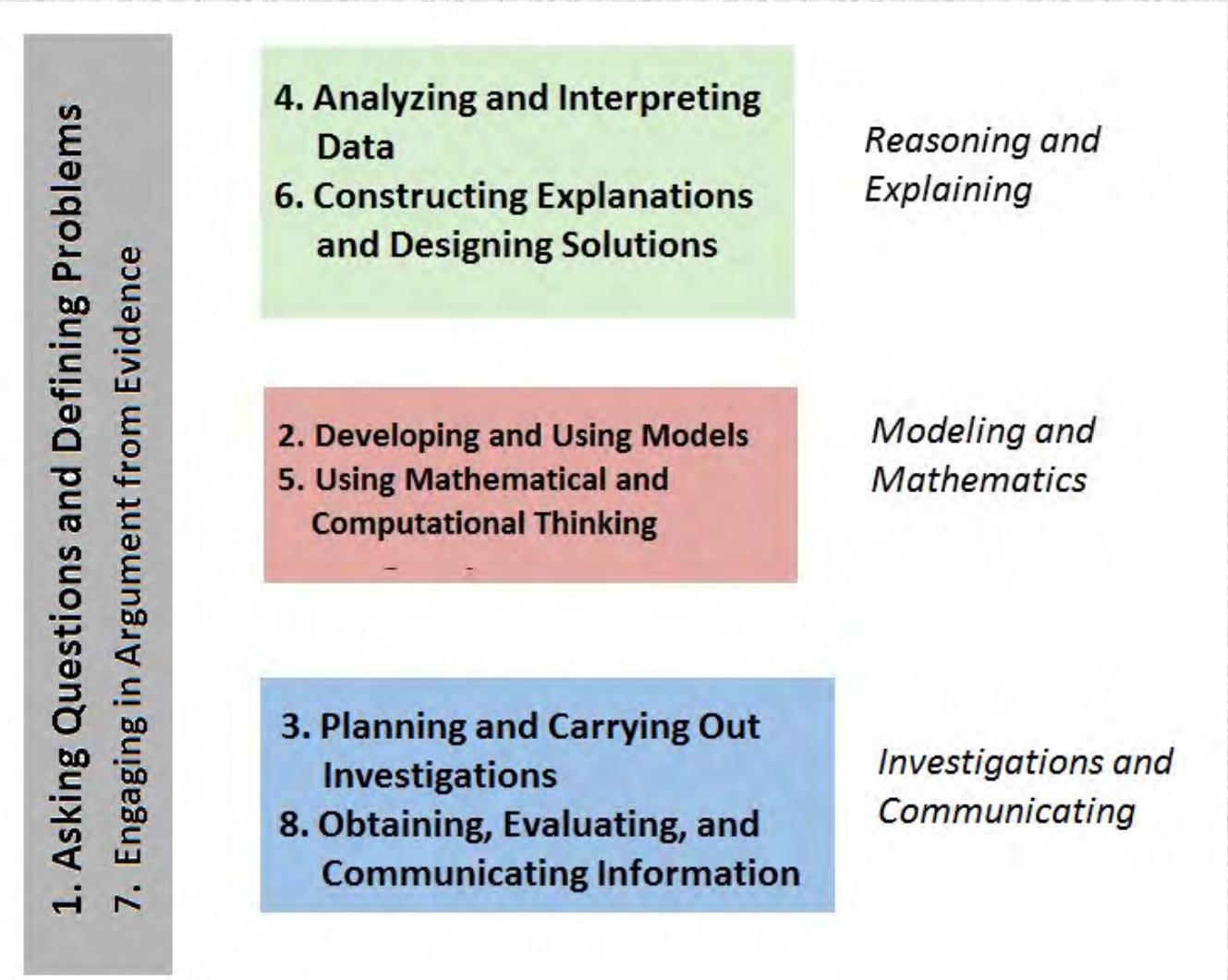
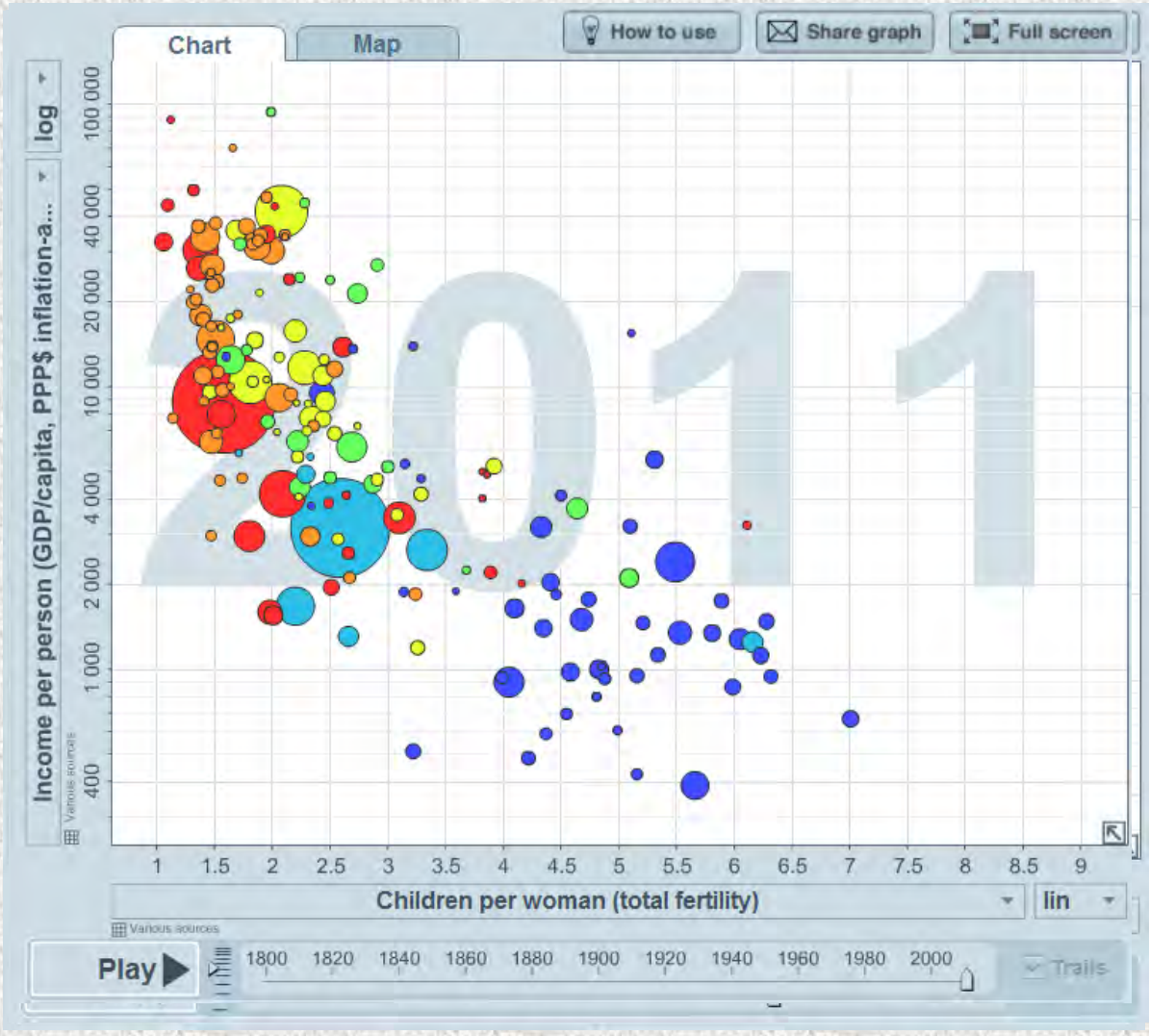


Visual Data Analysis

- V

Some Examples

- Children per Woman vs. Income per person



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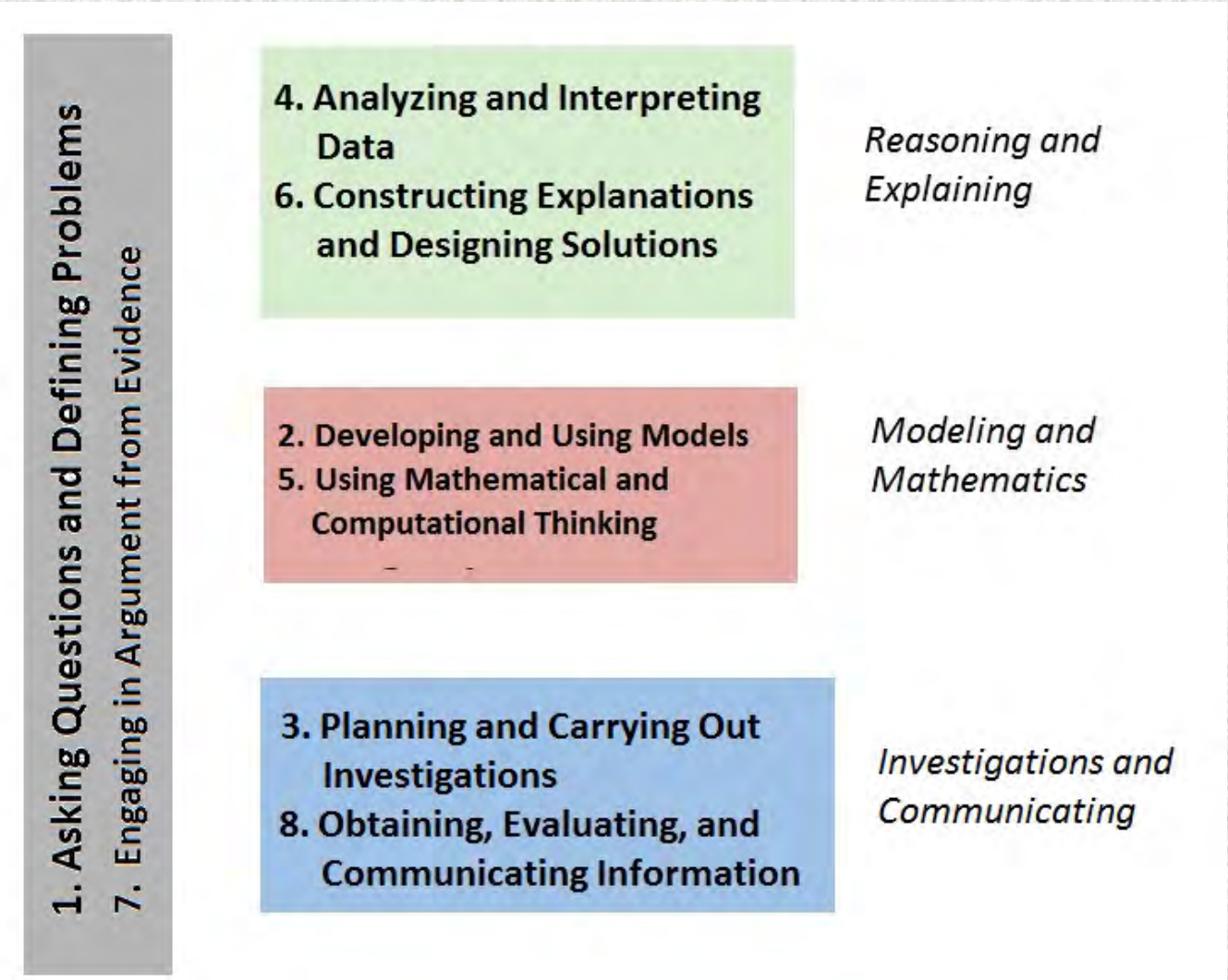

Vi Hart

- How to Snakes
- http://www.youtube.com/watch?v=Gx5D09s5X6U
- Buy at Amazon

How Many Possible Snakes?

- Each sna ody/tail part b
  d le (S).
- est
- smallest (one body part and one

How Many Possible Snakes?

- Given each snake is "unique" if it is oriented with its body or tail L, R, or S,
- How long must a snake be so that the number of unique snakes equals or surpasses the population of South Carolina? … the U.S.? … the world?

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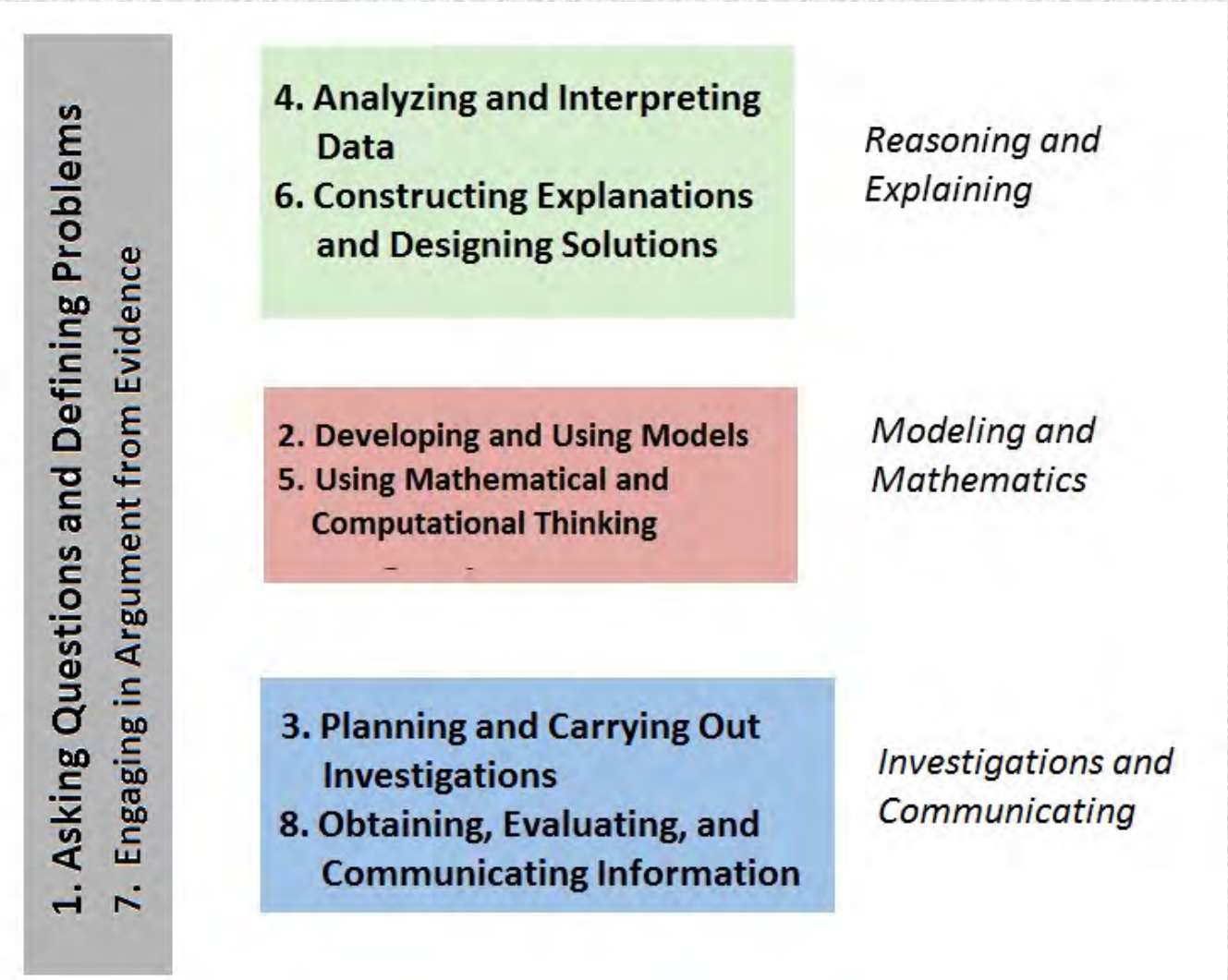
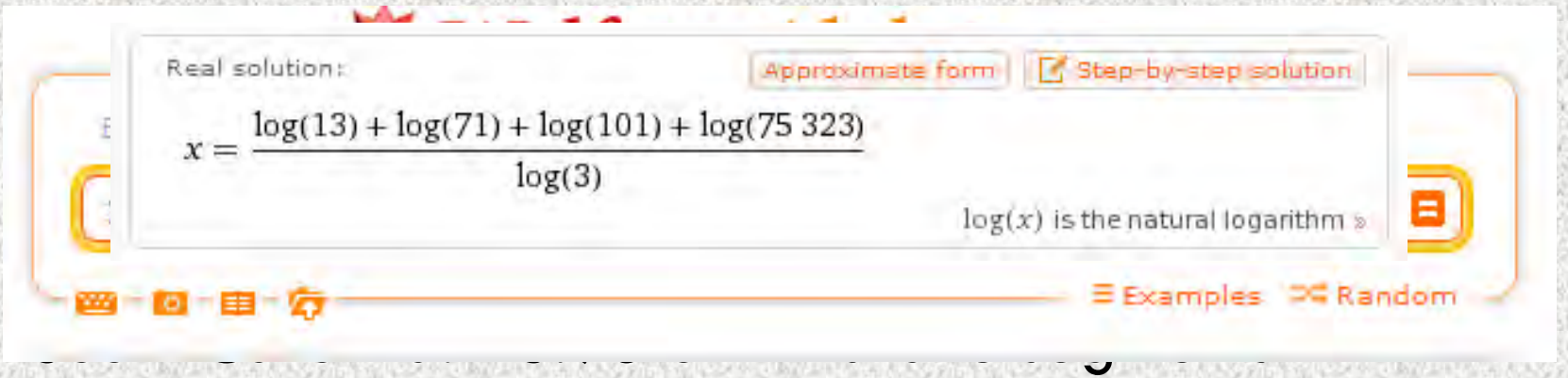


Population

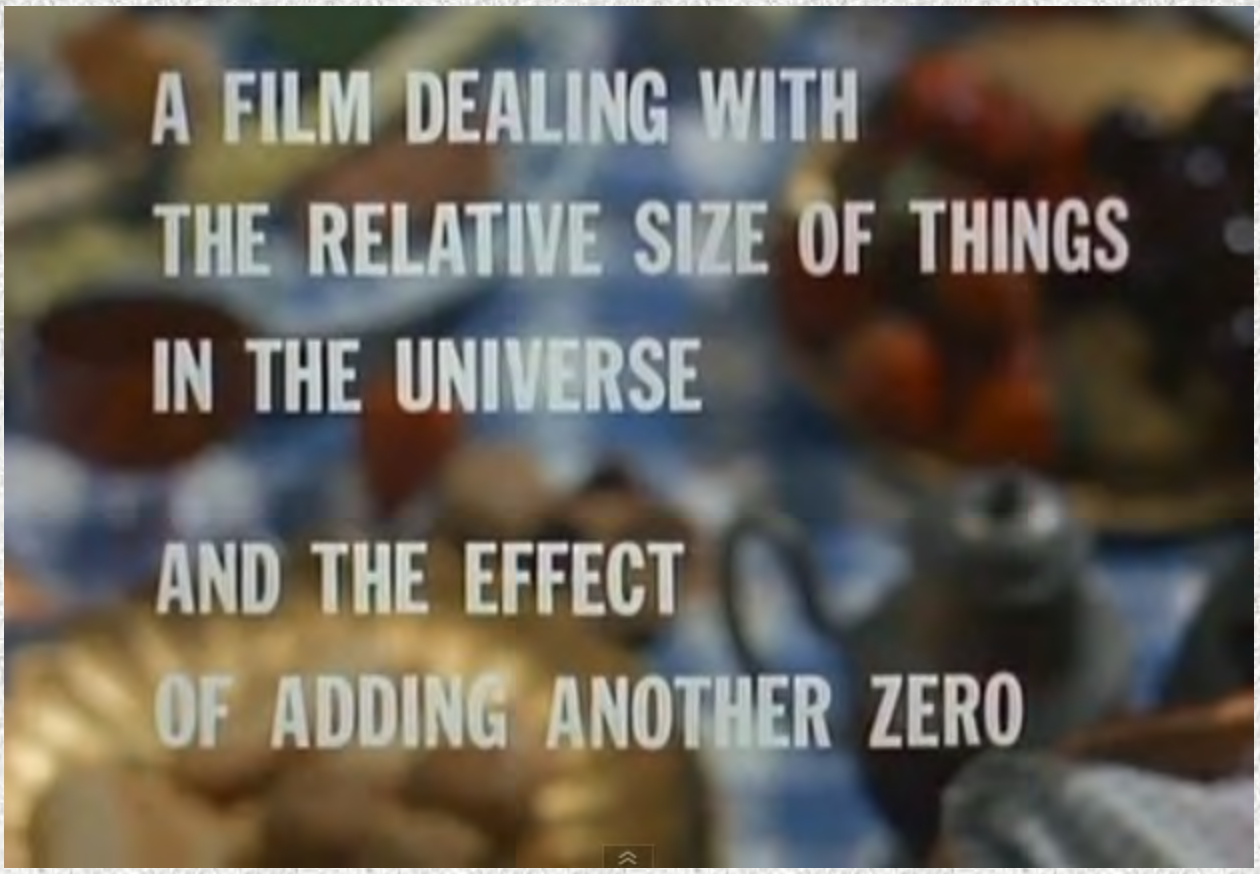
- South Carolina: 4,679,230 (est. in 2011)
- U.S.: 311,591,917 (est. in 2011)
- World: 7,021,836,029 (est. in 2011)



- U.S.: 17.8 or 18 snake segments
- World: 20.637 or 21 snake segments

Powers of Ten

- By Charles and Ray Eames for IBM in 1977



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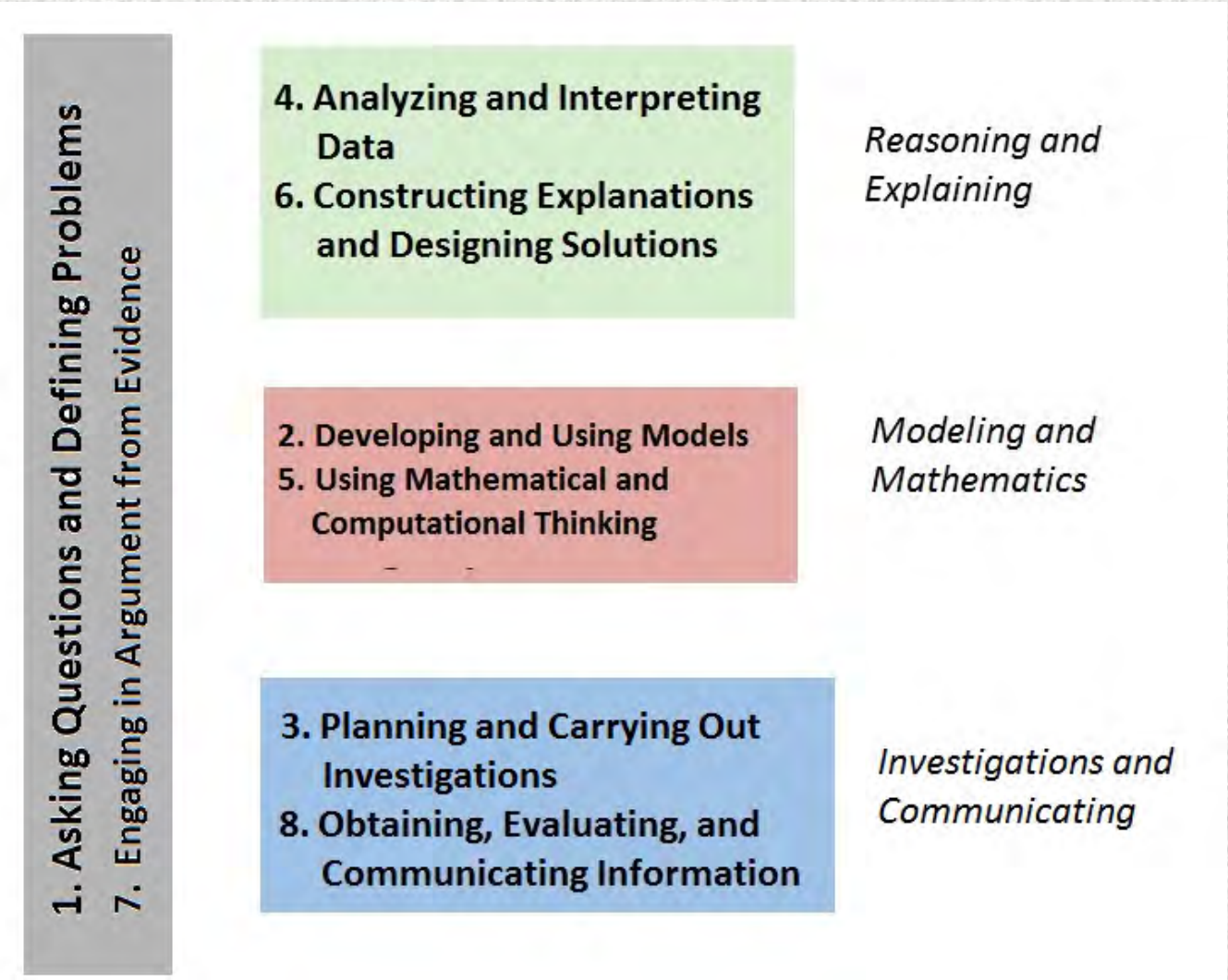


2013 Institutes

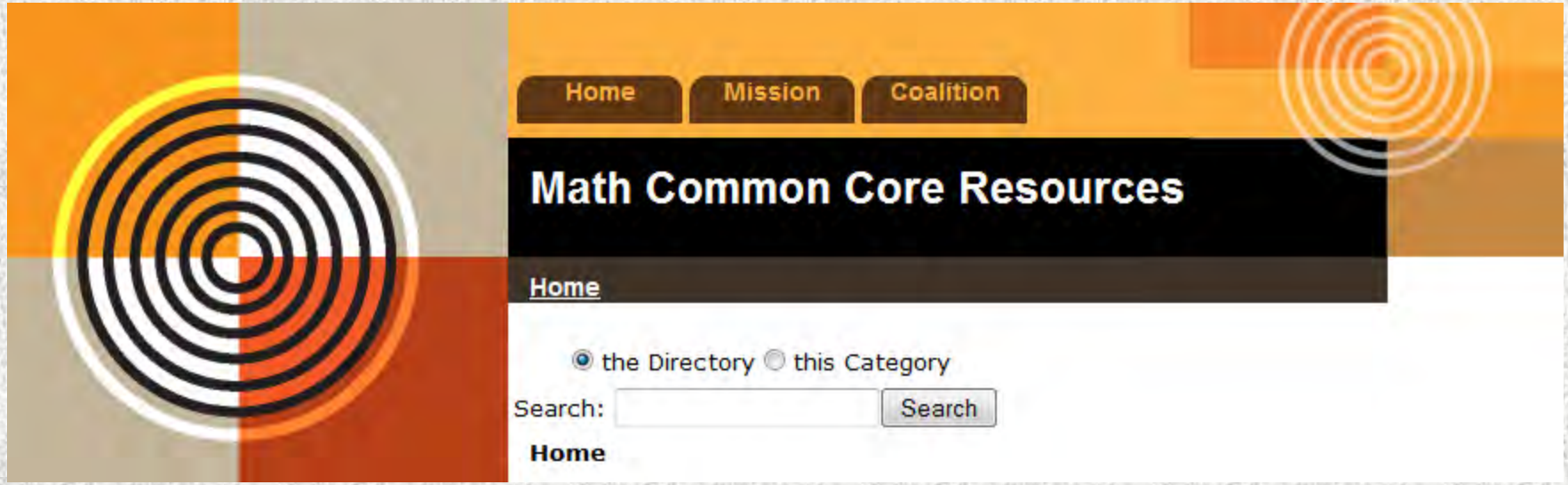
High School Mathematical Practices:
August 1-3, Washington, DC

***K-5* Number and Operations Institute**
July 11-13, New Orleans

***6-8* Algebra Readiness Institute:**
July 8-10, New Orleans

Math Common Core Resources

- http://www.nctm.org/standards/mathcommoncore/



Web Resources

- Common Core: http://www.corestandards.org
- Math Common Core Resources: http://www.nctm.org/standards/mathcommoncore/
- SBAC: http://www.k12.wa.us/smarter/
- South Carolina Common Core: http://ed.sc.gov/agency/pr/standards-and-curriculum/South_Carolina_Common_Core.cfm
- Next Generation Science Standards: http://www.nextgenscience.org/

Web Resources

- Core Math Tools: http://www.nctm.org/coremathtools
- Wolfram Alpha: http://www.wolframalpha.com
- UPS Girth: http://www.ups.com/content/us/en/resources/ship/packaging/weight_size.html?srch_pos=3&srch_phr=girth
- Vi Hart Blog: http://vihart.com
- Snakes at Amazon: http://www.amazon.com/dp/B003I6USDW?tag=notcot-20
- Orders of Magnitude
  http://en.wikipedia.org/wiki/Orders_of_magnitude_%28time%29
  http://en.wikipedia.org/wiki/Orders_of_magnitude_%28length%29

Videos

- The Importance of Mathematical Practices: https://www.youtube.com/watch?v=m1rxkW8ucAI
- Kylie Minogue – Come Into My World: http://www.youtube.com/watch?v=ErU5hKT2KMs
- UPS and Girth: http://www.youtube.com/watch?v=89frRi8GgGA
- The Big Bang Theory: http://www.youtube.com/watch?v=iQ3CyK1osY8
- How to Snakes by Vi Hart: http://www.youtube.com/watch?v=Gx5D09s5X6U
- Powers of Ten: http://www.powersof10.com/film

Thank you…

ed.dickey@sc.edu

www.ite.sc.edu/dickey.html