math.code

You can incorporate coding into your math classroom

2018 OCTM Conference on October 11-12 in Akron, Ohio
Friday (the 12th) from 1:00 - 1:50 in room Firestone A

Session Goals for Each Participant

Goal 1: Do one more coding activity with your students than you did last year.
Goal 2: Collect some ideas and formulate a strategy on how to incorporate coding in your classroom.

Session Agenda:

The Whys and Hows (<= 5 minutes)
Coding examples and illustrations
Coding resources
Discussion with group on doing this

This is not a teach you mathematics session (you probably know it better than I do), rather the focus is to provide examples, generate ideas, and allow for discussion around using coding as another tool in your math classroom.

Coding activities in math classroom to explore concepts in a concrete way and problem solve.

Thomas Edison Quotes

I have not failed. I've just found 10,000 ways that won't work.

Our greatest weakness lies in giving up. The most certain way to succeed is always to try just one more time.

- Encourage your students to try
- Encourage your students to make mistakes while trying
- Encourage your students to learn from their mistakes
- Encourage your students to break problem down into pieces and tackle it pieces at a time (How do you eat an elephant? One bite at a time.)

My favorite question from students … When am I ever going to use this?

Enrichment – finished early, need a challenge

Integrated – coding activities as part of the curriculum

Research project – partner with community, company, college needing some research

Remediation – trouble learning or visualizing a concept

Incorporate coding … how?

coding club – before/after school, during activity period (student led?)

get some help from others

Hour of Code event --- https://hourofcode.com/ for more information. Dec 3-9, 2018

Science fair – structured approach to exploring and application of mathematics and coding

See Presentation Notes for more explanation of these items

why code?

Coding is a tool many students will use again in some form

modeling / simulations

Explore a topic too time consuming to explore by hand or with other tools.

Fun!

automate the repetitive

Students learn by teaching/instructing a concept … to a computer. They must learn/understand the topic well. Must be precise when coding, get immediate feedback.

visualization of patterns, results, data, etc

let computer do what it does best, let humans do what they do best

math ≠ computer science

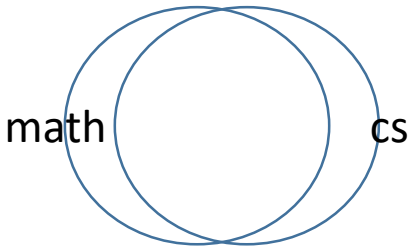
x = x

Equality – left side equals the right side

computer science <> math

x = x + 5

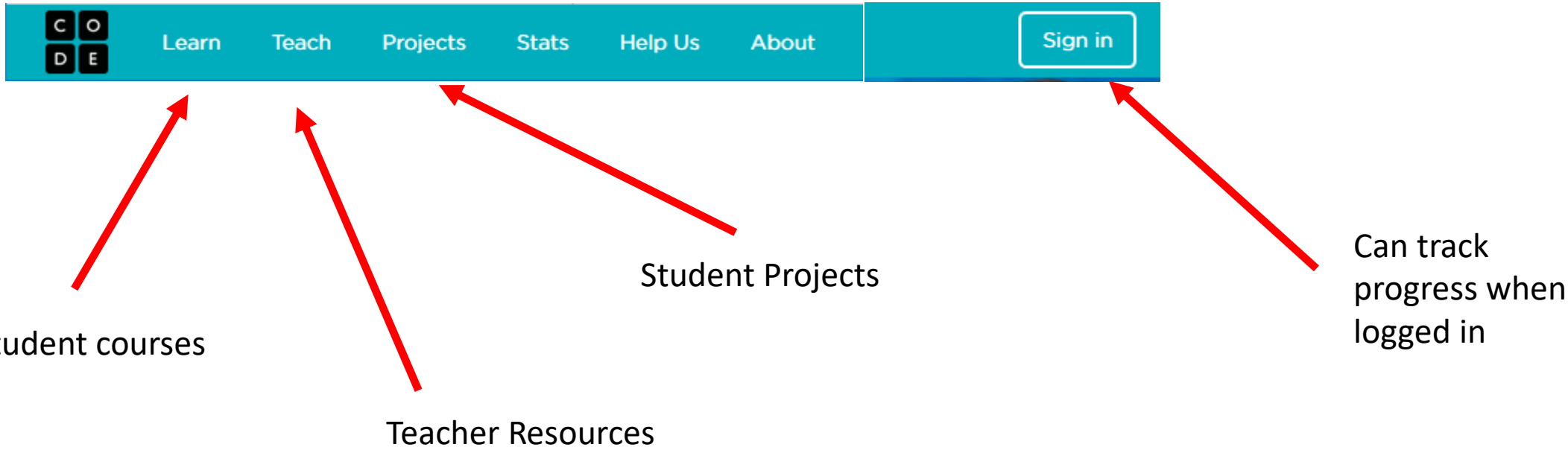
Assignment – x is assigned the current value of x plus 5
Some languages use = for equality (i.e. does this equal that) and other languages use a different symbol (i.e. ==)



Some differences, however, a lot of related/shared items

…. Shout-outs …

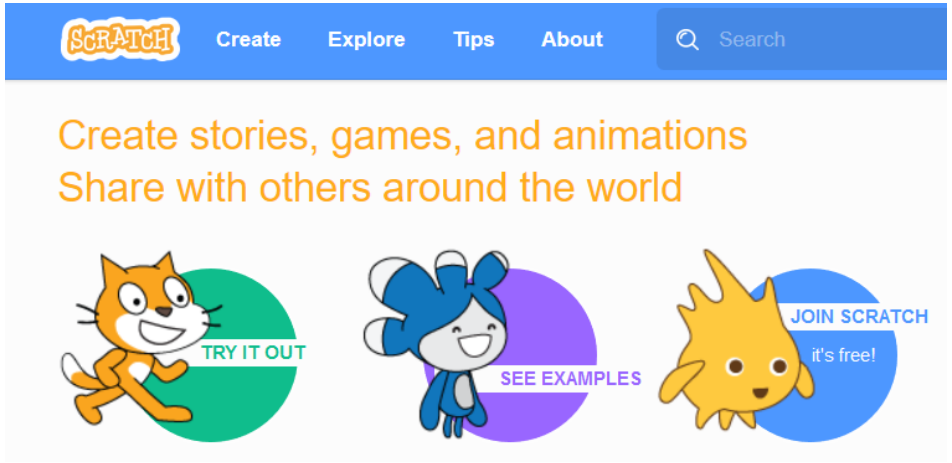
Shout-out: studio.code.org



Hour of Code Type of Activity

- Go to https://studio.code.org/ then click on the Learn more button for “Grades K-5”. Scroll down to Course D and click on the “7. Drawing Shapes with Loops” number 1 (to see the video) or number 2 (to start coding).
- Follow the on-screen instructions and help speech bubbles.
- Note: You will be clicking on the Run or Reset in the left side window to run your code
- Note2: You can make different initial selections for harder or easier activities. There is a Sign in option to track your progress.

Shout-out: Scratch

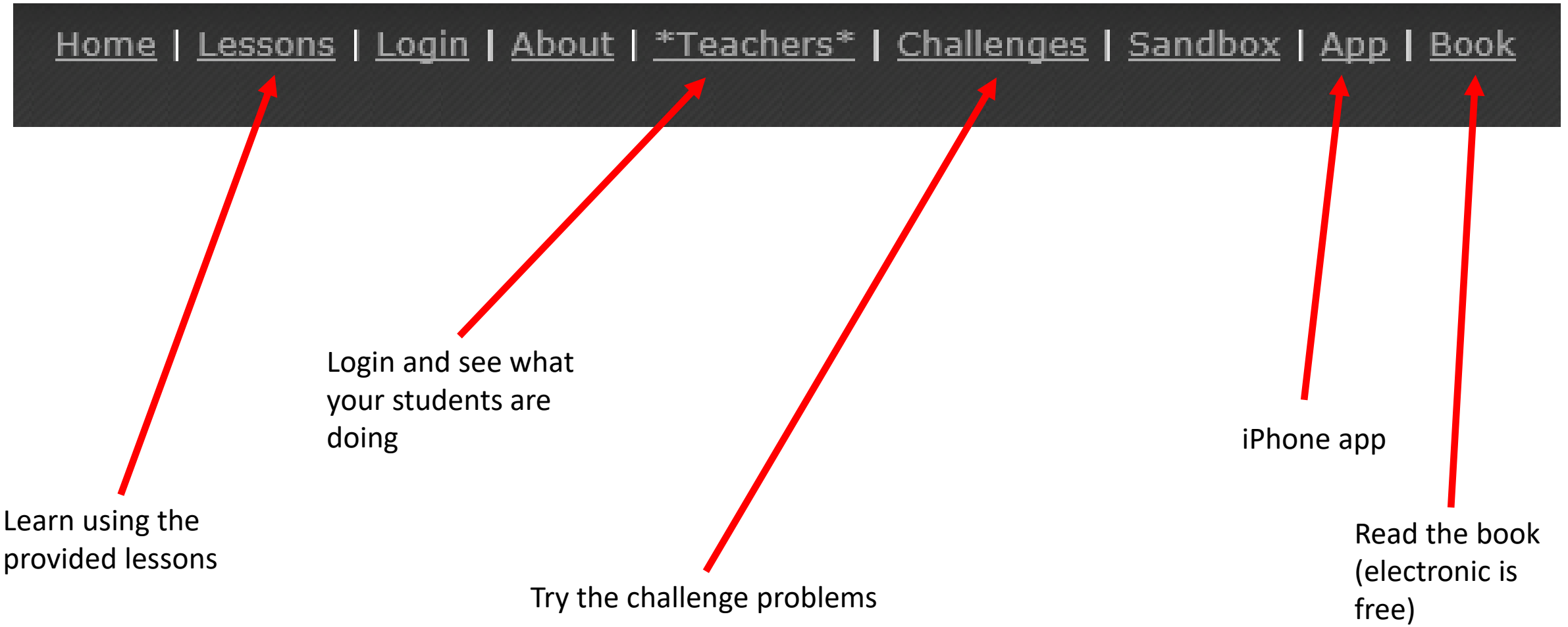


- Scratch 2.0 is current version and available at https://scratch.mit.edu
- Scratch 2.0 runs on Adobe Flash
- iPad does not run Flash … so Scratch 2.0 will not work, however, there is an app for the iPad called Pyonkee that runs Scratch 1.4 … https://en.scratch-wiki.info/wiki/Pyonkee
- Scratch 3.0 is in beta currently and scheduled to be available around January 2019. Uses HTML5 and other technologies that will run on multiple computers/devices and browsers without the need for Flash. See below.
- Some tips when using with your students …
  - Login in order to save what you are creating and continue working on it later and also share it with others.
  - Color matters … types of blocks are organized by color. Easy for students to find the block when looking at examples
  - Lots of examples to see how others use Scratch

You can also try out the Scratch 3.0 beta to see how it is progressing …

https://beta.scratch.mit.edu/

Shout-out: code_by_math



Shout-out: Python add-in Packages

Some (not comprehensive list) popular packages …

https://pypi.org/

Note: packages below part of … https://www.scipy.org with funding from https://numfocus.org/ (and also other projects)

http://www.numpy.org/

http://www.sympy.org

http://www.sagemath.org/

Python has a number of excellent add-in packages to provide more functionality. Most are free and used by experts in the scientific community.

… Activities …

<code_by_math> Website

Go to the <code_by_math> website (link at the bottom of the page) and go through the Lessons.

Keep a log of the lessons completed and when completed.

Go to the <code_by_math> website (link at the bottom of the page) and work through each of the Challenges

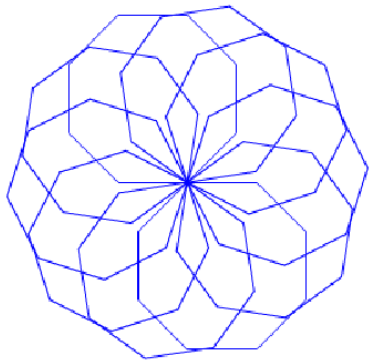
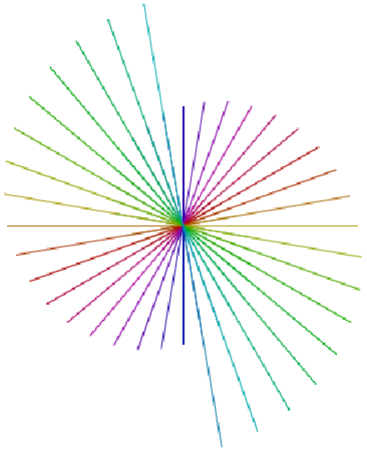
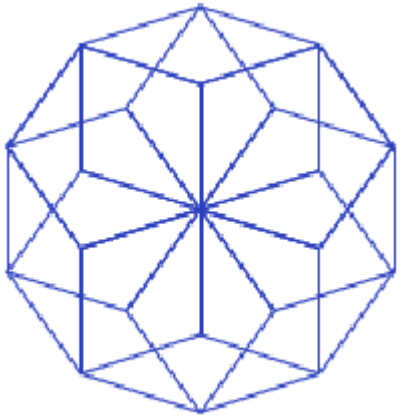
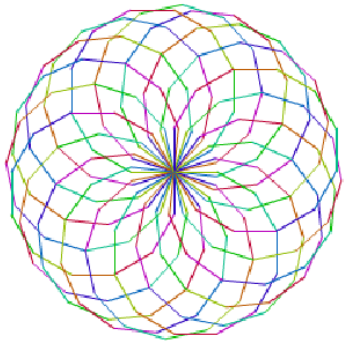
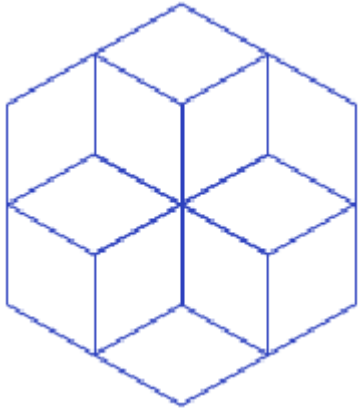
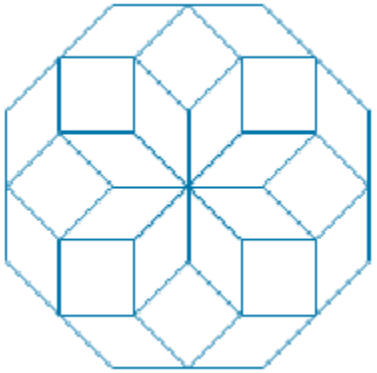
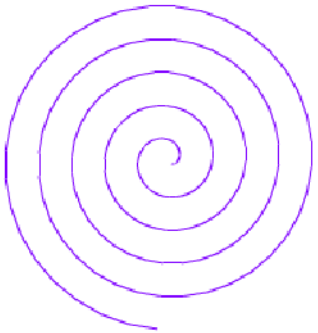
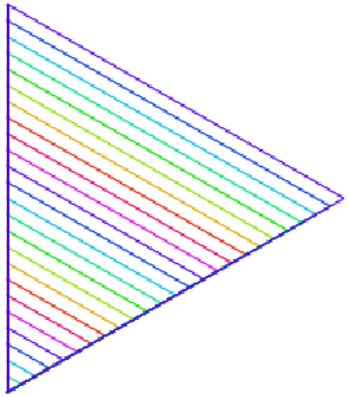
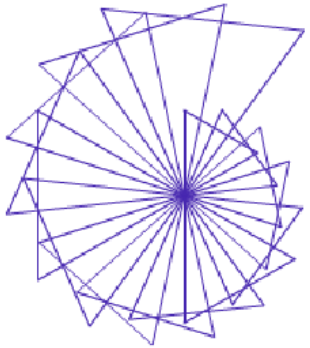
Keep a log of the Challenges completed and when completed.

Can try the Challenge in a different language if desired.

<code_by_math/>
Learn code. Learn math.

http://www.codebymath.com/

Geometric Patterns

See Presentation Notes Item … Geometric Drawing, Shapes, and Patterns (Scratch)

Animation

Animation uses mathematics and is an excellent way to teach, illustrate, and practice several mathematical concepts. Some resources …

Presentation Notes – See the topic "Animation (Scratch) for some simple animation activities in Scratch to explore the coordinate system, transformations, and general math.

<code_by_math> Lessons then the "Code to make an animated-GIF" section. Go through the lessons/examples then create your own animated-GIF. Note the animated-GIFs are below the code.

Google's CS First Curriculum --- Animate a Name --- videos on animation in Scratch
https://csfirst.withgoogle.com/c/cs-first/en/animate-a-name/overview.html

Games/Puzzles

Students write code to solve puzzles and play mathematically sound games. The students need to understand the puzzle/game well enough to figure out a solution/strategy/algorithm, then put that into code.

Game of 45

Pick a number between 1 and 7 which is added to the running total. The first player to 45 wins the game.

Player 1: Start with the number 3
Player 2: 6 + 3 is 9
…
Player 1: 2 + 26 is 28
Player 2: 6 + 28 is 34
Player 1: 5 + 34 is 39
Player 2: 6 + 39 is 45
Player 2 wins

Common Puzzles/Games

Sudoku
Tic-Tac-Toe
Word Find
Cryptoquote

U.S. Measurement Converter

MEASUREMENT AND DATA **5.MD**

Convert like measurement units within a given measurement system.

5.MD.1 Know relative sizes of these U.S. customary measurement units: pounds, ounces, miles, yards, feet, inches, gallons, quarts, pints, cups, fluid ounces, hours, minutes, and seconds. Convert between pounds and ounces; miles and feet; yards, feet, and inches; gallons, quarts, pints, cups, and fluid ounces; hours, minutes, and seconds in solving multi-step, real-world problems.

Worksheet reference below provides an illustration of how that might be done with students based on liquids. Adjust and assign a similar activity to students using distance and time. Provide additional challenge problems for those students capable of doing such problems.

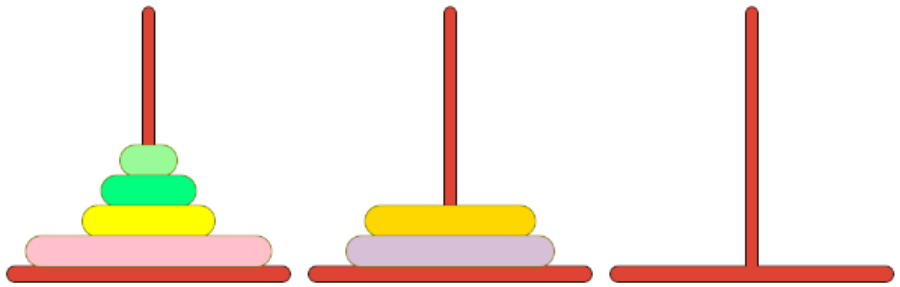
See Worksheets topic … Convert Between U.S. Measurements (liquids)

Recursion

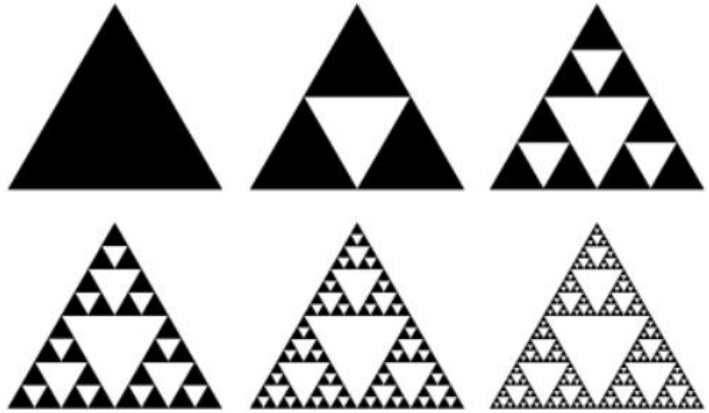
The Functions section of the Math Standards make several references to recursive and recursively defined functions. What is recursion and how does it work?

Some common uses of recursion …

0, 1, 1, 2, 3, 5, 8, 13, 21, 34 …
$f(n + 1) = f(n) + f(n -1)$ for $n >= 1$
Fibonacci Sequence



Tower of Hanoi puzzle

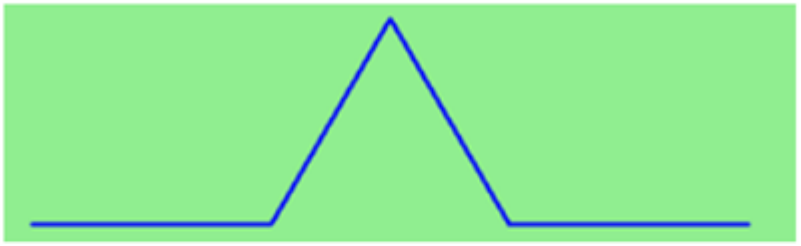


Fractals (example above is Sierpinski Triangle)

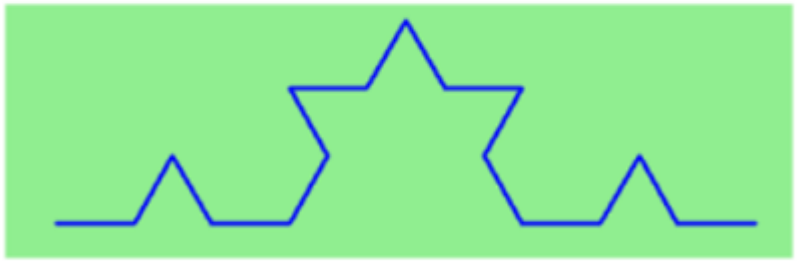
Recursion - Fractals

order 0 Koch fractal

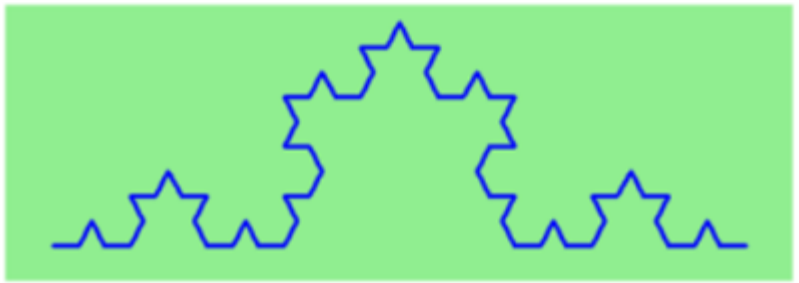
order 1 Koch fractal

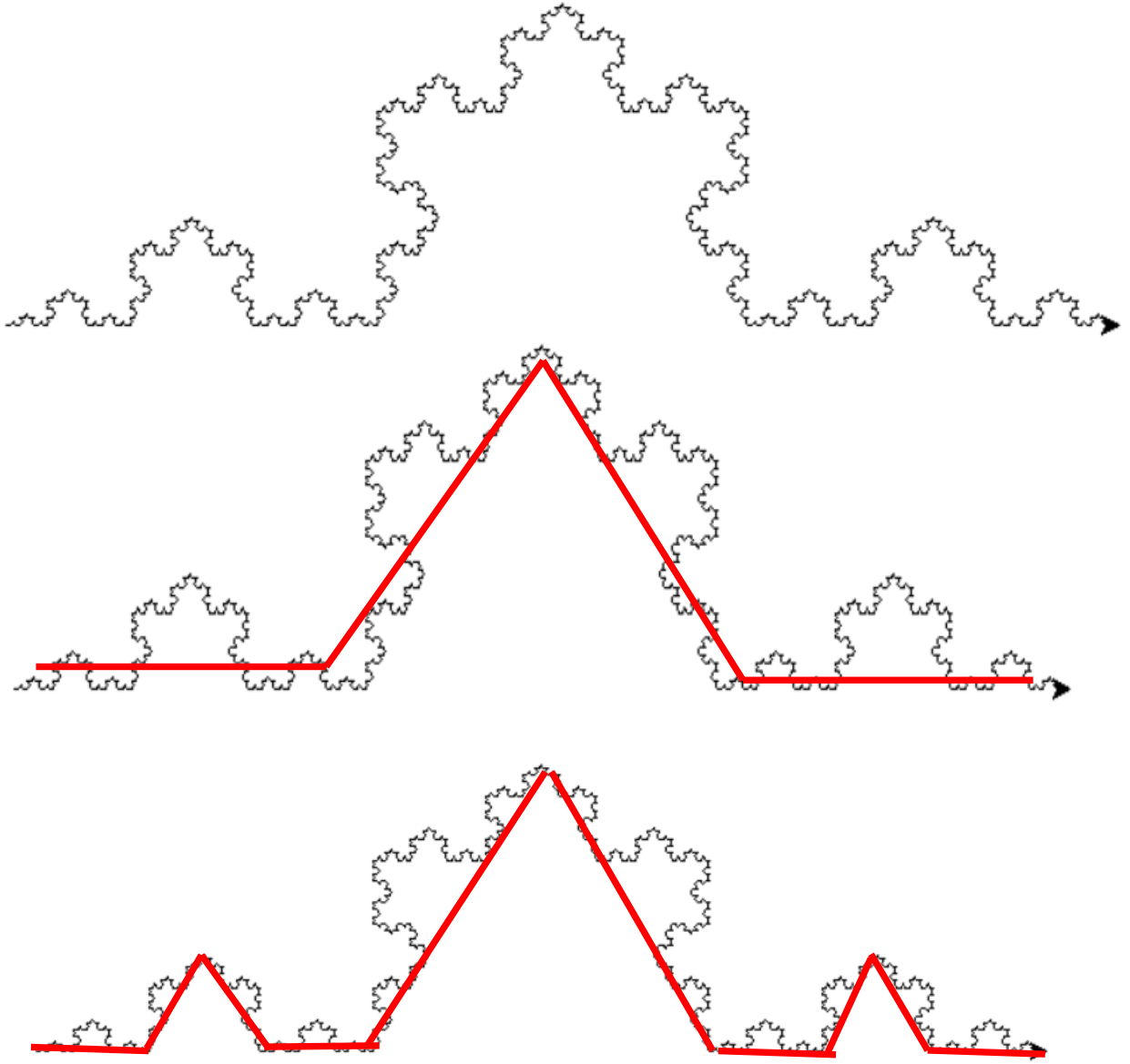


order 2 Koch fractal:



order 3 Koch fractal:





See the pattern?

http://openbookproject.net/thinkcs/python/english3e/recursion.html

Structure of rectangular arrays

Grade 3

In Grade 3, instructional time should focus on five critical areas:

Critical Area 3: Developing understanding of the structure of rectangular arrays and of area

Students recognize area as an attribute of two-dimensional regions. They measure the area of a shape by finding the total number of same-size units of area required to cover the shape without gaps or overlaps, a square with sides of unit length being the standard unit for measuring area. Students understand that rectangular arrays can be decomposed into identical rows or into identical columns. By decomposing rectangles into rectangular arrays of squares, students connect area to multiplication, and justify using multiplication to determine the area of a rectangle.

Students write code to draw unit squares to represent a rectangle that is 6 units across and 7 units down. The code should include a variable that counts each unit square that is drawn. The student then adjusts the code for a 7 across 6 down rectangle. Each student then is given their own problem to solve (x by y units).

Solving multi-step problems

Grade 3

In Grade 3, instructional time should focus on five critical areas:

Critical Area 5: Solving multi-step problems

Students apply previous understanding of addition and subtraction strategies and algorithms to solve multi-step problems. They reason abstractly and quantitatively by modeling problem situations with equations or graphs, assessing their processes and results, and justifying their answers through mental computation and estimation strategies. Students incorporate multiplication and division within 100 to solve multi-step problems with the four operations.

Working in pairs, each pair of students is assigned a word problem recently discussed in the curriculum. The students write code to accurately solve the problem. They then are given different values to incorporate into the problem and verify that their code still produces the correct results. When applicable, the students graph the values use in and results from solving the problem.

Unit Rate

6.RP.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams[G], double number line diagrams[G], or equations.

- **a.** Make tables of equivalent ratios relating quantities with whole number measurements; find missing values in the tables; and plot the pairs of values on the coordinate plane. Use tables to compare ratios.
- **b.** Solve unit rate problems including those involving unit pricing and constant speed. *For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?*
- **c.** Find a percent of a quantity as a rate per 100, e.g., 30% of a quantity means $^{30}/_{100}$ times the quantity; solve problems involving finding the whole, given a part and the percent.
- **d.** Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

7 hours for 6 small lawns
7 hours for 4 medium lawns
16 hours for 5 large lawns

Code a table showing how many of each size lawns can be mowed in a 32 hour through 40 hour work week.

If get $10 for small yard, $20 for medium size yard, and $30 for large lawn, which type of lawn is most profitable.

Show calculations in a table.

Python - CAS

CAS = Computer Algebra System

Research what CAS is, how used, and who uses it. Find some less complex examples of using CAS and try it out. Find one or more problems where CAS can be useful and code a solution to that problem. Explore the NCTM CAS tool, some of the CAS articles on the NCTM site, and other sources for information on CAS.

NCTM

Core Math Tools -> General Purpose Tools -> CAS

https://www.nctm.org/coremathtools/

http://www.sympy.org

http://www.sagemath.org/

Machine Learning

Student research:

- What is machine learning?
- What role does math play in machine learning?
- How is machine learning used today?

Student Exploration:

- Find a simple example of a machine learning program to get running and better understand machine learning.
- Create your own (simple) machine learning program.

Q&A … Moving Forward

What questions/comments do you have?

How can I or this group help you do at least one more coding activity with your students this year?

Attending conferences and sessions can be fun. How does this session (and others you attended) going to positively impact your students?

What can I (or the group) help you with to move forward with coding in the mathematics classroom?