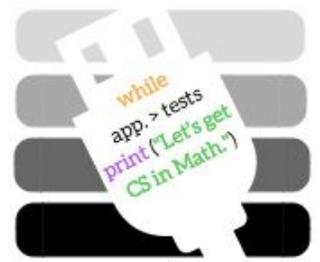# Playful Polygons - #CSandMath

@dandersod

Lesson Credit:
This lesson was first presented by Dan Anderson ([@dandersod](#)) at the 2016 NCTM Annual in his session titled [Geometry from Scratch](#)

Project Goal:
Students will use their knowledge of interior and exterior polygon angles to draw various regular shapes. They will then extend that understanding to the generalizations of equations for those angles, and explore some artistic applications.

Standards:
6.3.2.3 Develop and use formulas for the sums of the interior angles of polygons by decomposing them into triangles.

9.3.3.7 Use properties of polygons-including quadrilaterals and regular polygons-to define them, classify them, solve problems and logically justify results.

[Student Handout](#) Linked Here

Teacher Guide:
Challenge 1: Resist the urge to just model how to make a square as an opening example. Give them basics like how to link blocks, pixel distance understanding, etc...but don't cheat them out of the original aha moment! Instead encourage collaboration with peers and celebrate their struggles and eventual successes :) After students have had a chance to play with the square and triangle, pull them back together and go over the code variations on the next page and have a conversation about efficiency and draw up the regular triangle on the board to talk about turning the exterior angle.

For the rest of the challenges, it's probably in your best interest to try all of them first hand before your students. Give yourself permission to feel good about your own struggles without first looking at the solutions.

#CSandMath

@BoundsofoutMath & @ashleyanntewes
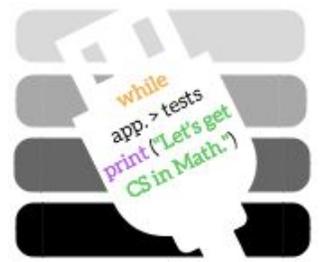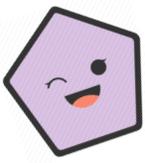
Possible square solutions:

Here are two common snips of code used by students to make their squares. Did you notice the pattern of moving the same length and turning 90 degrees? Do you see how the repeat loops can help to make the code more efficient? What about turning the exterior angle instead of the interior? Most students reported this as their biggest hang up for challenge 1!

```
when [flag] clicked
pen down
repeat 3
    move 100 steps
    turn ↺ 120 degrees
```
Exterior Angle :)

```
when [flag] clicked
clear
pen down
move 100 steps
turn ↺ 90 degrees
move 100 steps
turn ↺ 90 degrees
move 100 steps
turn ↺ 90 degrees
move 100 steps
turn ↺ 90 degrees
pen up
```

```
when [flag] clicked
clear
pen down
repeat 4
    move 100 steps
    turn ↺ 90 degrees
pen up
```

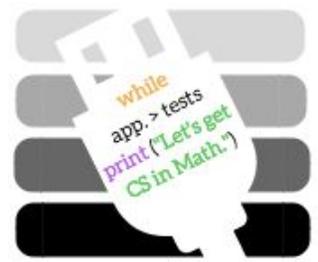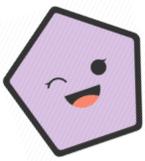## Possible Solutions to Challenge 1: Polygons

Triangle

```
when [flag] clicked
clear
pen down
repeat 5
    move 100 steps
    turn ↺ 72 degrees
```

Pentagon

```
when [flag] clicked
clear
pen down
repeat 3
    move 100 steps
    turn ↺ 120 degrees
```

Hexagon

```
when [flag] clicked
clear
pen down
repeat 6
    move 100 steps
    turn ↺ 60 degrees
```

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while app. > tests print ("Let's get CS in Math.")

Challenge 2: N-Gon Maker

Note that students could have taken 180 - ((n-2)*180 for the turn formula. Although not quite as efficient, this is strong student thinking that should receive validation :)

```
when [flag] clicked
ask [How many sides?] and wait
set [n] to (answer)
repeat (n)
    move (75) steps
    turn ↺ (360 / n) degrees
```

Challenge 3: Cascading Convex

```
when [flag] clicked
Initialize
ask [How many sides to start?] and wait
set [n] to (answer)
pen down
repeat until < (n) = (12) >
    repeat (n)
        move (75) steps
        turn ↺ (360 / n) degrees
    change [n] by (1)
    set pen color to (pick random (500) to (1000))
```

Challenge 3: Example artistic release classic concaved polygon

```
when [flag] clicked
ask [length?] and wait
set [n] to (answer)
pen down
set pen color to [ ]
set pen size to (4)
move (n) steps
repeat (4)
    turn ↻ (45) degrees
    move (n) steps
    turn ↺ (90) degrees
    move (n) steps
    turn ↻ (45) degrees
    move (n) steps
    turn ↻ (90) degrees
    move (n) steps
```

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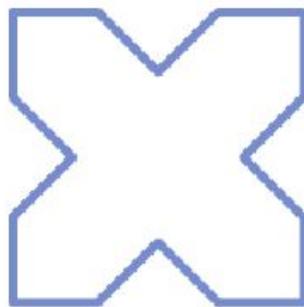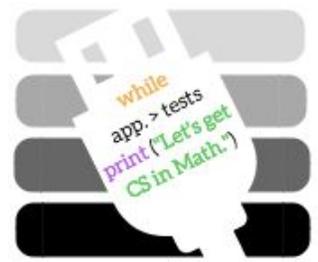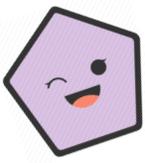
Challenge 4: Polygon Illusion (Possible Solution)

```
when [flag] clicked
clear
pen up
point in direction (90 ▼)
glide (1) secs to x: (0) y: (-5)
ask [How many sides? (3-8 for best look)] and wait
set [n ▼] to (answer)
ask [side length? (Start small...like 0-20)] and wait
set [d ▼] to (answer)
set [a ▼] to ((360) / (n))
set pen color to [ ]
set pen size to (2)
repeat until <(y position) > [170]>
    pen down
    move (d) steps
    turn ↻ (a) degrees
    set [d ▼] to ((d) + (1))
    turn ↻ (2) degrees
    change pen color by (4)
```