Coding and STEM Elementary Schools

While we are waiting . . .
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Changing Math Instruction with STEM Integration

Facts on Computer Science

There are currently 523 222 open Computer Science-related jobs that are unfilled

71% of all new jobs in STEM are computer related yet only 8% of STEM graduates have Computer Science qualifications

A Computer Science major earns 40% more than the college graduate

In elementary, only 10% of classrooms incorporate STEM

Only ⅕ of students studying computer sciences are female

Information from code.org

Computing jobs are in every industry across the country and will grow at twice the rate of other jobs

“Traditional” Math Instructional

Textbook driven

Instruction was compartmentalized into units

“Monkey see, monkey do” style math examples

Unrelated mathematical terms

Little to no importance placed on collaboration

Emphasis on single, correct answer

Point A to Point B thinking

How effective is traditional math instruction?

Making Students “Doers” of Math

For effective math instruction, students need to:

- Understand mathematical processes
- Dialogue about math in real life situations
- Apply classroom mathematics to their everyday lives
- Represent and model mathematical thinking
- Value incorrect responses at the same value as correct responses
- Multiple methods to arrive at a response

Computational Thinking

Computational Thinking

- Decomposing larger problems into smaller portions that need solving

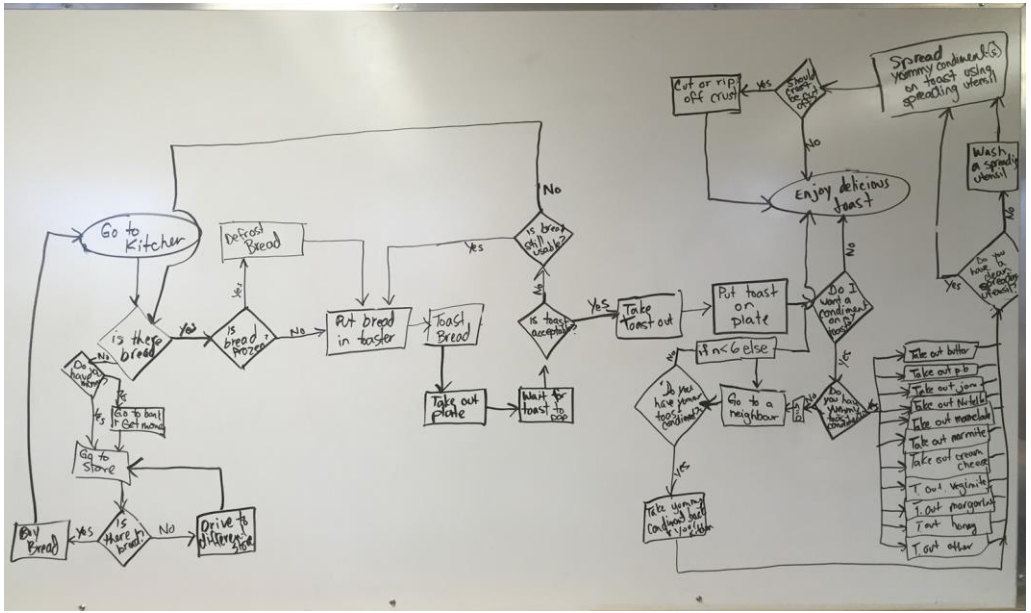
CodeSpeak

To understand code, students need to understand the circumstances..

Term	Definition	Example
Conditional	Code that runs only when specific conditions are met	“If it rains, I will bring my umbrella.”
Function	A named set of commands that can be run whenever needed.	“When mom tells me to set the table, I know that involves counting plates, getting napkins . . .”

Algorithmic Thinking

- Providing students with a simple task and having them write the algorithm to see it through, is a great way to introduce CodeSpeak
- Easily connects to literacy programming (procedural writing)

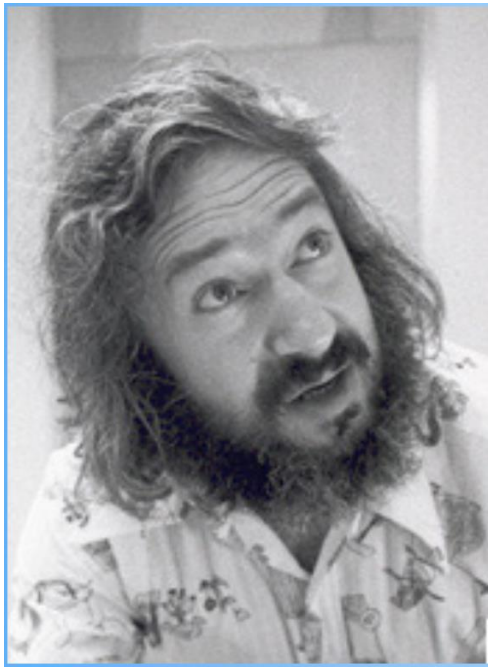



NO
NO

How to Start Teaching Code

Fact: Ethan Elliott, programmer for 2056,
learned to code starting in Grade 4
AT HOME!

History of CS in Schools



Seymour Papert

Teaching Code - Dos and Don’ts

- Do - Start with small goals
- Do - Focus on a few offerings - Scratch
- Do - Find connections with math
- Do - Seek help so that you don’t give up

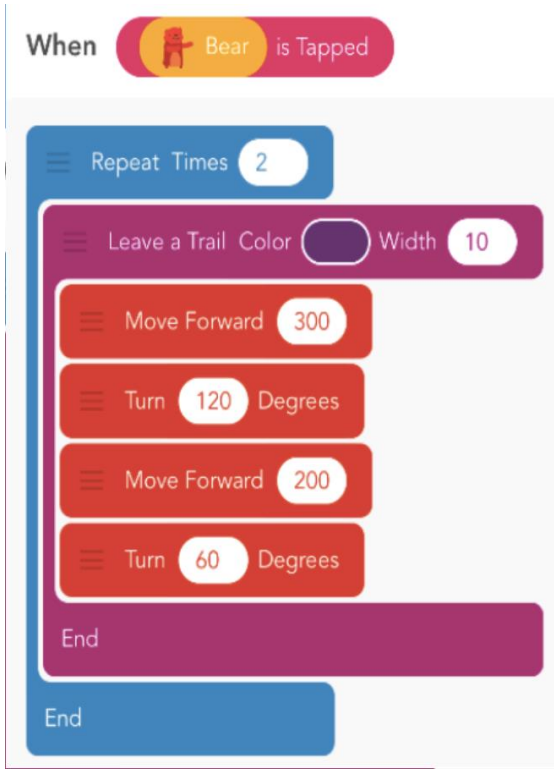
- Don’t - Use Hour of Code with no follow up
- Don’t - Assume Coding is only for “smart” kids
- Don’t - Rely on tools such as Khan Academy that focus on programming language

Coding Shapes

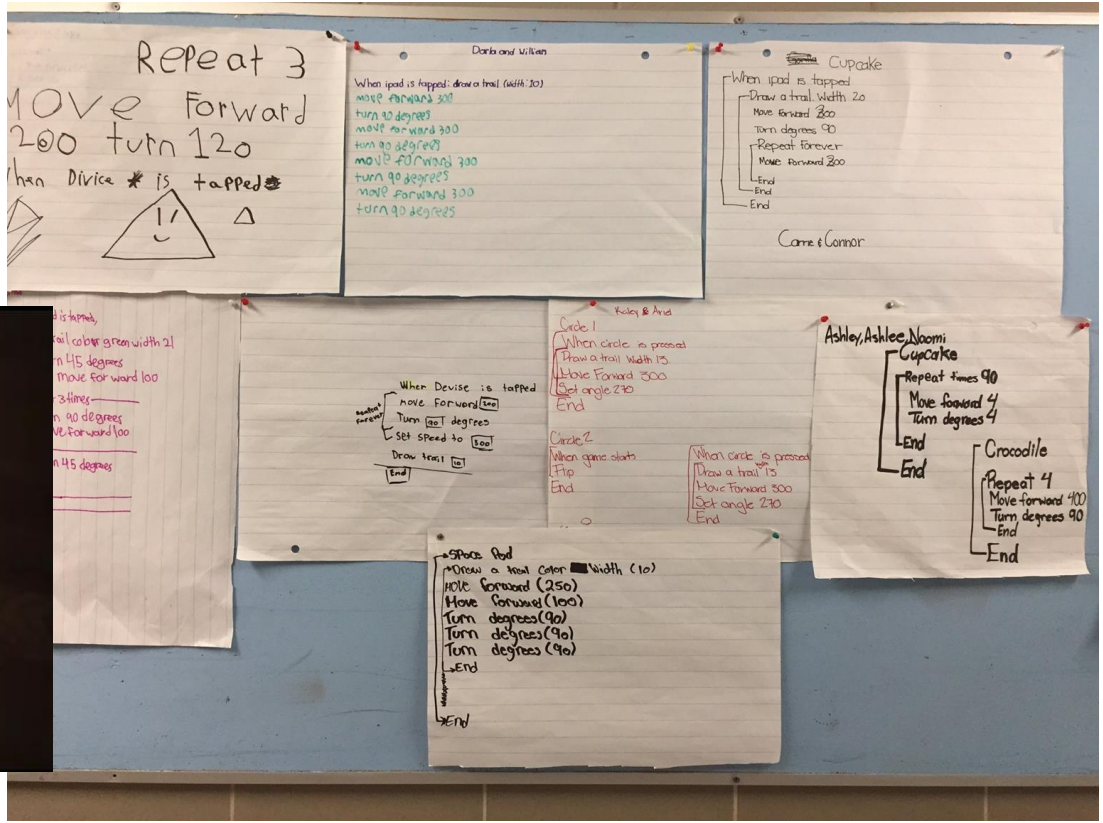
Try to Code a Square or Diamond

scratch.mit.edu

Coding Shapes

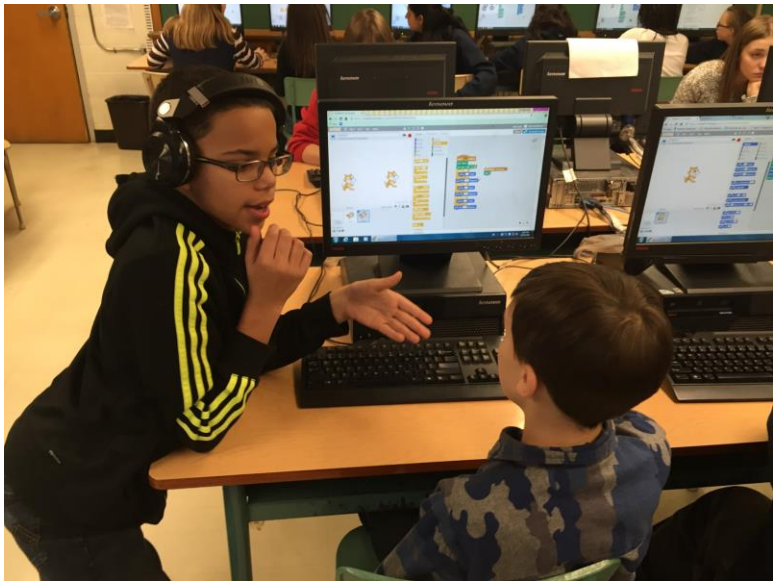


Coding Shapes



Coding Shapes

- Provides students opportunities to explore the geometric properties of shapes
- Great application for geometric concepts - i.e. enlargements & reductions; congruence & similar; etc.
- Students are more willing to naturally collaborate and ask for help from each other when writing code
- Excellent opportunity to co-learn along with your students!



Coding Challenges

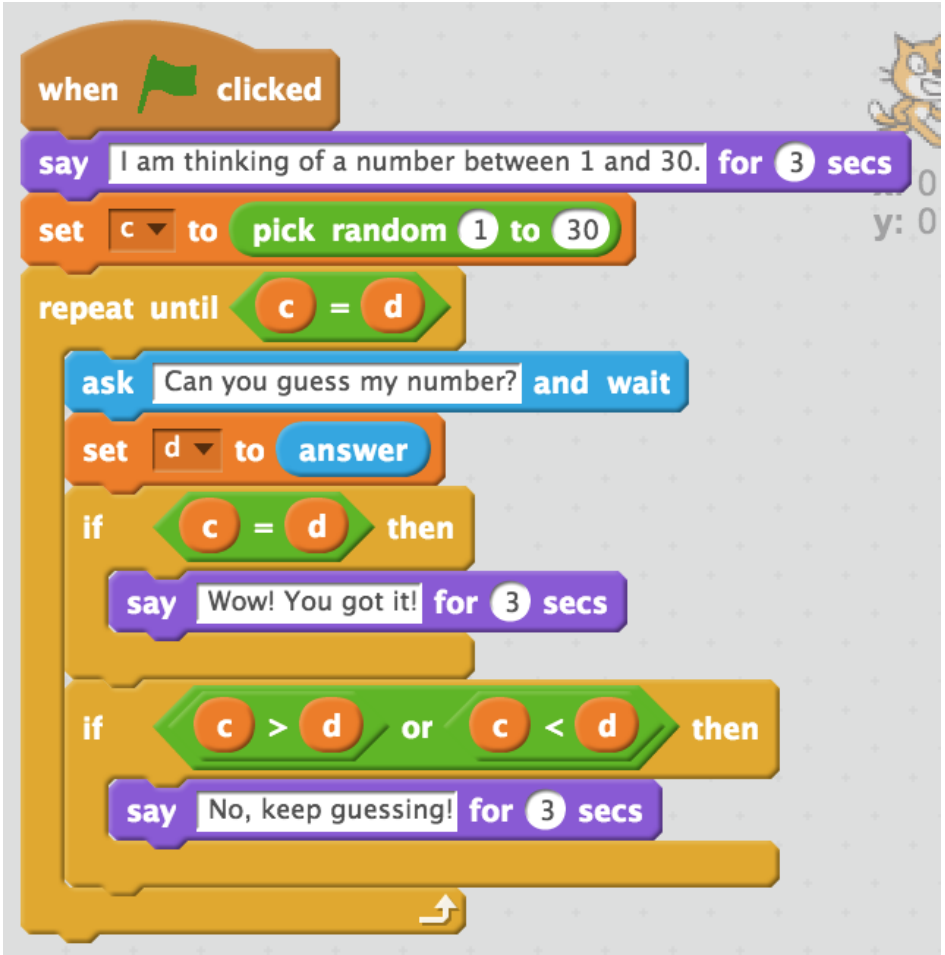
Create a program . . .

- Indicates whether a number is even or odd
- That converts metric conversion
- Create a number guessing program
- That drills multiplication facts

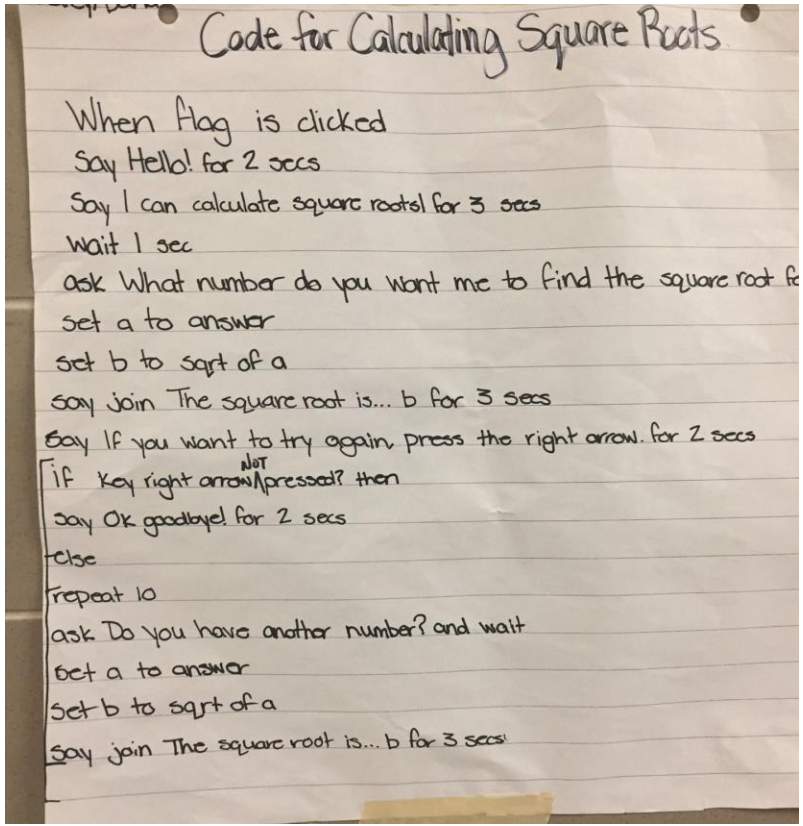
Coding Challenges

Where is the math in this program?

Where is the CT?

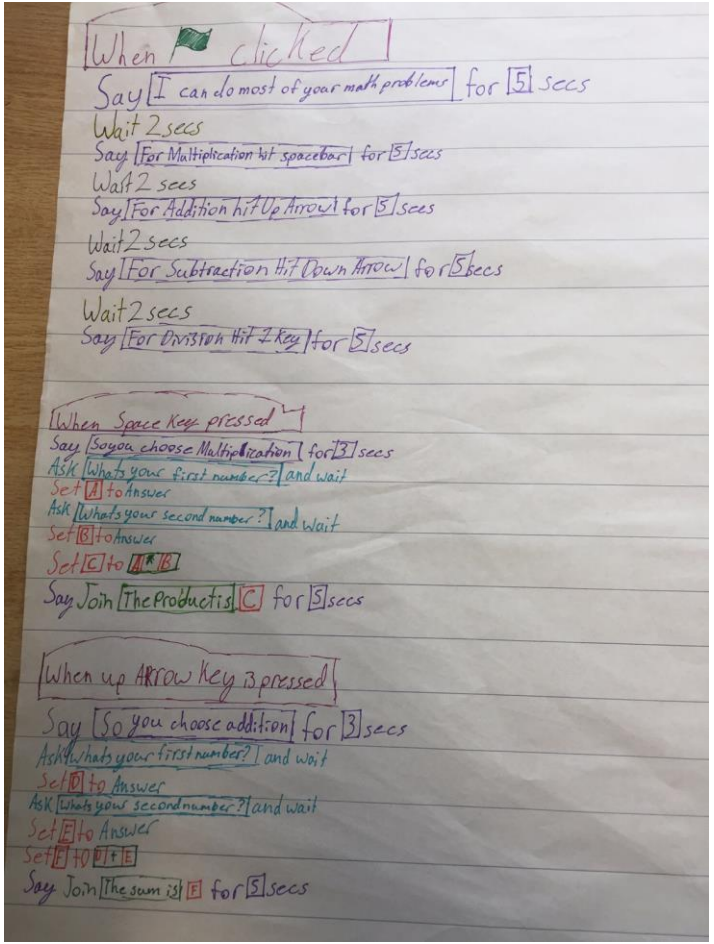


Coding - Student Work



Code for Calculating Square Roots

When flag is clicked
Say Hello! for 2 secs
Say I can calculate square roots! for 3 secs
wait 1 sec
ask What number do you want me to find the square root fo
set a to answer
set b to sqrt of a
say join The square root is... b for 3 secs
Say If you want to try again, press the right arrow. for 2 secs
if key right arrow NOT pressed? then
say Ok goodbye! for 2 secs
else
repeat 10
ask Do you have another number? and wait
set a to answer
set b to sqrt of a
say join The square root is... b for 3 secs

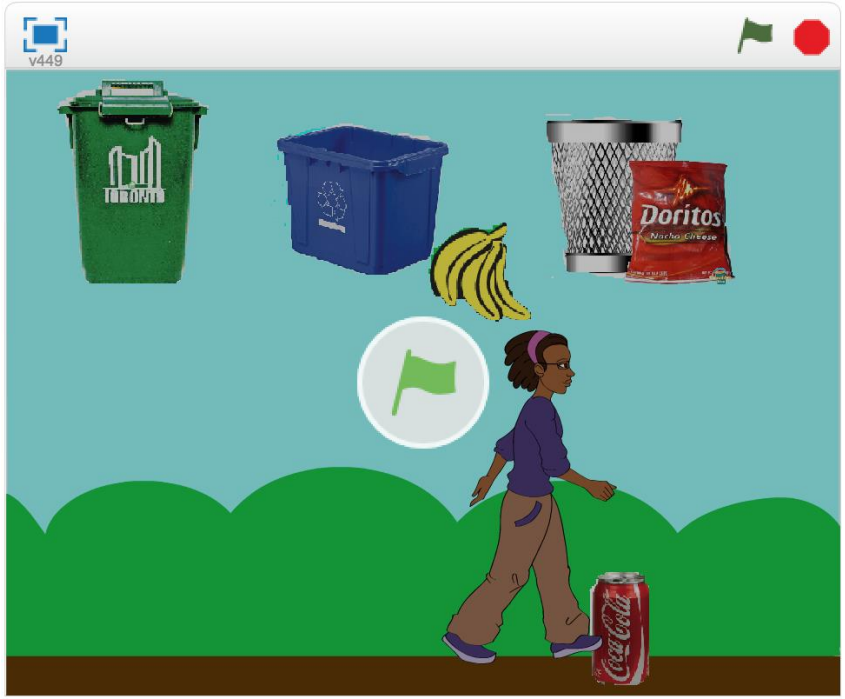


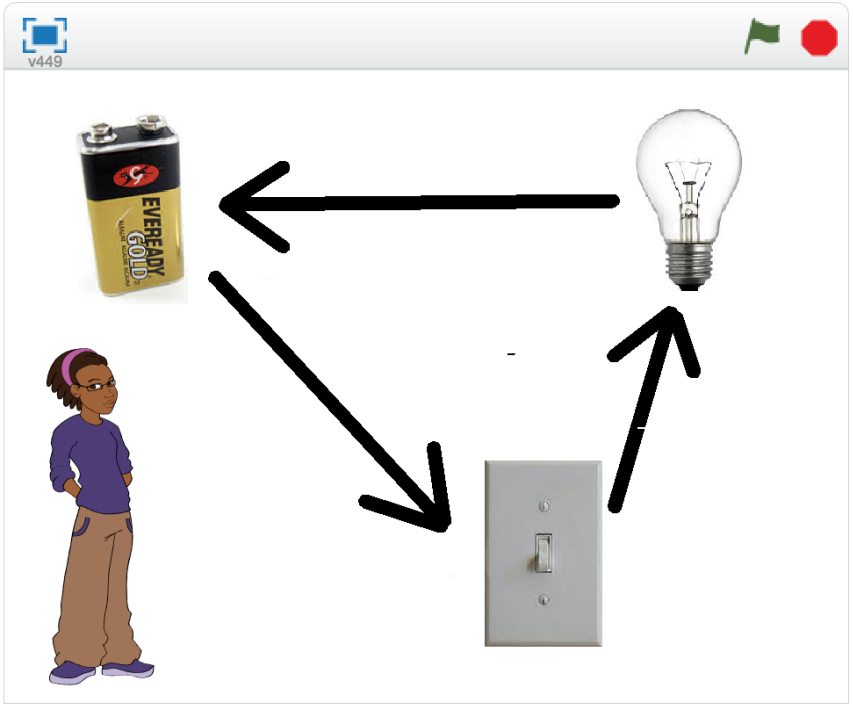
When flag clicked
Say I can do most of your math problems for 5 secs
Wait 2 secs
Say For Multiplication hit spacebar for 5 secs
Wait 2 secs
Say For Addition hit Up Arrow for 5 secs
Wait 2 secs
Say For Subtraction Hit Down Arrow for 5 secs
Wait 2 secs
Say For Division Hit Z Key for 5 secs

When Space Key pressed
Say So you choose Multiplication for 3 secs
Ask What's your first number? and wait
Set A to Answer
Ask What's your second number? and wait
Set B to Answer
Set C to A * B
Say Join The product is C for 5 secs

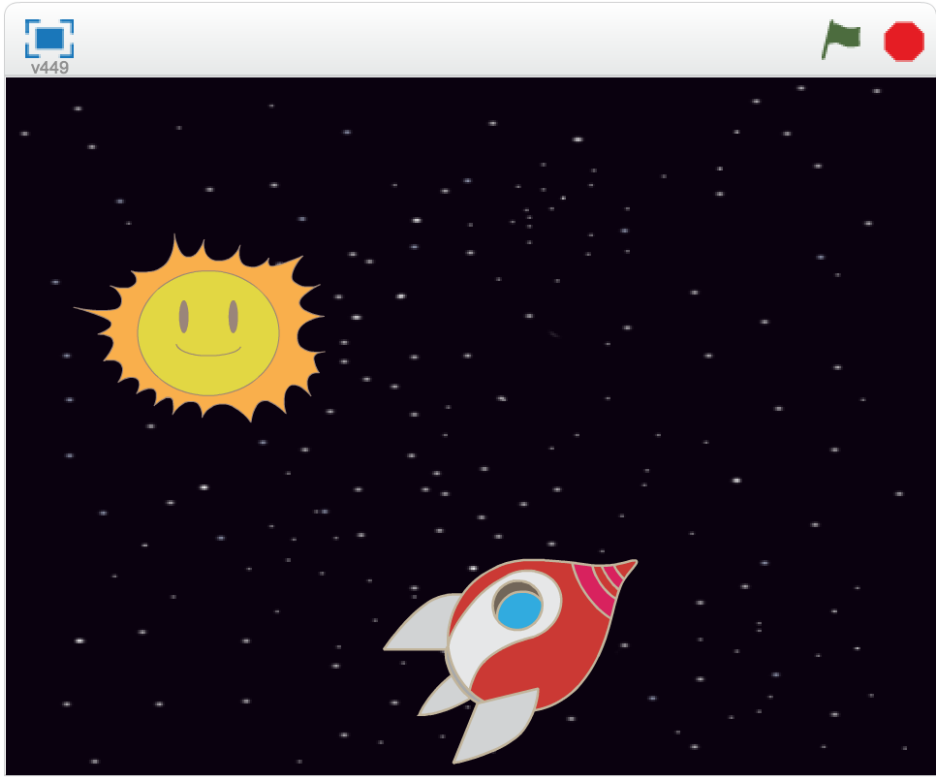
When up Arrow Key is pressed
Say So you choose addition for 3 secs
Ask What's your first number? and wait
Set D to Answer
Ask What's your second number? and wait
Set E to Answer
Set F to D + E
Say Join The sum is F for 5 secs

Coding - Student Work in Other Areas





Coding - One Last Sample . . .

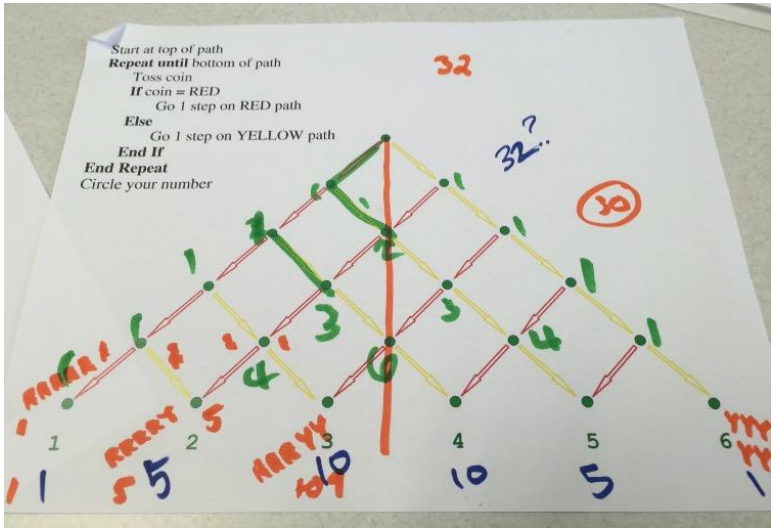


Finding the Math

A great teaching opportunity, when teaching through CS, is to have students find the math in what they are doing. They are always amazed at what they are able to identify. Find opportunities in math activities to integrate code!

Coding - Instructions as Extensions

Start at the top of path
Repeat until bottom of path
Toss coin
If coin = RED
Go 1 step on RED path
Else
Go 1 step on YELLOW path
End if
End Repeat
Circle your number



Courtesy of Prof George Gadanidis

Circuits: It Should Be Taught Every Year!

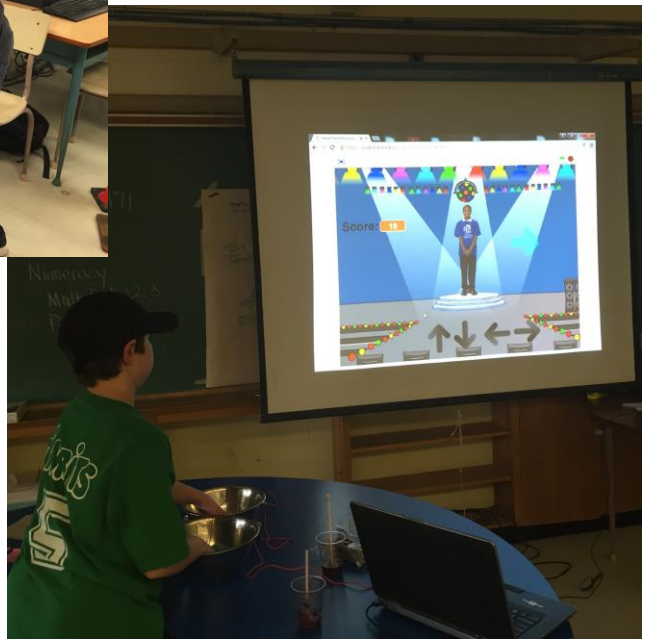
Circuits - Teaching Points

- Current electricity concerns the travel of electrical charge
- Conductors, such as electrical power, allow charge to travel easily
- In a circuit, we can identify the power unit, conductor and the load
- Objects require a continuous current to work (not a static charge)
- Circuits may have a breaker

Circuits - Snap Circuits

Circuits - Makey Makey

- Great tool for students to explore circuits
- Allows to explore and discover materials capable of carrying an electric current
- Fantastic extension of Scratch-coded games

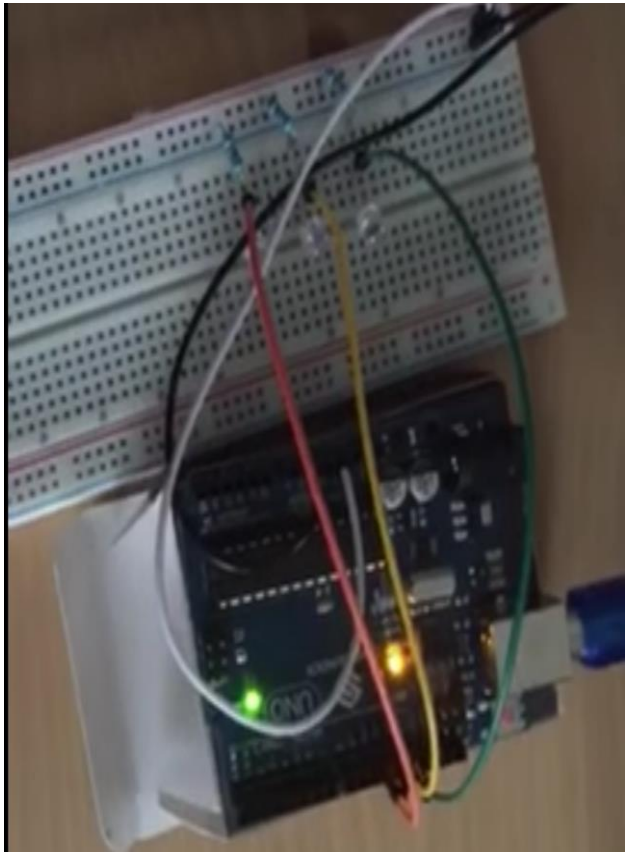


Arduino Uno

Controlling_LED_by_Button | Arduino 1.6.7

Controlling_LED_by_Button

```
const int ledPin = 13;//the number of the led pin
/**********************************/
void setup()
{
  pinMode(keyPin,INPUT);//initialize the key pin as input
  pinMode(ledPin,OUTPUT);//initialize the led pin as output
}
/**********************************/
void loop()
{
  //read the state of the key value
  //and check if the kye is pressed
  //if it is,the state is HIGH
  if(digitalRead(keyPin) ==HIGH )
  {
    digitalWrite(ledPin,HIGH);//turn on the led
  }
  else
  {
    digitalWrite(ledPin,LOW);//turn off the led
  }
}
/**********************************/
```



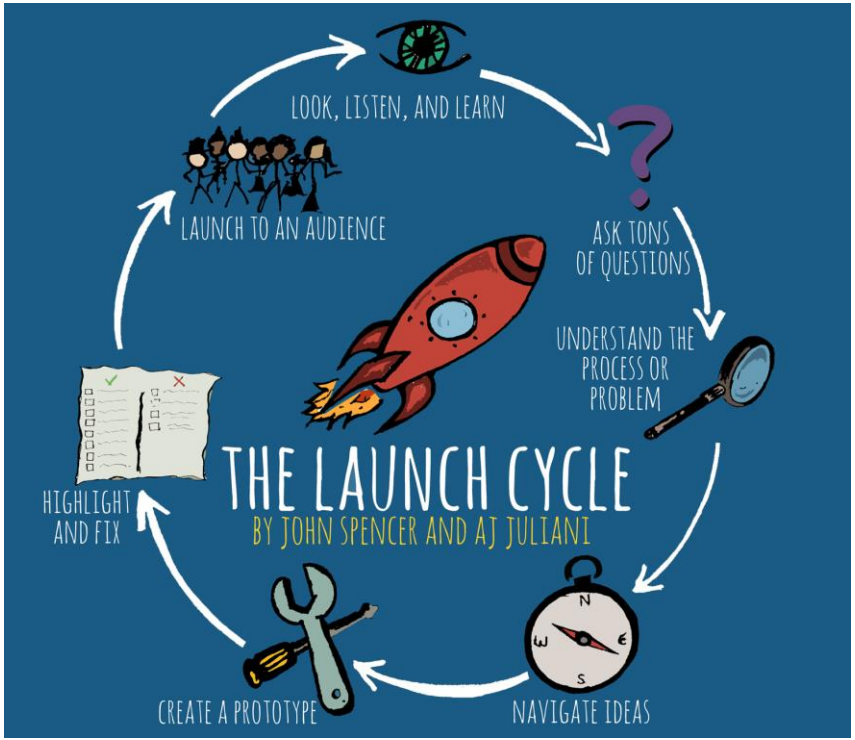
Design Thinking - Unleashing Creativity

Design Thinking

David Kelley

- Founder and Chairman of IDEO
- Professor at Stanford University
- Advocate for Design Thinking in schools

Design Thinking



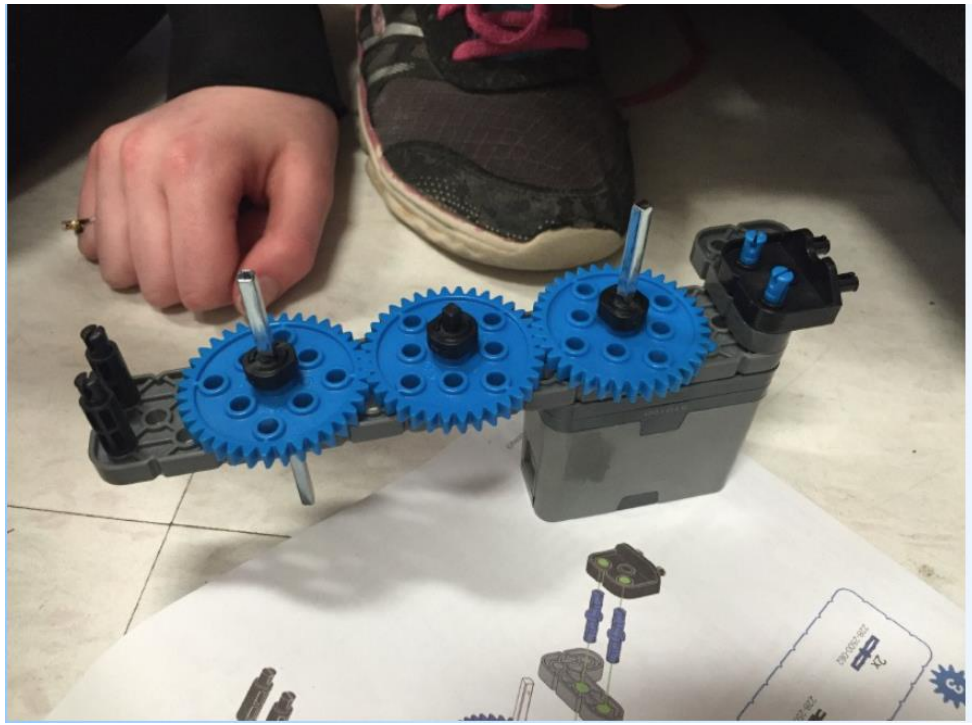
- Research and design a roller-coaster
- Research and design a trash sorter
- Paper Airplanes carrying a certain weight

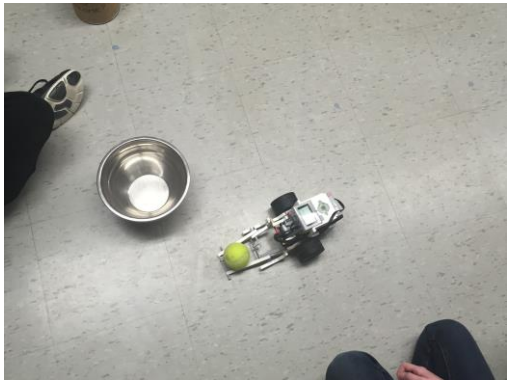
Robotics - Kids' Roadmap to 2056

Vex Robots - Building Phase

Thoughts:

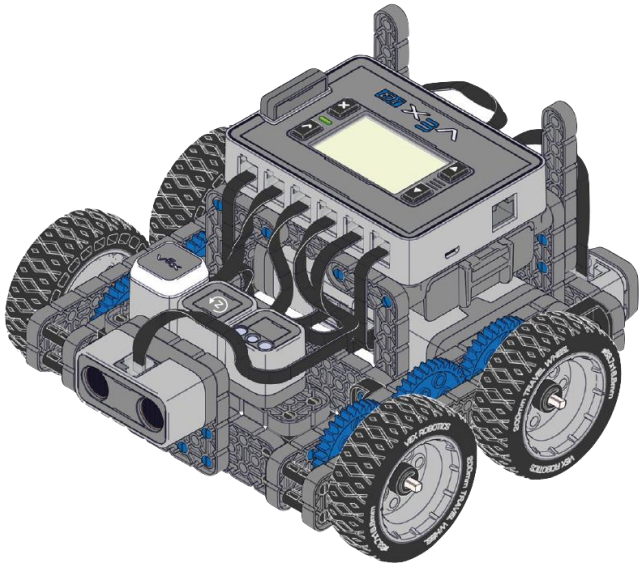
- How the gears work
- Back motors only
- Terminology
- Doing “wheelies”
- Comparison with circuits
- Weight distribution
- Friction

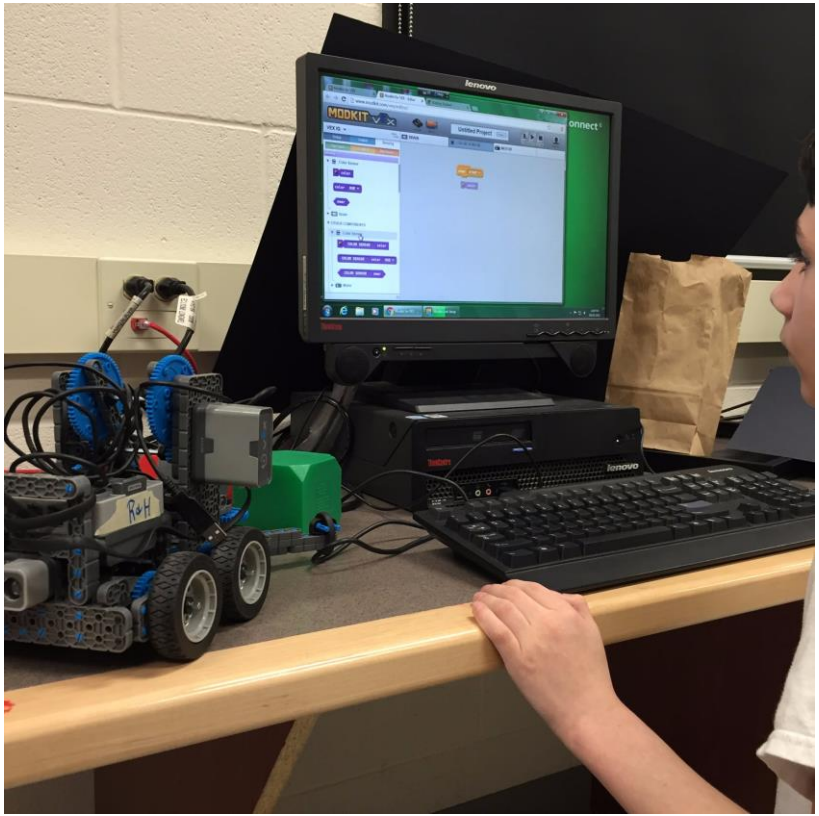




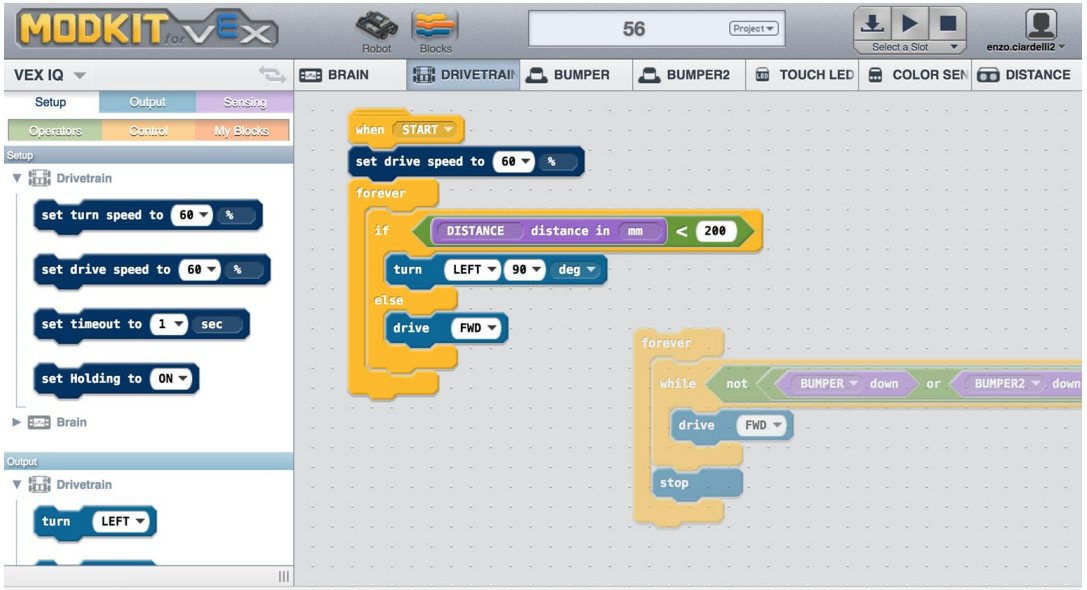
VEX challenges allow students to conceptualize and apply abstract mathematical and scientific principles without even realizing they are doing so!

Vex Robots - Programming Phase





Vex Robots - Programming Phase



The Vex Robot is Programmed so that it does not hit obstacles. Kids had to figure out how to program the distance censor. They decided that the robot will stop, and turn left.

They also programmed the LED light and the bumpers.

Vex Robots - Programming Phase

Student Voice

“I am really good at math. I finish my work quickly and sometimes my teacher just gave me more of the same work. Coding gave me the opportunity to challenge my knowledge of math.”

“I’m okay at math. I became better at developing basic codes. I also like seeing what other students developed. That gives me the chance to make my program better.”

“Coding and working with VEX robots helped me to see the math. Like, did you know that the degree of angles MATTER?!”

“Tech Walk”

Let’s play / explore:

Try building a circuit with Arduinos

Explore a Vex Robotics kit and the built model

Create with a Makey Makey

Take a Sphero for a spin