Using Scratch to teach Algorithmic Thinking at all Grade Levels

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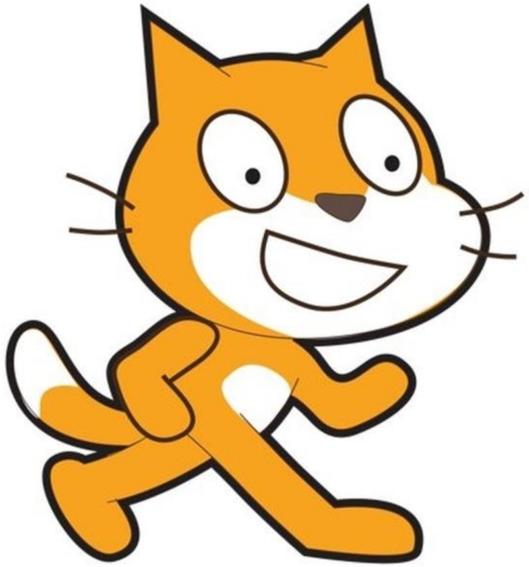
Introductions

Stephen King, PhD PMP is the Computer Science Education Program Consultant for the Kansas State Department of Education. With a doctorate in education and a masters in telecommunications management, he has over twenty years of experience leading and teaching IT and computer science to high school and college students.

What Will Our Takeaways Be Today?

- Algorithmic thinking at various grade levels
- Introduction to Scratch and block programming
- Ideas for classroom activities
- Best Practices
- Share ideas for learning activities using Scratch



Algorithmic Thinking

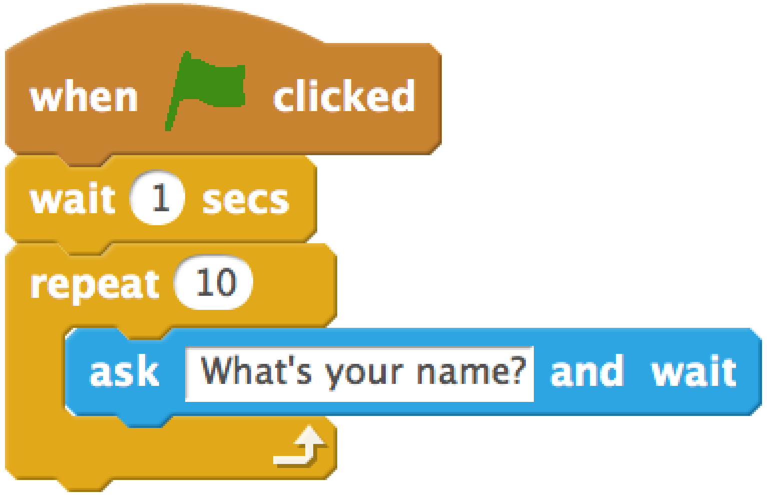
- "Algorithmic thinking is a derivative of computer science and coding. This approach **automates the problem-solving process** by creating a series of systematic logical steps that process a defined set of inputs and produce a defined set of outputs based on these." – Learning.com
- "Solving a problem in logical, repeatable, step-by-step manner." – IGI Global
- "Algorithm design is determining appropriate steps to take and organizing them into a series of instructions (a plan) for solving a problem or completing a task correctly." – ISTE.org
- "Computational thinking requires understanding the capabilities of computers, formulating problems to be addressed by a computer, and designing algorithms that a computer can execute." – K12cs.org

KS P-12 Model Computer Science Standards

- K.AP.A.01 Construct and execute algorithms (set of step-by-step instructions) that includes sequencing and simple loops to accomplish a task, both independently, collaboratively, with or without a computing device (e.g. verbally, kinesthetically, with robot devices or a programming language, block coding).
- 4.AP.A.01 Analyze and refine multiple algorithms for the same task.
- MG.AP.A.01 Design algorithms in natural language, flow and control diagrams, comments within code, and/or pseudocode to solve complex problems.
- L1.AP.A.01 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests.

Why Scratch?

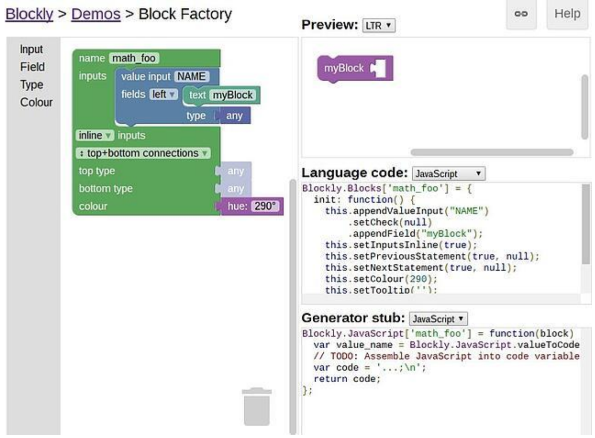
- Block programming
  - Rapidly assemble programs
  - Remove syntax errors
  - Simplify variables
  - Watch algorithms progress
  - Used elementary – university levels
- https://Scratch.MIT.edu
  - Good price: free!
  - Plenty of tutorials and examples
  - Keep application private or share with class or world
  - Downside: can’t readily view the associated code (JavaScript Object Notation: JSON)



```
when 🏁 clicked
wait 1 secs
repeat 10
    ask What's your name? and wait
```

Scratch vs. Others

- Scratch vs Blockly (MIT vs Google)
  - Both free, browser based, syntax free
  - Blockly blocks can be translated into JS, PHP, or Python
  - Scratch has larger user community
- Scratch vs Tynker
  - Tynker has Minecraft (et al.) integration
  - Tynker allows coding in Python, JS, HTML, CSS
  - Tynker free to a point, then requires subscription
- Scratch vs CodeCombat
  - CodeCombat includes Python and JS
  - CodeCombat has free games but subscription-based programming
- Others



Preview: LTR

Language code: JavaScript

```
Blockly.Blocks['math_foo'] = {
  init: function() {
    this.appendValueInput("NAME")
        .setCheck(null)
        .appendField("myBlock");
    this.setInputsInline(true);
    this.setPreviousStatement(true, null);
    this.setNextStatement(true, null);
    this.setColour(290);
    this.setTooltip('');
```

Generator stub: JavaScript

```
Blockly.JavaScript['math_foo'] = function(block)
  var value_name = Blockly.JavaScript.valueToCode
  // TODO: Assemble JavaScript into code variable
  var code = '...;\n';
  return code;
};
```

** KSDE does not promote specific vendors

Getting Started

- https://opensource.com/article/20/9/scratch
- Lingo
  - Sprite
  - Stage
  - Event Hat -> Code Block
  - Can (usually do) have >1 Code Block
  - Loops ("Control")

  - PLAY/EXPERIMENT! You can't break it.

Ideas for Classroom Activities

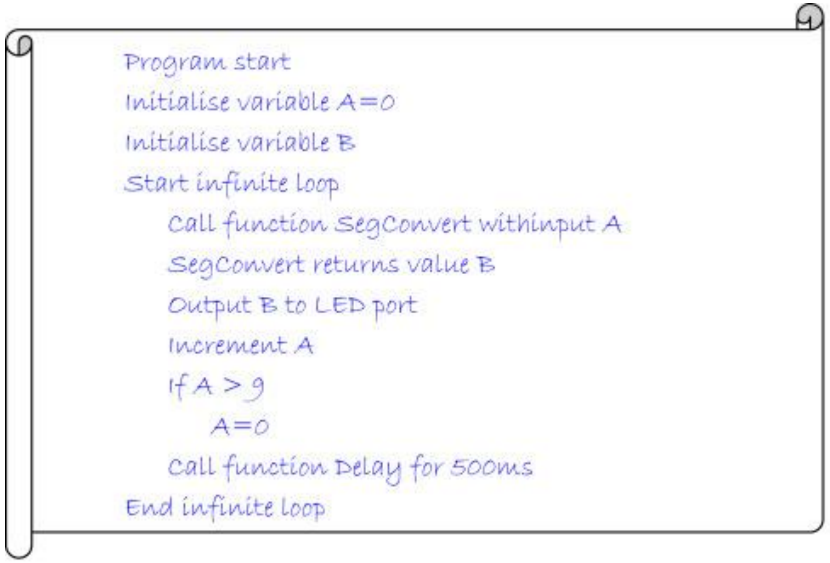
- https://scratch.mit.edu/starter-projects (starter projects)
- https://scratch.mit.edu/studios/245640/ (Top 100 Scratch Projects – currently only 98)
- https://scratch.mit.edu/studios/43961/ (Best Scratch projects of all time)
- https://cpb-us-e1.wpmucdn.com/blogs.uoregon.edu/dist/f/14720/files/2017/05/EDST-422-Lesson-Plan-2-1-2j6pj5q.pdf (lesson plan, Scratch and poems)
- https://www.create-learn.us/blog/scratch-projects-for-kids/ (as the URL says, Scratch projects for kids)

Examples

- https://scratch.mit.edu/projects/60917032/editor/ - Appel (popular game like Mario Bros)
- https://www.youtube.com/watch?v=QXru0rSV2ZQ – Tutorial on “Shooter Game” (12 parts, steps through the logic)
- https://www.youtube.com/watch?v=rQERThpnKKE – Tutorial on making a Scratch game
- https://www.youtube.com/watch?v=YpTPKiPN9G4 – Let’s make a story in Scratch
- https://www.youtube.com/watch?v=sBwJw9LogsU – Let’s make music in Scratch

Best Practices

- Encourage/require pseudocoding
- Build slowly, step-by-step, age-appropriate
- Make mistakes, allow students to find/fix
- Have fun
- Allow creativity



```
Program start
Initialise variable A=0
Initialise variable B
Start infinite loop
    Call function SegConvert withinput A
    SegConvert returns value B
    Output B to LED port
    Increment A
    If A > 9
        A=0
    Call function Delay for 500ms
End infinite loop
```

But Does It Work?

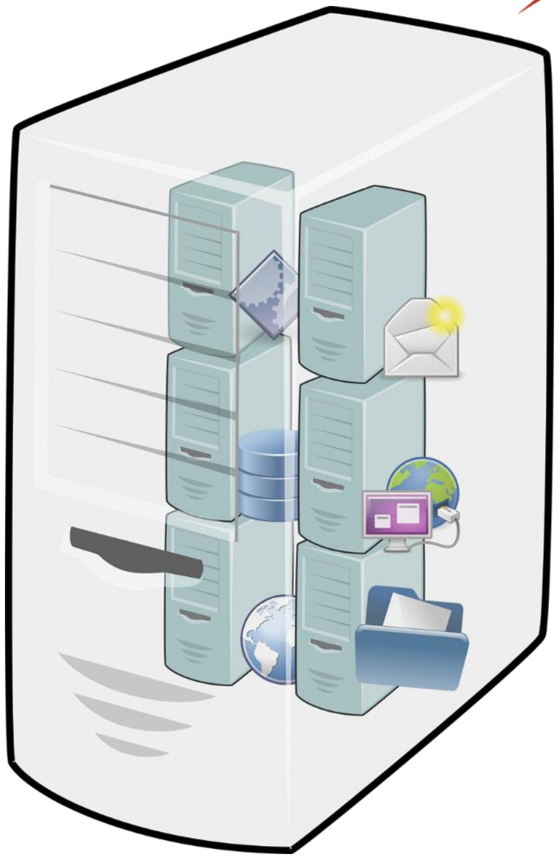
- https://www.sciencedirect.com/science/article/pii/S1877042815024842
- Three groups of HS students
  - Two used Pascal
  - One used Scratch
- "The analysis of the surveys shows that using an environment for learning programming such as Scratch highly motivate students and empower them to pursue their studies in programming. In fact, when learners were asked about their desire to continue their studies in programming, 65% of students who have experience with Scratch environment consider continuing their studies in programming whereas only 10.3% of students who used a standard programming environment showed some interest."

Please take a moment and complete an Evaluation:

https://docs.google.com/forms/d/e/1FAIpQLSeuFk_rD_pbKW3xgW5sDckomYGFAl7r0be_bCAbmwyWsBNpwQ/viewform

Short: bit.ly/GBU2021Certificate

Let's DO THIS!



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