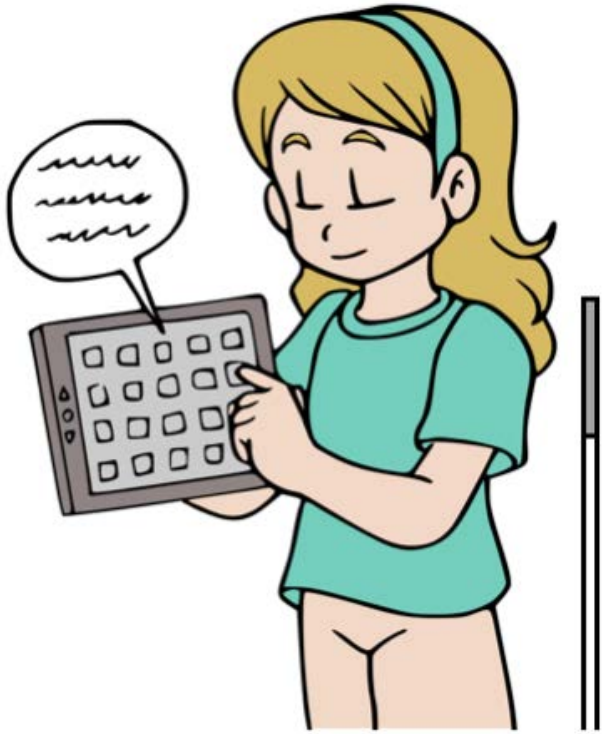
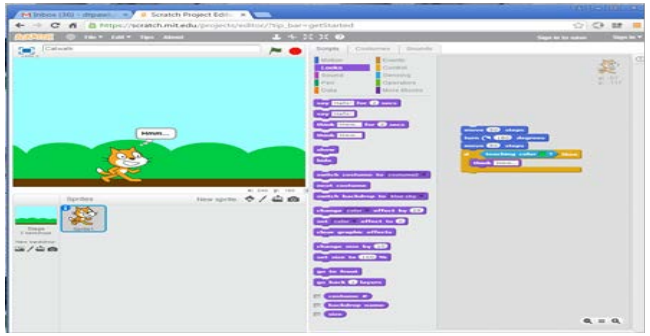
tScratch: Tangible Programming Environment Targeted for Students who are Blind or Visually Impaired (BVIs)



DIANNE PAWLUK, VIRGINIA COMMONWEALTH UNIVERSITY (PI)

GIOVANNI FUSCO, THE SMITH KETTLEWELL EYE RESEARCH INSTITUTE (CO-PI)

Need



Problem: a lot of effort has gone into lowering the hurdles to programming for sighted students

- No such effort has been made for blind and visually impaired students (BVIs)
- **Worse!** The effort for sighted students (using graphical interaction) has eliminated opportunities for BVI students

Equal but separate is **NOT** the solution

- Most BVI students are in mainstream schools with sighted peers

Need: resources for BVIs to learn computer programming alongside their sighted peers

- Lower hurdles for BVI students will keeping them low for sighted students
- Improve engagement for BVI students while keeping engagement high for sighted students

Project Research Questions

Based on a comparison of the use of tScratch/Scratch versus a programming environment that uses a text based programming language:

Did the students in the tScratch/Scratch group improve more significantly from the intervention than the students in the text based programming group….

1. In their ability to apply programming concepts (concepts already specified)
2. In their ability to share in teamwork
3. In their perspective of working with visually impaired students
4. In their interest in computing science and STEM
5. In their view of their ability to have a career in computing science/STEM fields
6. In their view of inclusion in the education community

Outcome Assessment of Project

- One week computer camps
  - One with tScratch/Scratch, one with text based programming environment
- 6 BVIs and 6 sighted in each camp
- Assessment
  - Defined performance metrics for each student outcome
  - Defined assessments for each performance metric
- Pilot test 1 year before actual assessment

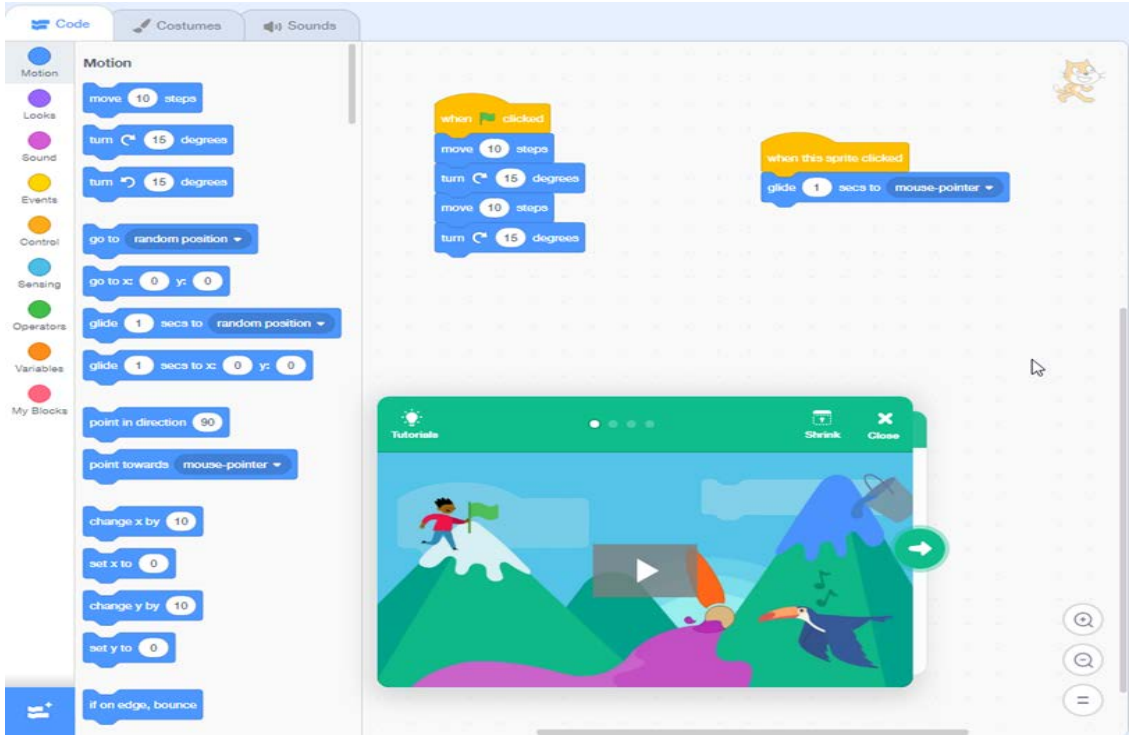
Outcome Assessment of Project

Student Outcome	Metric	Assessment Method
Applying Programming Concepts	Understanding program someone else wrote	Pre/post Test, Student Portfolios
	Write a program	Pre/post Test, Student Portfolios
	Debug a program	Pre-post Test, Student Portfolios
Ability to Share in Teamwork	Share in program writing	Pre/post Group Projects, Peer Assessment
	Contributed to programming	Pre/post Group Projects, Peer Assessment
	Critique others	Pre/post Group Projects, Peer Assessment
Working with Students of Opposite Visual Condition	How treat students in the two visual condition groups (sighted, blind)	Pre/post Questionnaire, Assessment by Teachers in Pre/post Group Projects
	View of students' abilities to program in the two visual condition groups	Pre/post Questionnaire, Assessment by Teachers in Pre/post Group Projects
	Comfort in working with students in the two visual condition groups	Pre/post Questionnaire, Assessment by Teachers in Pre/post Group Projects
Interest in CS/STEM	View of Computer Scientists	Pre/post Questionnaire
	View of Computing Science/STEM	Pre/post Questionnaire
Career in CS/STEM	Frustration level in class	Assessment by Teachers Day 1 and Day 5
	Sees obstacles to a career in CS/STEM	Pre/post Questionnaire
Inclusion in Education Community	View of how treated by teachers	Pre/post Questionnaire
	View of how the two visual condition groups are treated by teachers	Pre/post Questionnaire

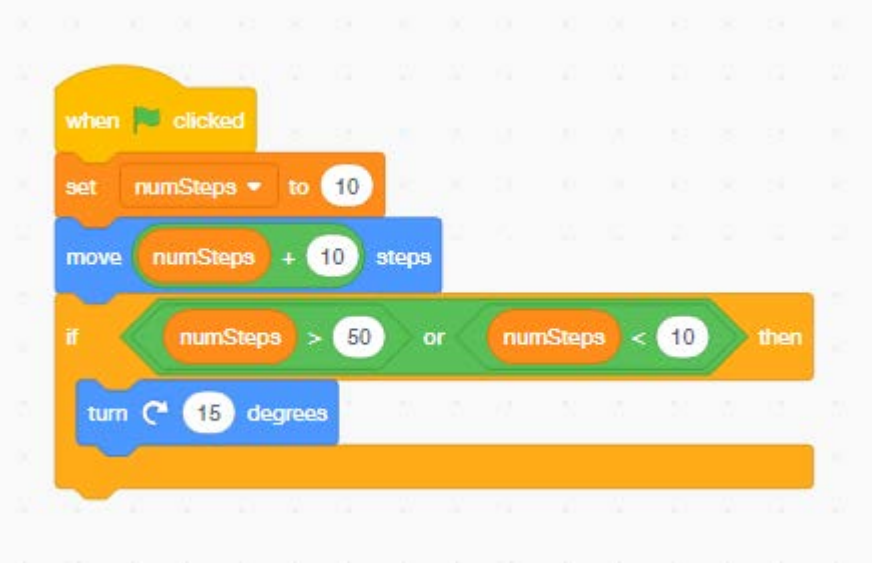
Tangible Environment Development

- Add a tangible + audio interface to the Scratch programming environment that can be used by BVI students alone or as part of a team of BVI and sighted students

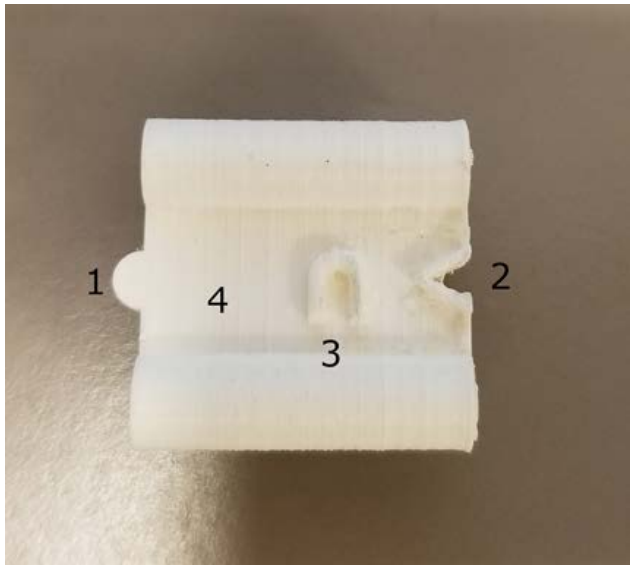
- Break down the environment development into smaller concepts and focus on those that lower hurdles
    1. Tangible code block
    2. Tangible workspace



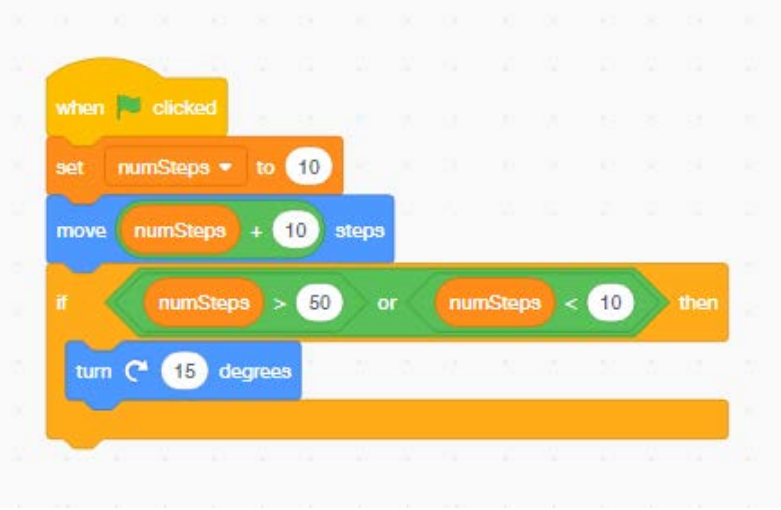
Code Blocks



1. Define Requirements and Constraints
   - physical connections of code blocks prevent invalid syntax
   - block assemblies indicate nesting
   - Identification of block category and block name
   - Etc.
2. Design Tables
   - Alternate designs and whether satisfy design requirements/constraints
3. Preliminary Physical Prototypes of Some Alternate Designs
   - Focus on arithmetic, relational and logical operators

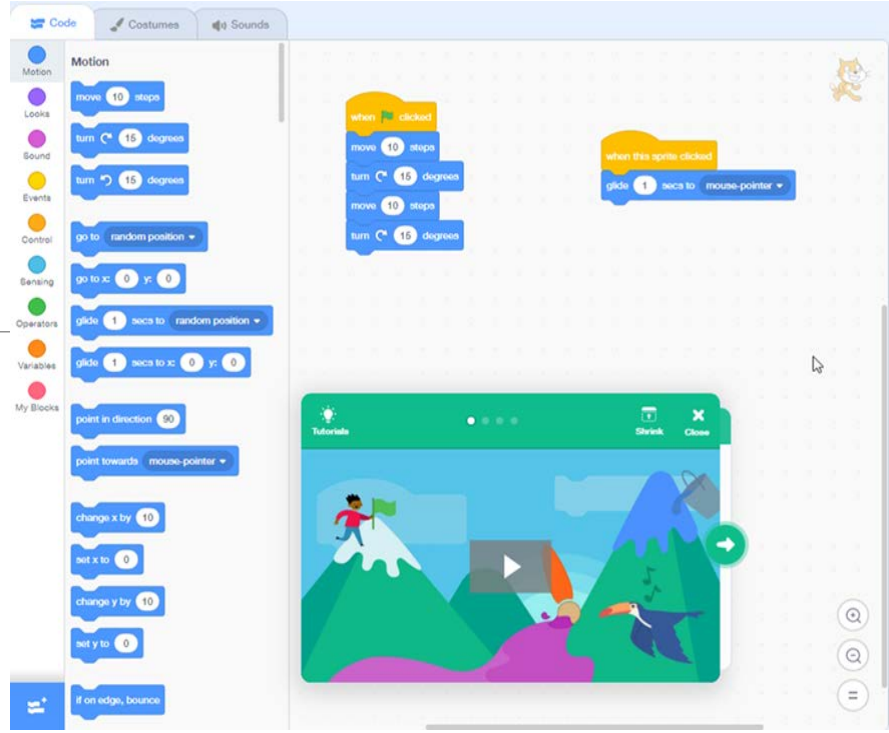


Code Blocks



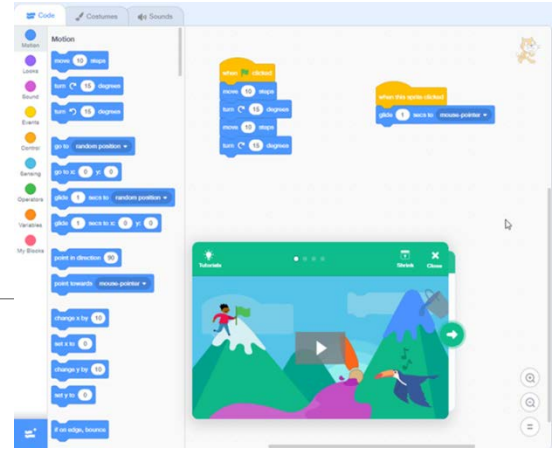
3. Preliminary Physical Prototypes of Some Alternate Designs
   - Example: nesting (slots for operands can expand to contain other operator expressions)
   - Retractable cord/band
   - Telescoping tubing
4. Functional testing/robustness
   - Does it work the way we want
   - Is it repeatable/reliable
5. User testing
   - Compare most promising design versus controls (e.g., simple blocks, text based environment)
   - Users will be required to construct expressions involving operators , and read and edit expressions created by another person. Some expressions will require nesting.
   - Use metrics of correctness of task and completion time, questionnaire about experience

Tangible Workspace



1. Define Requirements and Constraints
   - Grouping of blocks into a script allows it be understood to go together
   - Moving of a group of code lines as a whole keeps things conceptually together (chunking)
   - Need to find/remember code blocks in code
   - Etc
2. Design Tables
   - Alternate designs and whether satisfy design requirements/constraints
3. Preliminary Physical Prototypes of Some Alternate Designs
   - Open workspace, event code blocks with suction cups, blocks connected by magnets
   - Gridded workspace that code blocks can slide along, blocks connected by magnets

Tangible Workspace



3. Preliminary Physical Prototypes of Some Alternate Designs
   - Locating code
     - Grid system (either gridded workspace for code blocks or incised markings but still free movement)
     - Hand guidance (auditory or tactile feedback)
4. Functional testing/robustness
   - Does it work the way we want
   - Is it repeatable/reliable
5. User testing
   - Compare most promising designs versus each other and control (e.g., alternatives mentioned in a crossed design, text based environment)
   - Users will be required to construct expressions involving move code blocks, read and edit expressions created by another person, find a code block based on another person pointing it out.
   - Use metrics of correctness of task and completion time, questionnaire