Young children's ScratchJr project scores and processes across a 12-week coding curriculum

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Agenda

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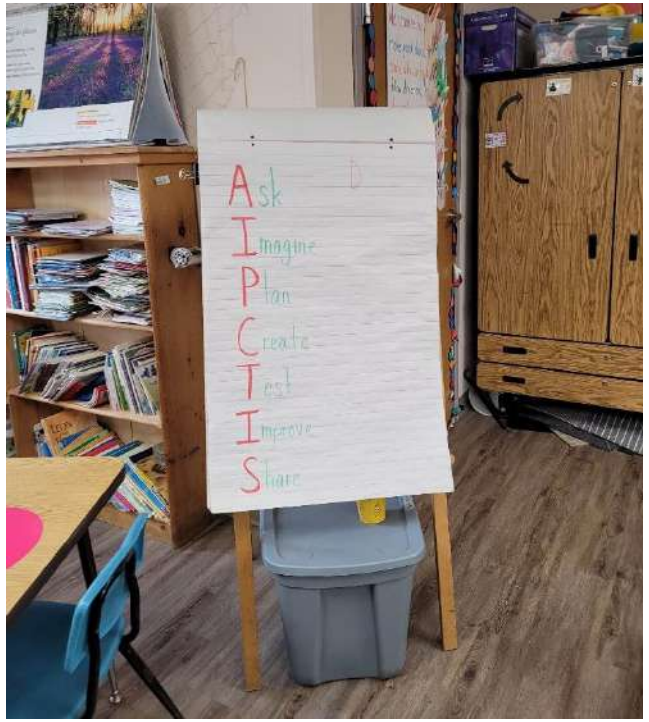
- Study 1: Development of ScratchJr Project Rubric
- Study 2: Young Children's Processes in Creating Coding Projects
- Breakout Rooms

The CAL Project

- Coding as Another Language K-2 Curricula: 24 ScratchJr lessons (45 min.)
- K-2 from multiple states in the US (MN, RK, RI and MA)

"Teaching programming as a literacy of the 21st century"



The CAL Project

https://sites.bc.edu/codingasanotherlanguage/

The CAL Project

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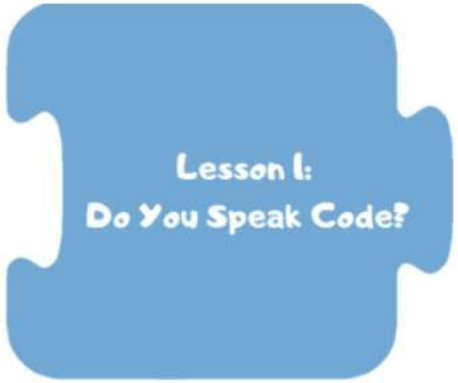

View | Download | Visual Overview

Powerful Ideas of Computer Science
Representation

Powerful Ideas of Literacy
Tools of Communication and Language

Children will be able to:

- Understand languages as means of communication
- Recognize that we use programming languages to communicate with computers
- Recognize that there are many different programming languages

Vocabulary covered:

- Programming languages
- Code
- Communication
- Human languages
- ScratchJr

Necessary Materials: Hello Around the World

▶ Warm Up

▶ Opening Tech Circle

▶ ScratchJr Time

▶ Word Time

Research Instruments

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Validated Research Instruments

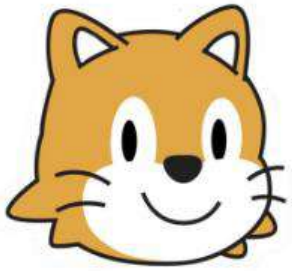
Search

Over the years, The DevTech Research Group directed by Prof. Marina Bers, has developed and validated research instruments that are developmentally appropriate for young children. These instruments can help researchers and educators evaluate skills related to Computer Science such as coding, robotics and computational thinking.

To gain access to these instruments, please fill out the Request an Instrument form. The DevTech team will review your request and, if approved, will give you free access to the requested instrument's Training and Certification. Once you have successfully completed the training and certification process, you will be emailed a password to the to access the requested instrument's Downloads.

Please click the icons below to learn more about each available instrument.

- ▶ Validated Instruments
- ▶ Training and Certification
- ▶ Downloads
- ▶ Request an Instrument



ScratchJr Instruments

KIBO Instruments

TechCheck

https://sites.bc.edu/devtech/research/validated-research-instruments/

Study 1: ScratchJr Project Rubric

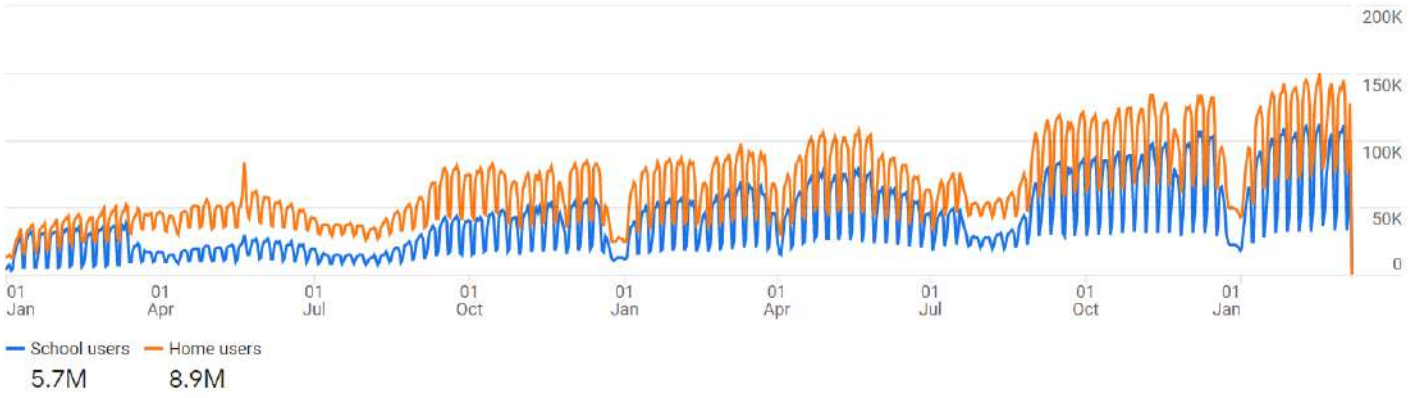
(Unahalekhaka & Bers, 2022)

Growth in Early CS Education

- Computational skills for the 21st century
- One effective learning pedagogy is to create open-ended coding projects
- Millions of ScratchJr projects have been created

Jan. 2020 – Feb. 2022

ScratchJr Users



28 ScratchJr Blocks

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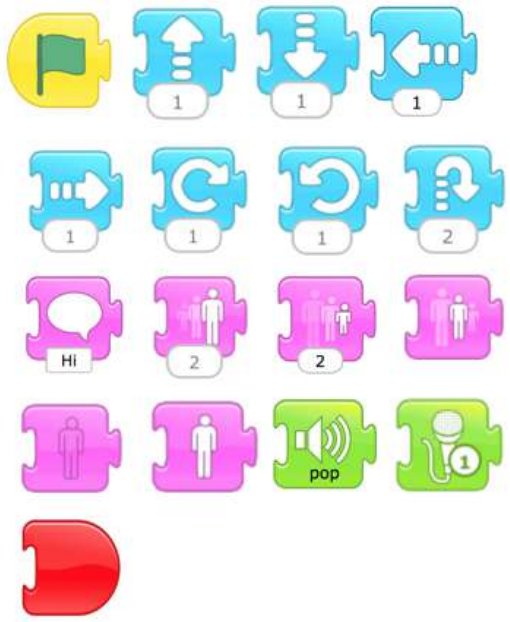
ScratchJr Block Complexity Levels

Beginner	Intermediate	Advanced
Green start, motion blocks, single character, say block, looks blocks (grow, shrink, hide, show), pop sound, record sound, end block	Start on tap, control speed, wait time, return to start, go to page, repeat forever	Start on bump, start on messages, send message, repeat, stop block
		

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ScratchJr Project Rubric

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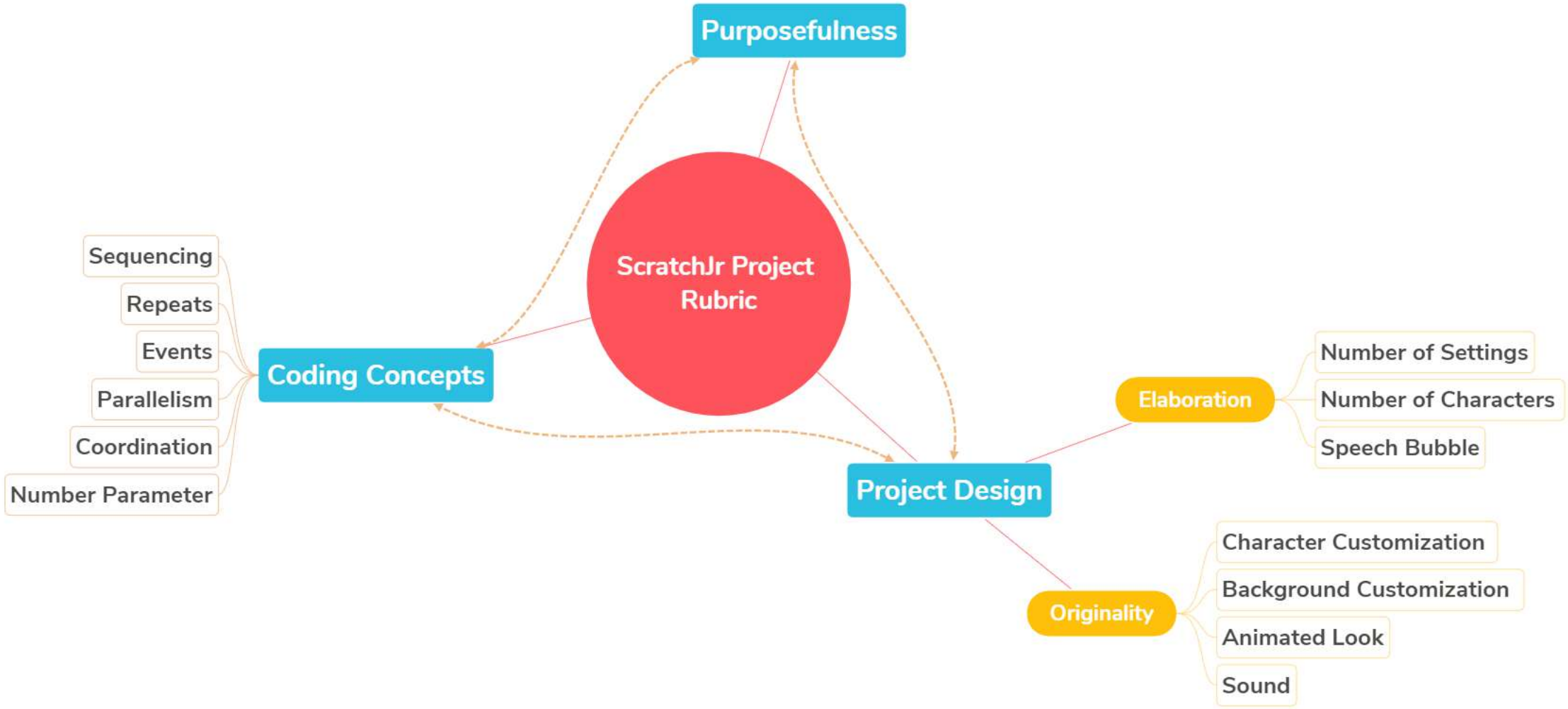
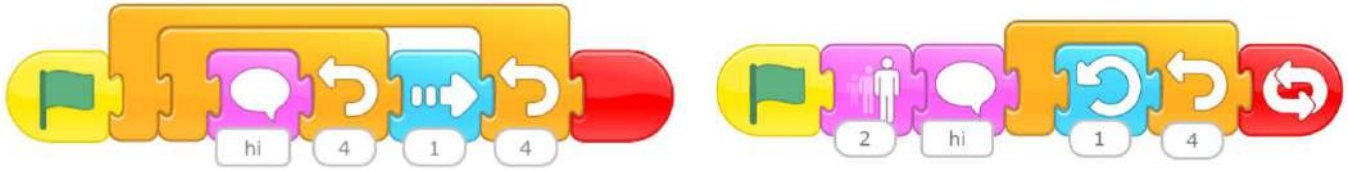
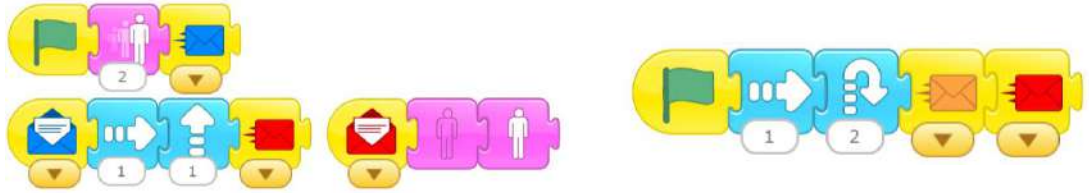


Coding Concepts	Examples of Score = 4 (Highest)
Sequencing	7 or more blocks excluding end etc. 
Repeats	Nested Loops 
Events	Multiple Colors Messages 
Parallelism	2 or more sequences within 1 character 
Coordination	Using these blocks across multiple characters 
Number Parameter	Using positive/negative/zero number parameter that's not default 

(Bers et. al, 2023)

Project Prompts Across Curriculum

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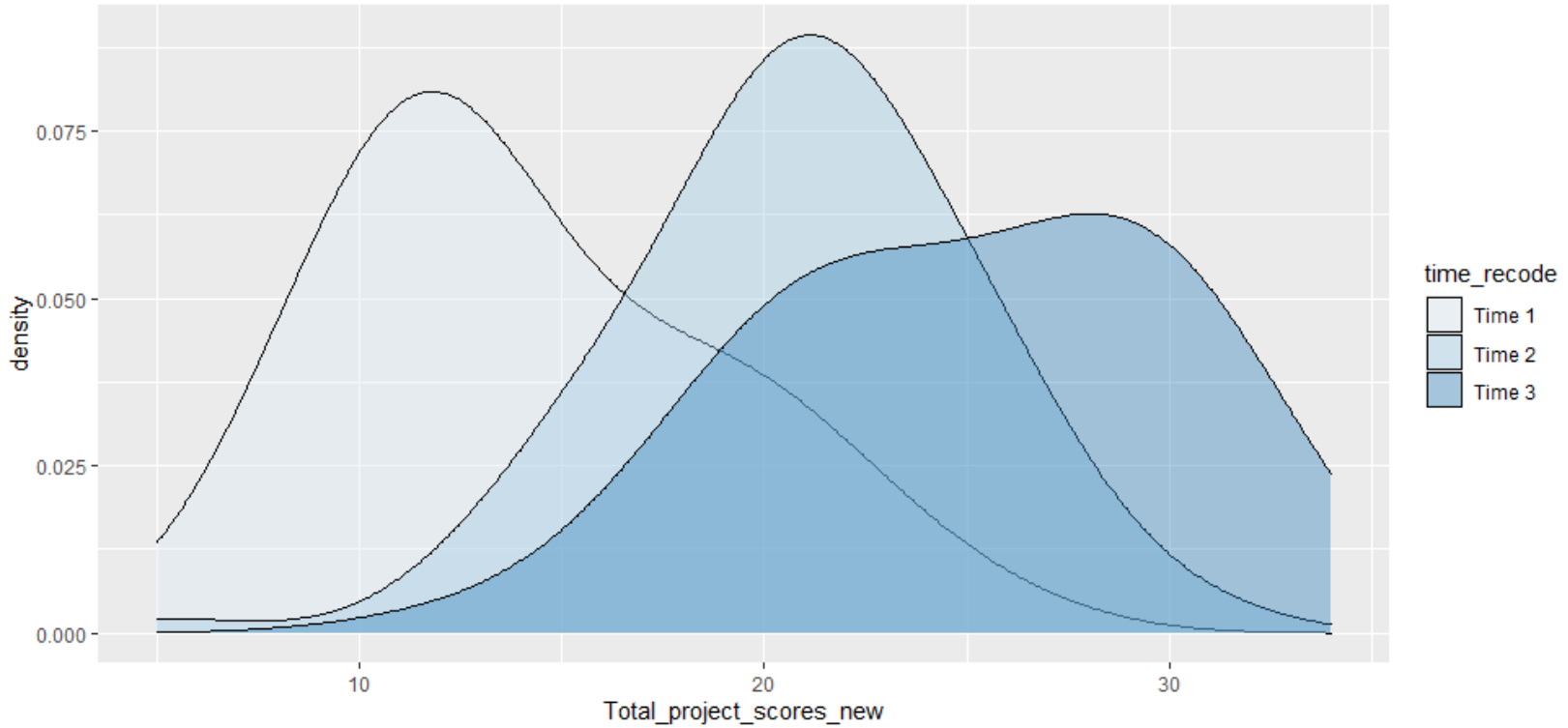
Kindergarten	Grade 1	Grade 2
Lesson 8: Program Head, Shoulders, Knees, and Toes	**Lesson 6:** Re-code the Hokey-Pokey	**Lesson 6:** Tell a Story (Grace Hopper)
Lesson 13: Expand Your Storytelling Toolbox (Katherine)	**Lesson 10:** Expand Your Storytelling Toolbox (Ada Lovelace Story)	**Lesson 11:** Our Classroom Story
Lesson 23: Final Project III (Knuffle Bunny)	**Lesson 23:** Final Project III (Where the Wild Things Are)	**Lesson 23:** Final Project III (Stellaluna)

(Bers et. al, 2023)

Total Project Scores over time by Grade

Out of 40 points



Minnesota

	Grade 1	Grade 2	Total
Time 1	47	26	**73**
Time 2	44	35	**79**
Time 3	45	31	**76**
Total	136	92	**228**

(Unahalekhaka & Bers, 2022)

Frequencies and Average scores by Categories (Time 3)

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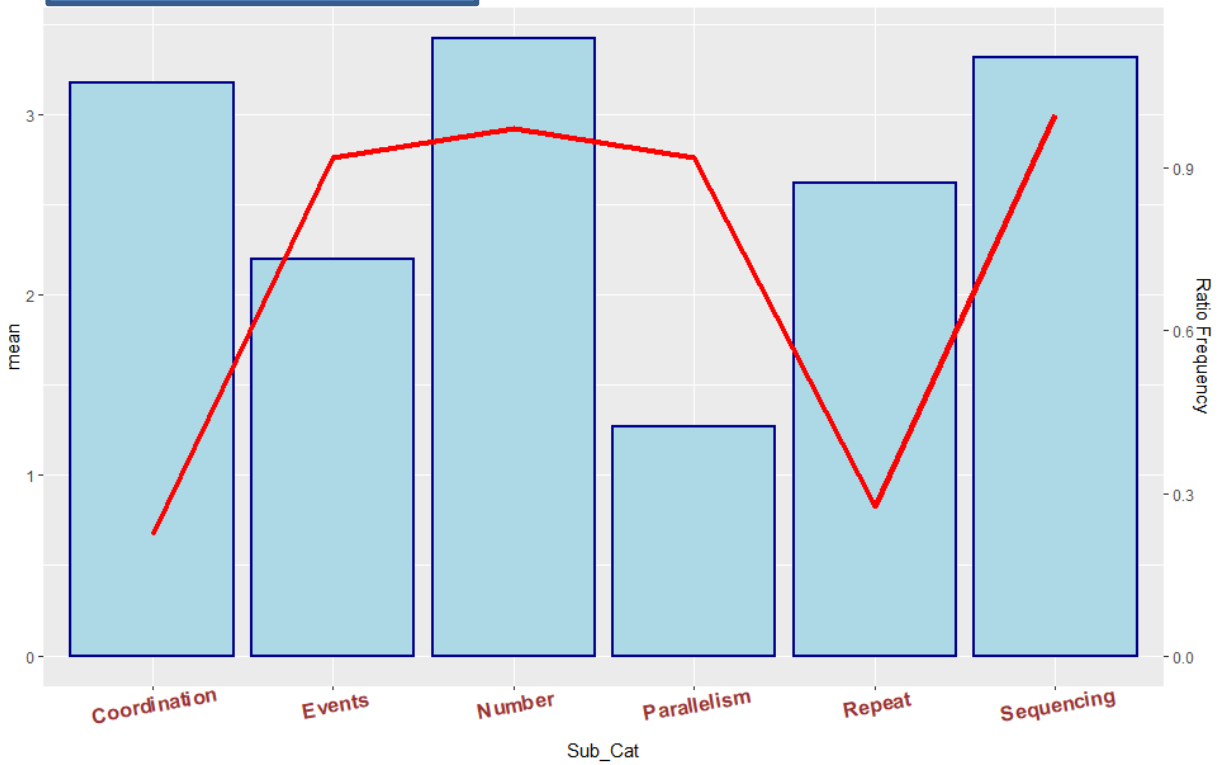
Coding Concepts

N=76 projects, Score out of 4



% project that have this sub-category

Mean score

Most common and highest mean scores:

- Sequencing
- Number parameter

Least common and lowest mean scores:

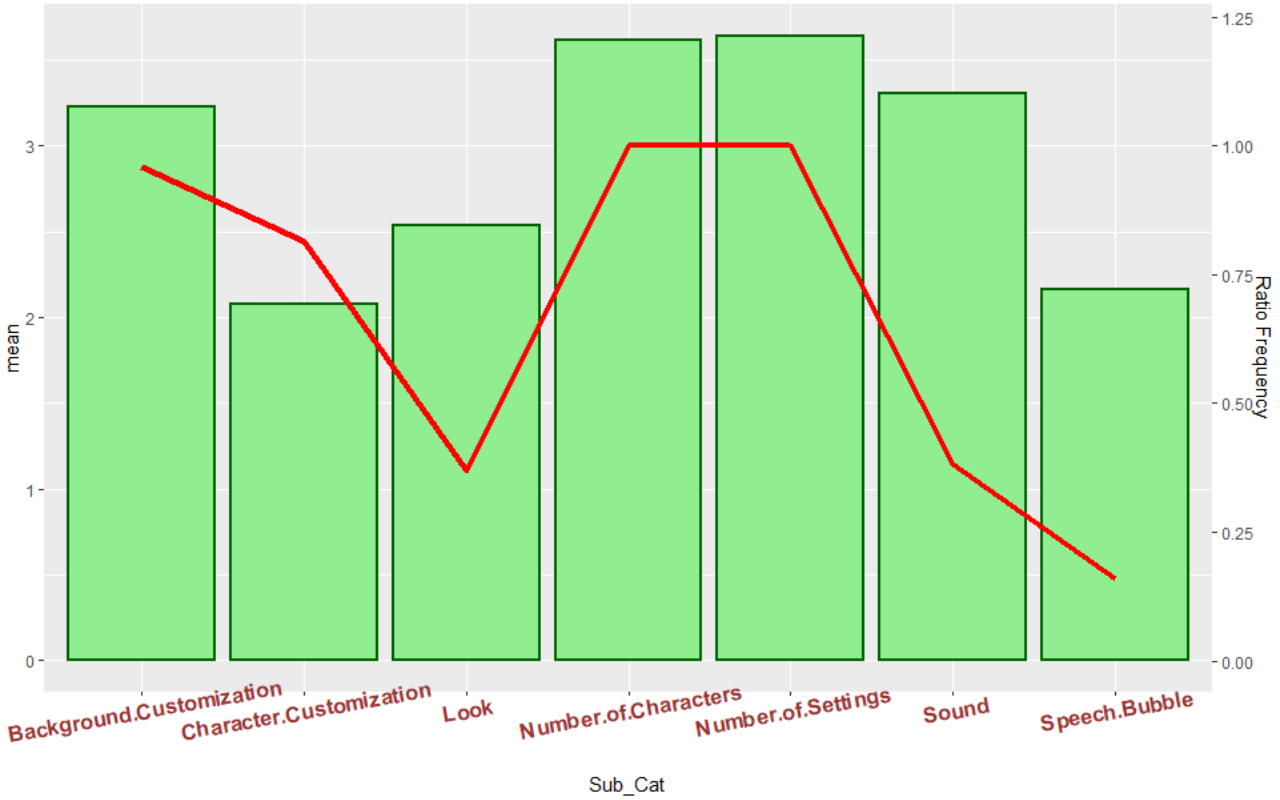
- Coordination
- Repeat
- Parallelism

(Unahalekhaka & Bers, 2022)

Frequencies and Average scores by Categories (Time 3)

Project Design

N=76 projects, Score out of 4



% project that have this sub-category

Mean score

Most common and highest mean scores:

- Number of characters
- Number of settings

Least common:

- Speech bubble
- Sound
- Look blocks

(Unahalekhaka & Bers, 2022)

Study 2: Young Children's Processes in Creating Coding Projects across CAL Curriculum

(Unahalekhaka, 2023)

How did children create these projects?

- Process is how a task is completed
- Learning is a process, rather than just the end outcome
- Understanding process can support children's needs and motivation

Mid-session

End-session

Problem

- Limited understanding of:

Young *children's processes* when creating coding projects

Better instructional and curriculum design for early CS learning experience

Objectives

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- How did young children create ScratchJr projects?

Pilot Phase

Identify difference in children's **creation actions and processes** from a qualitative observation of their ScratchJr **screen recordings**

Main Phase

Quantify occurrences of children's **creation processes** across curriculum

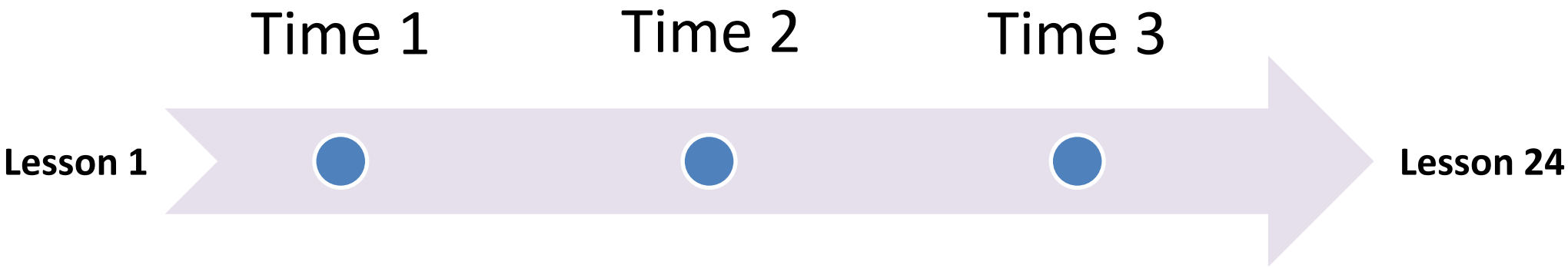
Understand the relationship between creation processes and block usage:

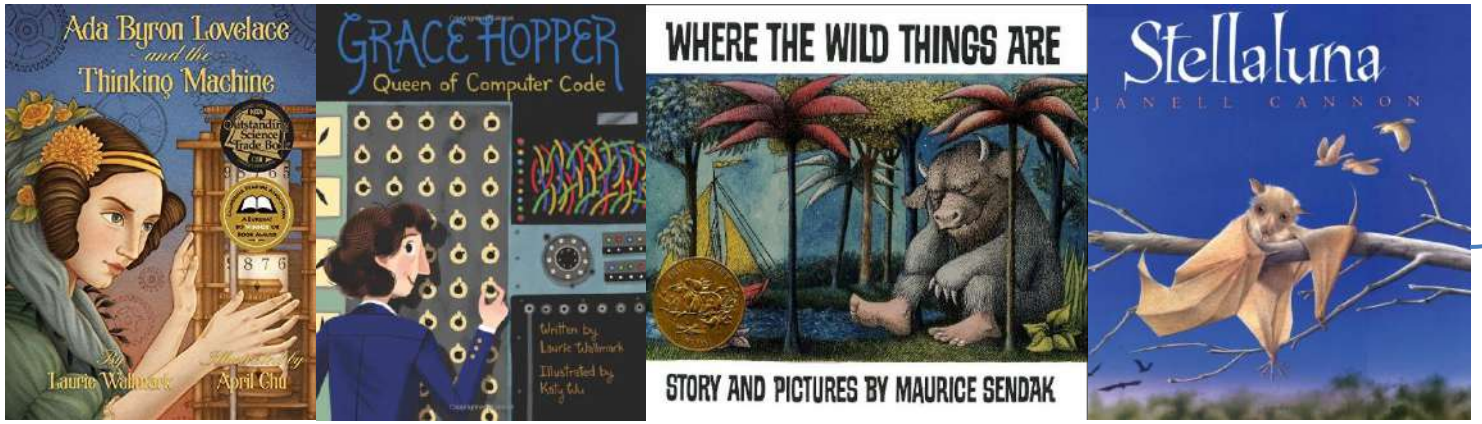
1) **variety**

2) **complexity**

Study Context

- Children in the main study created major ScratchJr projects at three timepoints





Program Stellaluna Story:

Children work on their stories, programming the first three pages of their project: the beginning, middle, and end of the story Stellaluna.

PILOT STUDY

Mixed-method: *Exploratory Sequential Design Process*

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Alignment of Exploratory Sequential Design Process (Creswell et al., 2018, p. 135) and the current study design

Exploratory Sequential Design Phases	Aligned Study Phases	Aligned Research questions	Method
Qualitative	Pilot	RQ1	Task-analysis and deductive coding approach
Bridging Qual-Quant	Main	RQ2	Rule-based identification
Quantitative	Main	RQ3 & RQ4 RQ5	Multilevel Regression T-test and Linear Regression

Results: Actions

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Project Creation Actions Coding Scheme

Categories	Actions	Definition
Coding	Create New	Start a new code from blank
	Revise	Rework on the same code after playing program
	Explore	Try out intermediate or advanced blocks repeatedly
Project Design	Customize	Decorate project or add character/background

Process 1: Project Iteration

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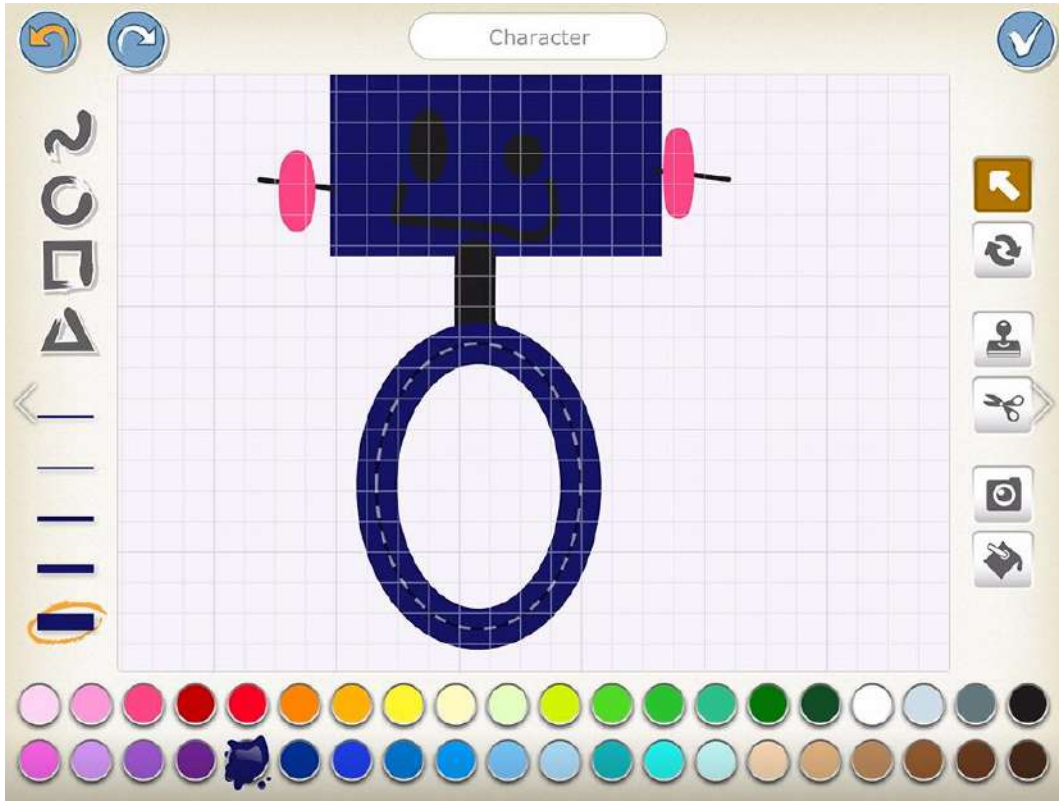
Create New

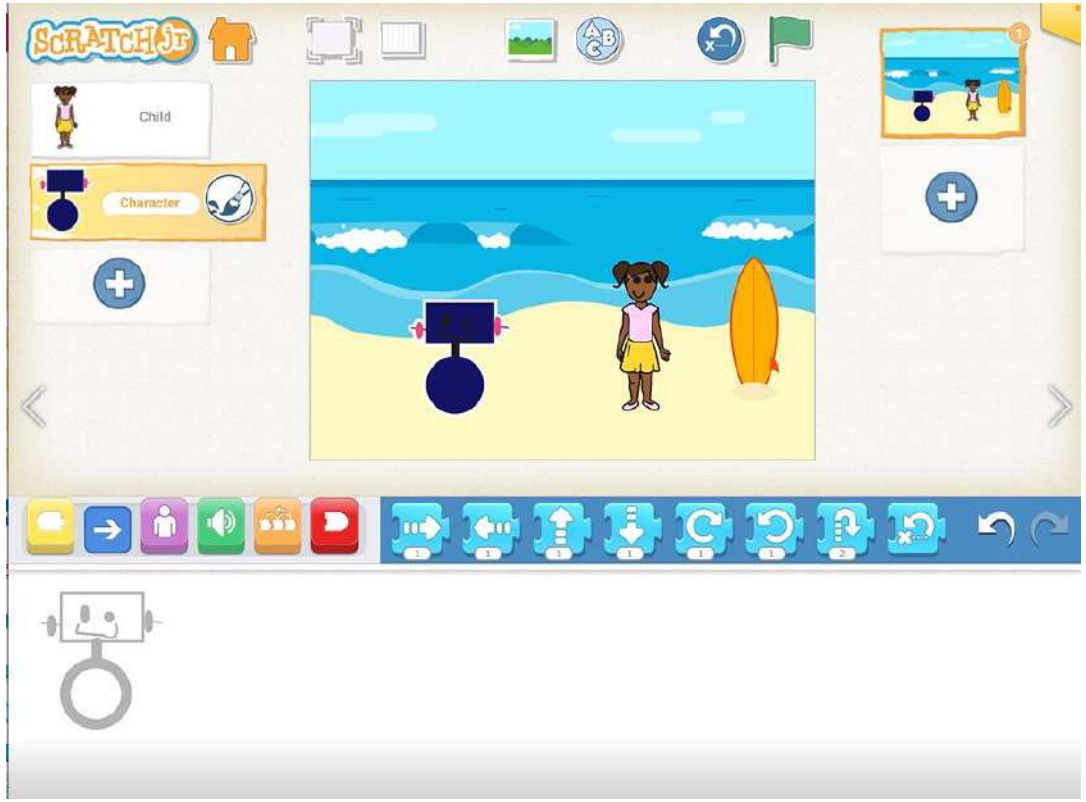
Customize

Create New

Revise

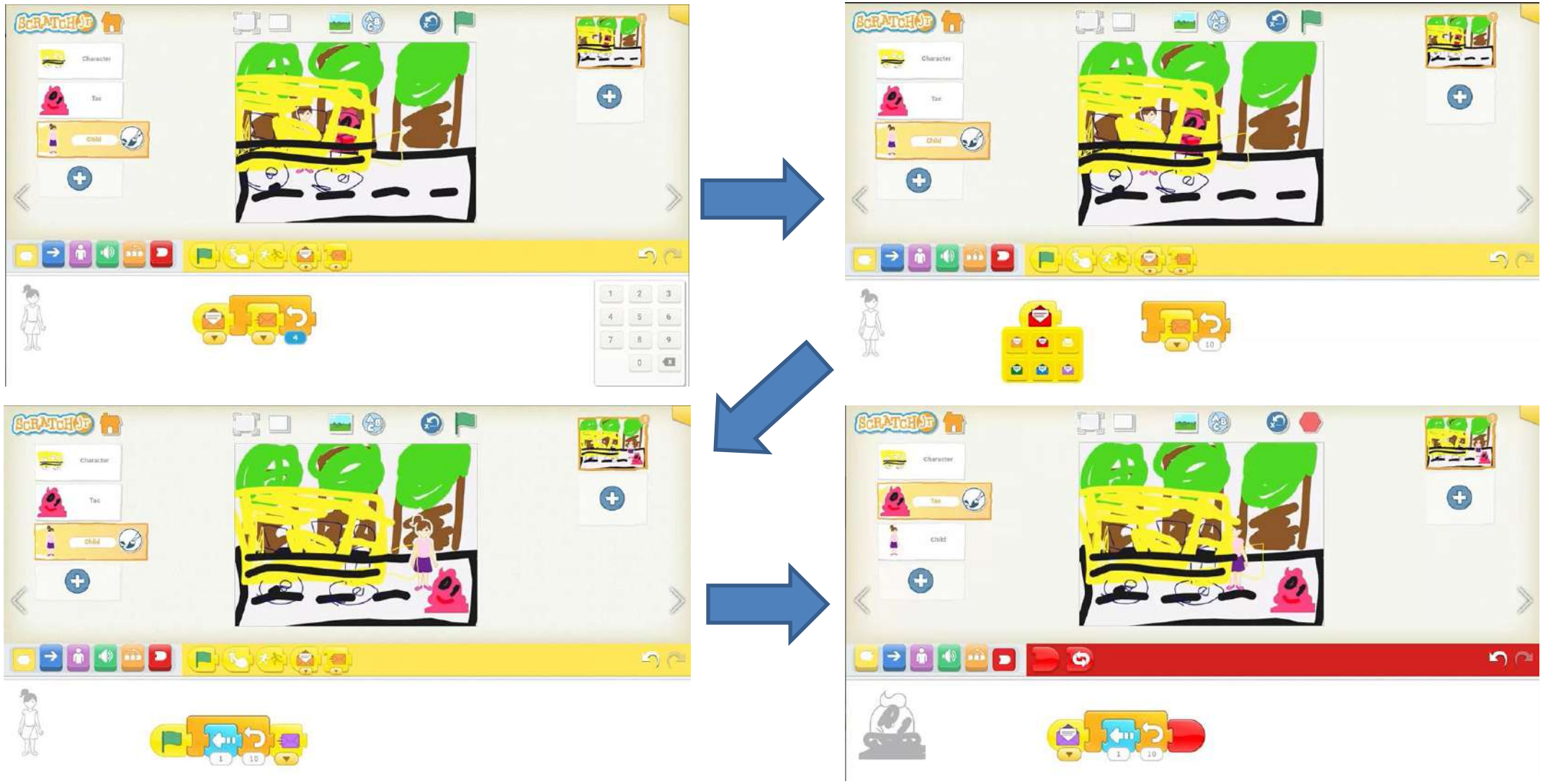
Process 2: Long Customization





Customizing longer than 10% of the session duration

Process 3: Coding Exploration



MAIN STUDY

Mixed-method: *Exploratory Sequential Design Process*

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Identifying Processes

Qualitative

user_pseu	School	GradeLevel	ClassLevel	Time_EST	event_name
190d3a09(	24	Kindergarte	Star2.svg	14:45:39	new_block_onflag
190d3a09(	24	Kindergarte	Star2.svg	14:45:42	new_block_forward
190d3a09(	24	Kindergarte	Star2.svg	14:45:45	new_block_endstack
190d3a09(	24	Kindergarte	Star2.svg	14:46:20	new_block_right
190d3a09(	24	Kindergarte	Star2.svg	14:46:26	new_block_endstack
190d3a09(	24	Kindergarte	Star2.svg	14:49:55	new_character
190d3a09(	24	Kindergarte	Star2.svg	14:50:37	choose_background
190d3a09(	24	Kindergarte	Star2.svg	14:51:02	new_block_onflag
190d3a09(	24	Kindergarte	Star2.svg	14:51:06	new_block_forward
190d3a09(	24	Kindergarte	Star2.svg	14:51:09	new_block_up
190d3a09(	24	Kindergarte	Star2.svg	14:51:12	new_block_forward
190d3a09(	24	Kindergarte	Star2.svg	14:51:14	new_block_up

Quantitative

Mixed-method: *Exploratory Sequential Design Process*

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Measures: What are the outcomes?

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Variety

Complexity

ScratchJr Block Complexity Levels

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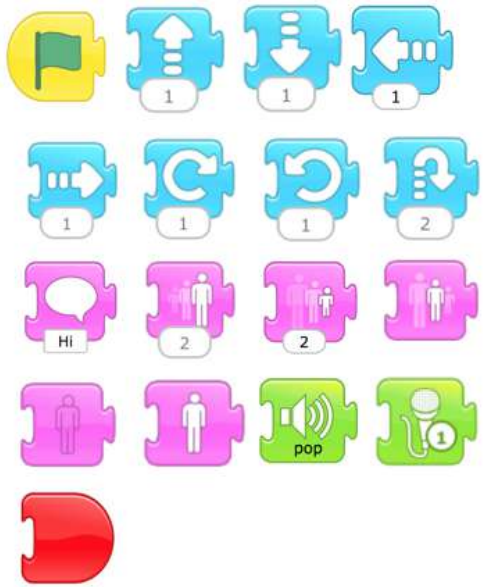
Green start, motion blocks, single character, say block, looks blocks (grow, shrink, hide, show), pop sound, record sound, end block	Start on tap, control speed, wait time, return to start, go to page, repeat forever	Start on bump, start on messages, send message, repeat, stop block
		

RESULTS & DISCUSSION

1. Exploration Promotes Coding Block Variety

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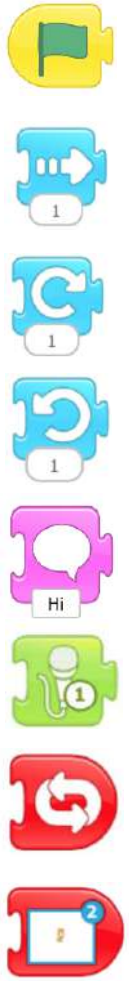
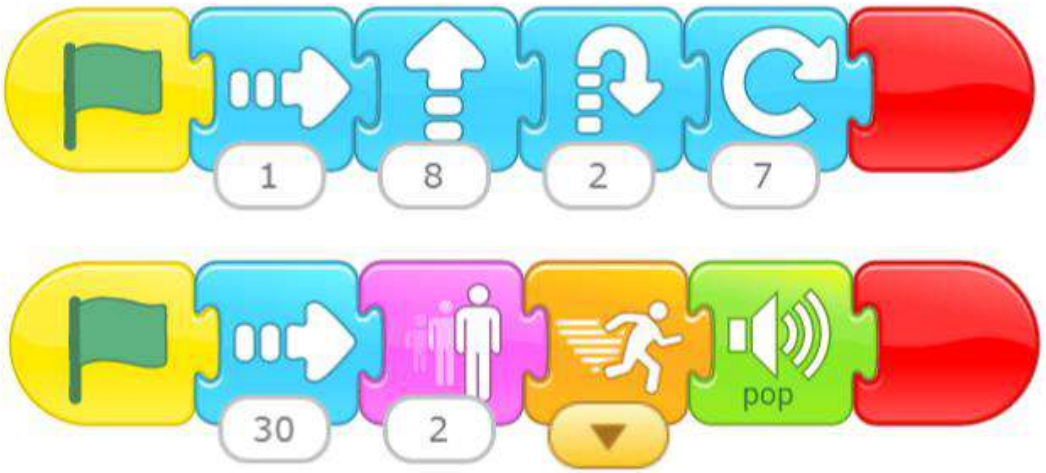
Project with 8 Block Types



1. Exploration Promotes Coding Block Variety

- Encourage children to explore complex or unfamiliar blocks
- Future research should also examine block category variety

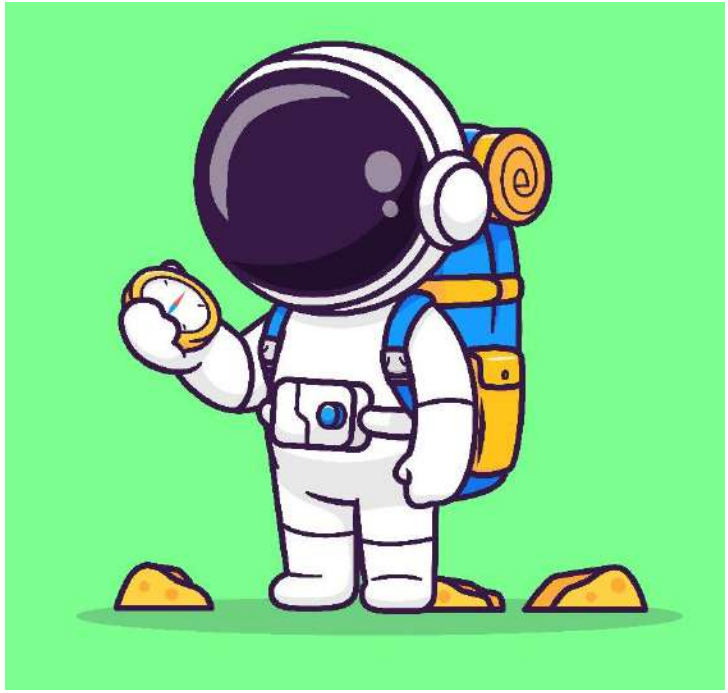


6 unique blocks

6 unique blocks

2. Combination of Guidance and Self-Discovery

- Guided exploration on the complex blocks may lead to more complex block usage in their final projects
- There was more exploration after children learned block functions



3. Different Teaching Strategies Across Curriculum

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Early

- Free play to self-discovered different functions, especially basic blocks

Mid

- Set plans on how long they will need for customizing vs. coding
- More guidance on the advanced blocks then let them explore

End

- Provide multiple sessions to work
- Promote iteration by encouraging children to keep improving codes and adding details

Conclusion

- Mixture of free exploration and direct guidance
- Important to show young children on what is available before they fully explore
- At least some guidance is needed in early childhood
  - CS concepts require multiple consequential steps
  - Working on their reading skills

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Remco Chung, Tufts University

Karen Brennan, Harvard University

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Breakout Groups

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1. Use a rubric to evaluate their ScratchJr projects (or provided ScratchJr project) and discuss the key areas that can be enhanced.

2. Brainstorm the teaching strategies that can support different creation processes children may use to create coding projects.

References

Bers, M. U., Blake-West , J., Kapoor, M. G., Levinson, T., Relkin, E., Unahalekhaka, A., & Yang, Z. (2023). Coding as another language: Research-based curriculum for early childhood computer science. *Early Childhood Research Quarterly*, *64*, 394–404. https://doi.org/https://doi.org/10.1016/j.ecresq.2023.05.002

Unahalekhaka, A. (2023) *Young Children's Processes in Creating Coding Projects across Coding as Another Language Curriculum*. (Doctoral dissertation)

Unahalekhaka, A., Bers, M.U. (2022). Evaluating young children's creative coding: rubric development and testing for ScratchJr projects. *Educ Inf Technol*. https://doi.org/10.1007/s10639-021-10873-w