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

Apittha Aim Unahalekhaka
July 18, 2023
Agenda

- 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

Coding as Another Language - Scratch Jr Curriculum

https://sites.bc.edu/codingasanotherlanguage/
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
Validated Research Instruments

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.

https://sites.bc.edu/devtech/research/validated-research-instruments/
Study 1: ScratchJr Project Rubric
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

5.7M 8.9M
## ScratchJr Block Complexity Levels

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

![Beginner Blocks](image1.png)
![Intermediate Blocks](image2.png)
![Advanced Blocks](image3.png)
Where the wild things Are
ScratchJr Project Rubric

- Purposefulness
- Coding Concepts: Sequencing, Repeats, Events, Parallelism, Coordination, Number Parameter
- Project Design: Elaboration (Number of Settings, Number of Characters, Speech Bubble), Originality (Character Customization, Background Customization, Animated Look, Sound)
<table>
<thead>
<tr>
<th>Coding Concepts</th>
<th>Examples of Score = 4 (Highest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequencing</td>
<td>7 or more blocks excluding end etc.</td>
</tr>
<tr>
<td>Repeats</td>
<td>Nested Loops</td>
</tr>
<tr>
<td>Events</td>
<td>Multiple Colors Messages</td>
</tr>
<tr>
<td>Parallelism</td>
<td>2 or more sequences within 1 character</td>
</tr>
<tr>
<td>Coordination</td>
<td>Using these blocks across multiple characters</td>
</tr>
<tr>
<td>Number Parameter</td>
<td>Using positive/negative/zero number parameter that's not default</td>
</tr>
</tbody>
</table>

(Bers et. al, 2023)
<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>Grade 1</th>
<th>Grade 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lesson 8:</strong> Program Head, Shoulders, Knees, and Toes</td>
<td><strong>Lesson 6:</strong> Re-code the Hokey-Pokey</td>
<td><strong>Lesson 6:</strong> Tell a Story (Grace Hopper)</td>
</tr>
<tr>
<td><strong>Lesson 13:</strong> Expand Your Storytelling Toolbox (Katherine)</td>
<td><strong>Lesson 10:</strong> Expand Your Storytelling Toolbox (Ada Lovelace Story)</td>
<td><strong>Lesson 11:</strong> Our Classroom Story</td>
</tr>
<tr>
<td><strong>Lesson 23:</strong> Final Project III (Knuffle Bunny)</td>
<td><strong>Lesson 23:</strong> Final Project III (Where the Wild Things Are)</td>
<td><strong>Lesson 23:</strong> Final Project III (Stellaluna)</td>
</tr>
</tbody>
</table>

(Bers et. al, 2023)
Total Project Scores over time by Grade

Out of 40 points

<table>
<thead>
<tr>
<th></th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>47</td>
<td>26</td>
<td>73</td>
</tr>
<tr>
<td>Time 2</td>
<td>44</td>
<td>35</td>
<td>79</td>
</tr>
<tr>
<td>Time 3</td>
<td>45</td>
<td>31</td>
<td>76</td>
</tr>
<tr>
<td>Total</td>
<td>136</td>
<td>92</td>
<td>228</td>
</tr>
</tbody>
</table>

(Unahalekhaka & Bers, 2022)
Frequencies and Average scores by Categories (Time 3)

N=76 projects, Score out of 4

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

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
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
Problem

• Limited understanding of:

Young children’s processes when creating coding projects

Better instructional and curriculum design for early CS learning experience
Objectives

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

Lesson 1

Time 1

Time 2

Time 3

Lesson 24

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

<table>
<thead>
<tr>
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<th>Aligned Study Phases</th>
<th>Aligned Research questions</th>
<th>Method</th>
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<tbody>
<tr>
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<td>Pilot</td>
<td>RQ1</td>
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<td>Rule-based identification</td>
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<td>RQ3 &amp; RQ4 &amp; RQ5</td>
<td>Multilevel Regression T-test and Linear Regression</td>
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# Results: Actions

## Project Creation Actions Coding Scheme

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<th>Categories</th>
<th>Actions</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Coding</td>
<td>Create New</td>
<td>Start a new code from blank</td>
</tr>
<tr>
<td></td>
<td>Revise</td>
<td>Rework on the same code after playing program</td>
</tr>
<tr>
<td></td>
<td>Explore</td>
<td>Try out intermediate or advanced blocks repeatedly</td>
</tr>
<tr>
<td>Project Design</td>
<td>Customize</td>
<td>Decorate project or add character/background</td>
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Process 1: Project Iteration

Create New

Create New

Customize

Revise
Process 2: Long Customization

Customizing longer than 10% of the session duration
Process 3: Coding Exploration

Background

The Study

Pilot Phase

Main Phase

Discussion

Conclusion
MAIN STUDY
**Mixed-method: *Exploratory Sequential Design Process***

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

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**Identifying Processes**

Qualitative

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

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Measures: What are the outcomes?

Variety

Complexity

**ScratchJr Block Complexity Levels**

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RESULTS & DISCUSSION
1. Exploration Promotes Coding Block Variety

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
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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<th>End</th>
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| ▪ Free play to self-discovered different functions, especially basic blocks | ▪ Set plans on how long they will need for customizing vs. coding  
▪ More guidance on the advanced blocks then let them explore | ▪ Provide multiple sessions to work  
▪ Promote iteration by encouraging children to keep improving codes and adding details |
• 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
Dissertation Committee:

Marina Bers, Boston College
Sara Johnson, Tufts University
Remco Chung, Tufts University
Karen Brennan, Harvard University

Acknowledgement

This research was funded by the U.S. Department of Education Grant # U411C190006
Breakout Groups

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.

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