ScratchJr: Computer Programming in Early Childhood Education as a Pathway to Academic Readiness and Success

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Overview
Children in kindergarten through grade 2, compared to older children, have fewer opportunities to use powerful educational technologies that provide developmentally appropriate interfaces as well as educationally rich activities. The ScratchJr project aims to develop and study the next generation of innovative technologies for 5-7 year old children to engage in open-ended creative design and digital construction. ScratchJr combines a programming tool with curricular materials that support integrated learning of STEM, math, and literacy, as well as problem solving and other general foundational knowledge skills. An online resource website also provides resources and peer support for parents and teachers.

Research Goals
Development of a version of the Scratch programming environment and accompanying curricular resources which are developmentally appropriate for 5-7 year olds and suitable for immediate implementation in early childhood educational settings.

Evaluation of learning outcomes and documentation of how ScratchJr engages children in three core areas of learning:
- Domain-specific knowledge drawn from state and national curriculum frameworks for early math and literacy
- Foundational knowledge structures that apply across many academic domains, such as sequencing, classification, symbols, estimation, and prediction
- Complex problem solving skills, specifically 1) identification of a goal, 2) formulation of a plan, 3) development of an initial attempt at meeting the goal; 4) testing, evaluating, and sharing outcomes; and 5) debugging and revising the initial attempt based on feedback.

Phase 4 Research Agenda
- Refine ScratchJr Beta-version based on classroom implementation
- Develop ScratchJr release version
- Develop and implement curricula to introduce ScratchJr and identify strategies for integrating it into teachers’ existing curricular themes and activities
- Evaluate children’s learning of the ScratchJr programming environment with pilot Solve It assessments
  - Programming block comprehension, understanding of symbolic representation of a programmatic command
  - Complex problem solving: program comprehension and reconstruction

Phase 4 Studies
During Phase 4, we conducted 2 studies to document and analyze the age-appropriateness and learning affordances of the features of the Beta-version ScratchJr tablet-based programming environment with N=98 children in grades K-2. Six teachers and several researchers collaborated at two New England elementary schools to implement ScratchJr curricula and evaluate learning outcomes.

Curricula
School A: N=66 K-2nd grade students participated in a researchers-designed curriculum on ScratchJr programming as a self-expression tool. Children explored features of different expressive genres (collages, stories, and games) and used ScratchJr for hour-long lessons twice weekly.

School B: N=31 Kindergarten students were exposed to ScratchJr as a short-term “center-time” activity for 15-minute sessions twice weekly. Children were encouraged to complete short teacher-directed tasks, and were then free to explore features of the app on their own.

Assessment: “Solve It” Tasks
All participants’ learning was assessed using pilot “Solve It” assessment tasks. ScratchJr projects were displayed onto a screen without the program visible. Children were then asked to guess the blocks used and the order in which they were sequenced.

Block Comprehension: “Watch the cat. Can you circle all of the blocks in this cat’s program?”

Program Sequencing: “Watch the cat. Can you build this cat’s program?”

Results and Key Findings
Solve It a scores based on errors, and a perfect score is a zero. All results are reported in terms of logical errors made by students

School A
Mean Errors by Grade and Gender

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<thead>
<tr>
<th></th>
<th>Kindergarten</th>
<th>First Grade</th>
<th>Second Grade</th>
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<tbody>
<tr>
<td>Male</td>
<td>22.4</td>
<td>18.7</td>
<td>13.5</td>
</tr>
<tr>
<td>Female</td>
<td>19.9</td>
<td>15.1</td>
<td>14.4</td>
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</tbody>
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- Males made more errors in Kindergarten and First Grade on assessments of sequencing ability and block comprehension.
- Females outperformed males in all grades except 2nd, where they had more errors.

Mean Errors in Block Comprehension vs Program Sequencing

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<th>0</th>
<th>1</th>
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<tbody>
<tr>
<td>Grade</td>
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Key Outcomes and Next Steps
The research from Phases 1-4 has contributed to the successful creation of a final ScratchJr release version, several pilot-tested curriculum and assessment methods, and public online resources, as well as numerous published research investigations (accessible from the DevTech Research Group Website).

In Phase 5, we will focus on three project areas for successful dissemination:
1. Curriculum development: We will develop Computer Science K-2 units that introduce concepts and skills that can be taught through ScratchJr, and as a foundation for other programming languages.
2. Assessments: We will further develop our current Solve It assessment to prepare it for dissemination so others can use it. We will also pilot test new assessment instruments for use with the new curriculum and lesson plans.
3. Dissemination: We will disseminate the finalized ScratchJr software as an application for iPad and Android tablet platforms. We will also disseminate the curriculum and video-tutorials through our website, as well as offer teaching materials in the form of traditional books about best practices to integrate computer programming with Scratch Jr. with other STEM disciplines, as well as literacy.

Publications
Kazakoff, E. R. (2014). Can in the Space. Post that goes: Does self-regulation play a role when kindergarten peers are code: Unframed by the University. Indiana University, Bloomington, IN.

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