An Examination of the Correlation Between Exploring Computer Science Course Performance and the Development of Programming Expertise

Chicago Alliance for Equity in Computer Science (CAFÉCS)
One day, an old man was walking along a beach that was littered with thousands of starfish that had been washed ashore by the high tide. As he walked he came upon a young girl who was eagerly throwing the starfish back into the ocean, one by one.

Puzzled, the man looked at the girl and asked what she was doing. Without looking up from her task, the girl simply replied, “I’m saving these starfish, Sir”.

The old man chuckled aloud, “There are thousands of starfish and only one of you. What difference can you make?”

The girl picked up a starfish, gently tossed it into the water and turning to the man, said, “I made a difference to that one!”
Growth of ECS in CPS

# of Active ECS Teachers

- 2012: 27
- 2013: 34
- 2014: 50
- 2015: 66
- 2016: 99
- 2017: 112
- 2018: 159

Red: Untrained Teachers  Blue: Trained

Number of ECS Students

- 2012: 3,163
- 2013: 6,165
- 2014: 10,764
- 2015: 15,348
- 2016: 23,249
- 2017: 33,827
- 2018: 45,762

Blue: Per Year  Red: Cumulative
EXPLORING COMPUTER SCIENCE

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This is a teacher copy of the curriculum and is intended solely for individual classroom use.
ECS Overview

- **Purpose/Objective:** curriculum and PD model to promote the inclusion of women and underrepresented groups in computing.

- **3 Strands**
  - Equity
  - Inquiry
  - CS Content

- **Computational Practices**
  - **Analyze** the effects of developments in computing (impact/connections)
  - **Design** and **implement** creative solutions and artifacts
  - **Apply** abstractions and models
  - **Analyze** their computational work and the work of others
  - **Communicate** computational thought processes, procedures, and results to others
  - **Collaborate** with peers on computing activities
Curriculum

- Differentiated and highly scaffolded.
- Lessons build on students’ prior knowledge and experiences.
- 6 Units
  - Human-Computer Interaction [~4 weeks]
  - Problem Solving [~4 weeks]
  - Web Design [~5 weeks]
  - **Introduction to Programming** [~6 weeks]
  - Computing and Data Analysis [~6 weeks]
  - Robotics [~7 weeks]
Students are introduced to some basic issues associated with program design and development.

Students design algorithms and create programming solutions to a variety of computational problems using an iterative development process in Scratch.

Programming problems include mathematical and logical concepts and a variety of programming constructs.
Learning Sciences

Cognition → Design

Social Context
<table>
<thead>
<tr>
<th>General Phases (Linn and Dalbey)</th>
<th>ECS Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension of language features</td>
<td>AND/OR game</td>
</tr>
<tr>
<td>Planning Solutions</td>
<td>Rock, Paper, Scissors Game</td>
</tr>
<tr>
<td>Generating Code</td>
<td>Define a problem, plan a solution, and use the features of Scratch to implement a solution</td>
</tr>
</tbody>
</table>
ECS Assessment Development

- Parallel pretest and posttest forms address first four units of ECS
- Developed by SRI International using Evidence-Centered-Design over the course of 2 years with 941 students.
  - Worked with stakeholders to identify important concepts and skills
  - Mapped those skills to a model of evidence to support inferences about those skills
  - Developed tasks that elicit the evidence
- Validity was established through expert review of items, cognitive think aloud with students, and analysis of test reliability.
Lucia’s algorithm

- **Step 1:** Ask how many laps the dog should run. Go to Step 2
- **Step 2:** Check the number entered.
  - **Step 2a:** If the number entered is less than 2, then the dog says “Not enough laps.” Then skip to Step 4.
  - **Step 2b:** If the number entered is NOT less than 2, then move to Step 3.
- **Step 3:** The dog runs the number of laps entered. Go to Step 4.
- **Step 4:** The program ends.

b) In Lucia’s algorithm, what is shown on the screen if the number entered is 120?

- Dog says “Not enough laps.”
- Dog says “Too many laps.”
- Dog runs 120 laps.
- Dog runs 60 laps.
3. Your teacher wants to create a class website as a place where students can go to view information from the class and to get help from the teacher and each other.

a) Your teacher wants a list of 4 requirements to give to a web design team who will create the website. Your teacher has provided the first requirement. List 3 more requirements to give to the web design team.

Be sure that each requirement describes **specific content** *(WHAT information is provided)* and **specific design** *(HOW the information should look)* for the website.

<table>
<thead>
<tr>
<th>Requirement 1</th>
<th>A section at the top left that shows the student’s current grade. The grade should be colored green, yellow, or red to indicate if the student is passing or not.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement 2</td>
<td></td>
</tr>
<tr>
<td>Requirement 3</td>
<td></td>
</tr>
<tr>
<td>Requirement 4</td>
<td></td>
</tr>
</tbody>
</table>
d) Which step(s) in Lucia’s algorithm would you program using the *Repeat Until* structure block? Select all that apply.

*Repeat Until* structure block:

- [ ] Step 1
- [ ] Step 2a
- [ ] Step 2b
- [ ] Step 3
- [ ] None of the steps

**Lucia’s algorithm**

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Methods

- Fall 2016
  - Pretest Assessment
- Spring 2017
  - Post Assessment (2 linked items)
Demographics of Study Participants (16/17)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Research Sample</th>
<th>Other ECS</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1931</td>
<td>4494</td>
</tr>
<tr>
<td>Female</td>
<td>42%</td>
<td>45%</td>
</tr>
<tr>
<td>Caucasian</td>
<td>15%</td>
<td>12%</td>
</tr>
<tr>
<td>African American</td>
<td>20%</td>
<td>29%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>58%</td>
<td>46%</td>
</tr>
<tr>
<td>Asian</td>
<td>5%</td>
<td>8%</td>
</tr>
</tbody>
</table>
Increase in Assessment Performance

A line graph showing the increase in assessment performance from pretest to posttest. The graph indicates an upward trend with the score increasing from a lower value at pretest to a higher value at posttest.
Correlation of Course Grade to Posttest Score
<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension</td>
<td>38%</td>
<td>61%</td>
</tr>
<tr>
<td>Planning</td>
<td>35%</td>
<td>64%</td>
</tr>
<tr>
<td>Generation</td>
<td>15%</td>
<td>25%</td>
</tr>
</tbody>
</table>
Social Context

- **Advanced Programming Classes**
  - One-third of ECS students have taken additional coursework, but many schools only offer ECS
  - Developing Coursework and Assessment Trajectory

- **Bridges to Math and Science**
  - Math: Bootstrap
  - Science: Netlogo, Sage Model
  - Course Team Support
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