Equal Outcomes 4 All

Chicago Alliance for Equity in Computer Science (CAFÉCS)
Preparing the Upper Midwest for Principles of Computer Science (PUMP-CS)
Principled Assessment of Computational Thinking (PACT)

S. McGee, R. McGee-Tekula, J. Duck, C. McGee, L. Dettori, R.I. Greenberg, E. Snow, D. Rutstein, D. Reed, B. Wilkerson, D. Yanek, A.M. Rasmussen, and D. Brylow. 2018. Equal Outcomes 4 All: A Study of Student Learning in ECS. In SIGCSE '18: 49th ACM Technical Symposium on Computer Science Education, Feb. 21–24, 2018, Baltimore, MD, USA. ACM, NY, NY, USA, 6 pages.
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CAFÉCS

Chicago Public Schools

UIC

LOYOLA UNIVERSITY CHICAGO

DEPAUL UNIVERSITY

The Learning Partnership

PUMP CS

Preparing the Upper Midwest for Principles of Computer Science

MARQUETTE UNIVERSITY

University of Wisconsin La Crosse

The Learning Partnership

Principled Assessment of Computational Thinking

SRI International

Computer Science Outcomes

- Attitudes towards computer science
  - Our prior research has shown that the quality of students course experiences influence computer science attitudes as well as subsequent high school course taking.
  - In this research, we took a systematic approach to measuring student attitudes and course experiences
- Computational Thinking Practices
  - Use of a new measure developed by SRI International
  - Examine the influence of teaching and student attitudes on learning outcomes
- How do these computer science outcomes compare by race and gender across two different contexts?

Preliminary Results

- These results represent one year of implementation.
- In the words of Bryk et. al. in *Learning to Improve*, these results are "probably wrong and definitely incomplete."
- It will take several years of data to have more confidence in the results.

Version 7.0

EXPLORING COMPUTER SCIENCE

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ECS Overview

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

Unit 2 Problem Solving

Purpose is to provide students with the opportunity to explore computational thinking by applying a variety of problem solving techniques. There is a focus on articulating thought processes, problem solving strategies and developing and applying algorithms.

Unit 2 Problem Solving

Daily Overview Chart	
Instructional Day	**Topic**
1 – 2	Introduce data collection and problem solving.
3	Introduce the four steps of the problem solving process.
4 – 6	Apply the problem solving process. Use different strategies to plan and carry out the plan to solve several problems. **Handshake Activities 1 & 2**
7 – 9	Reinforce the four steps of the problems solving process.
10 – 12	Count in the binary number system. Convert between binary and decimal numbers in the context of topics that are important to computer science.
13 – 14	Introduce **the linear and binary search algorithms. Tower Building**
15 – 16	Explore sorted and unsorted lists and various sorting algorithms. **Selection Sort: same as the handshake problem** **QuickSort: Divide and Conquer algorithm**
17	Introduce minimal spanning trees and how graphs can be used to help solve problems.
18 – 21	Final projects and presentations

Unit 2: Concept Map

Handshake #1
(N – 1)

days
4 - 6

Handshake #2
N(N – 1)/2

Linear Search
(N – 1)

days
13-14

Tower Building
Binary Search
(reduce data
set by ½)
O(logN)

Selection Sort
N(N – 1)/2

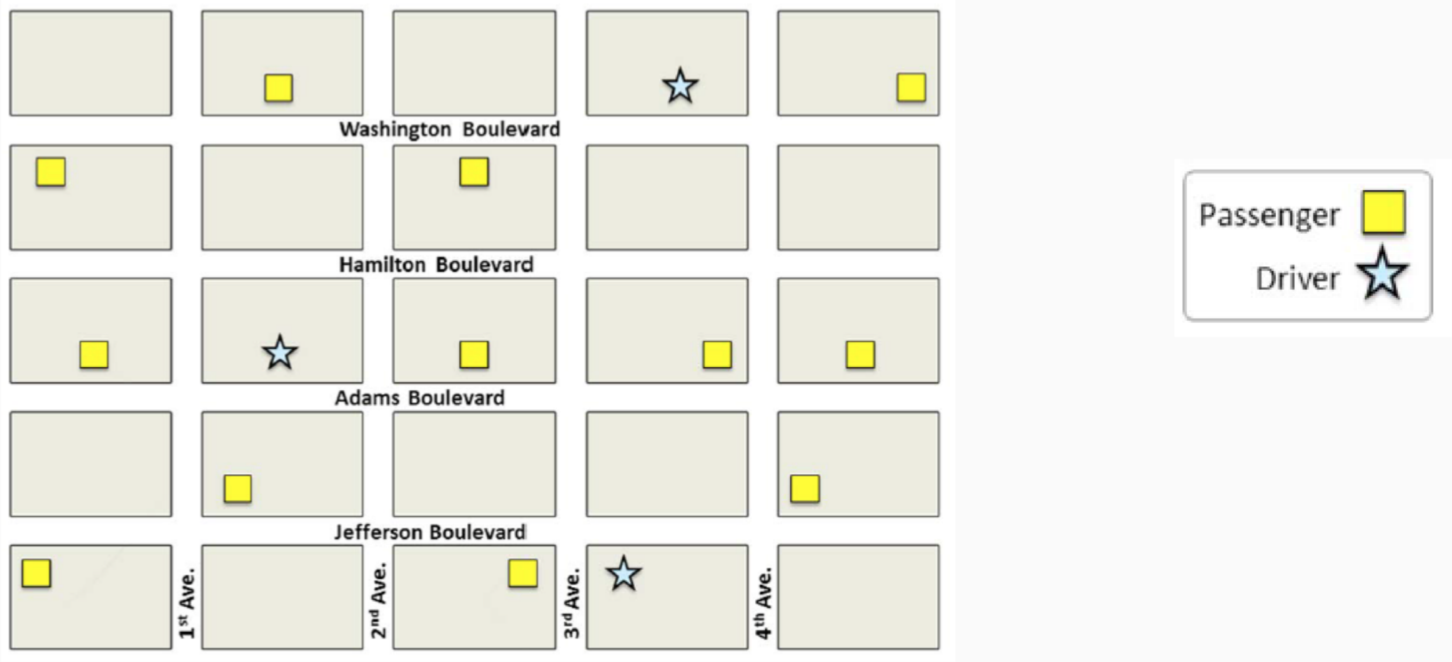
days
15-16

QuickSort
(reduce data set)
O(NlogN)

Divide
&
Conquer

Sample Assessment Question

You and your classmates are making plans to see a concert in another city. There are 15 people going, and you decide to drive several cars to the concert. Each car can hold up to 5 people, including the driver. Arya wants to take only 3 cars and put 5 people in each car. Below is a map showing your classmates' locations. The stars show the people who are driving, and the squares show where the other people live. Figure out who goes in which car.



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.

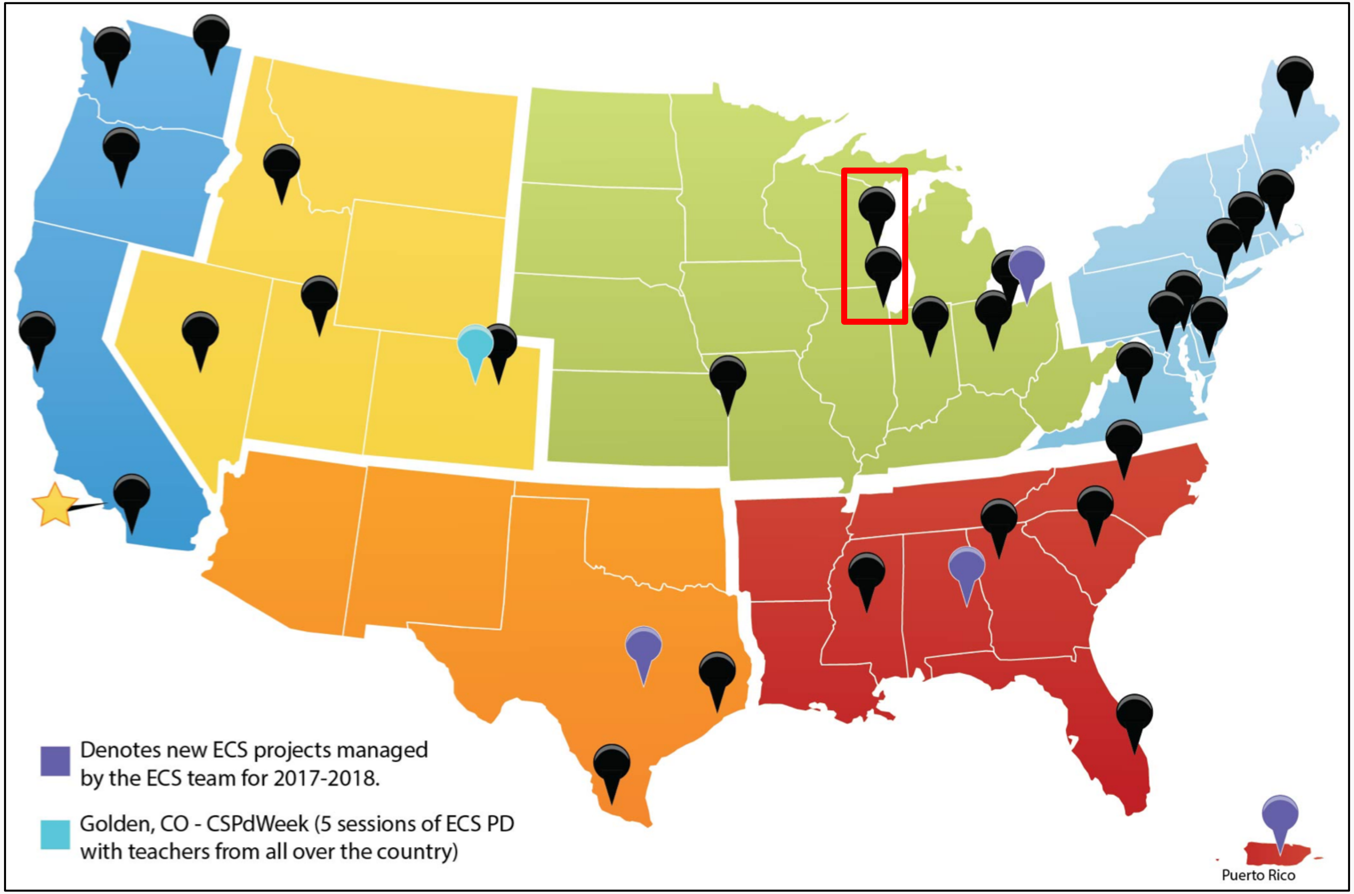
Principled Assessment of Computational Thinking

Attitudes towards Computer Science

- Expectancy-Value-Cost theory (Eccles)
  - I *expect* to do well in a discipline
  - I *value* the discipline for myself and society
  - The *cost* of participating is low

- Decades of research has shown expectancy-value-cost is strong predictor of college major, free time activities and career choices

Reach of Exploring Computer Science



Methods

- Fall 2016
  - Pretest Assessment
  - Presurvey (demographics, EVC)
- Spring 2017
  - Post Assessment (2 linked items)
  - Postsurvey (demographics, EVC, teaching index)

Teaching Index

- Student surveys of the prevalence of pedagogical strategies have been correlated with observations and outcomes.
- Tripod 7C correlates with Charlotte Danielson
- Vekiri pedagogy scale correlated with EVC
- Prior research shows correlation with assessment outcomes

Collaboration
Confer
Challenge
Active Learning
Meaningful Learning

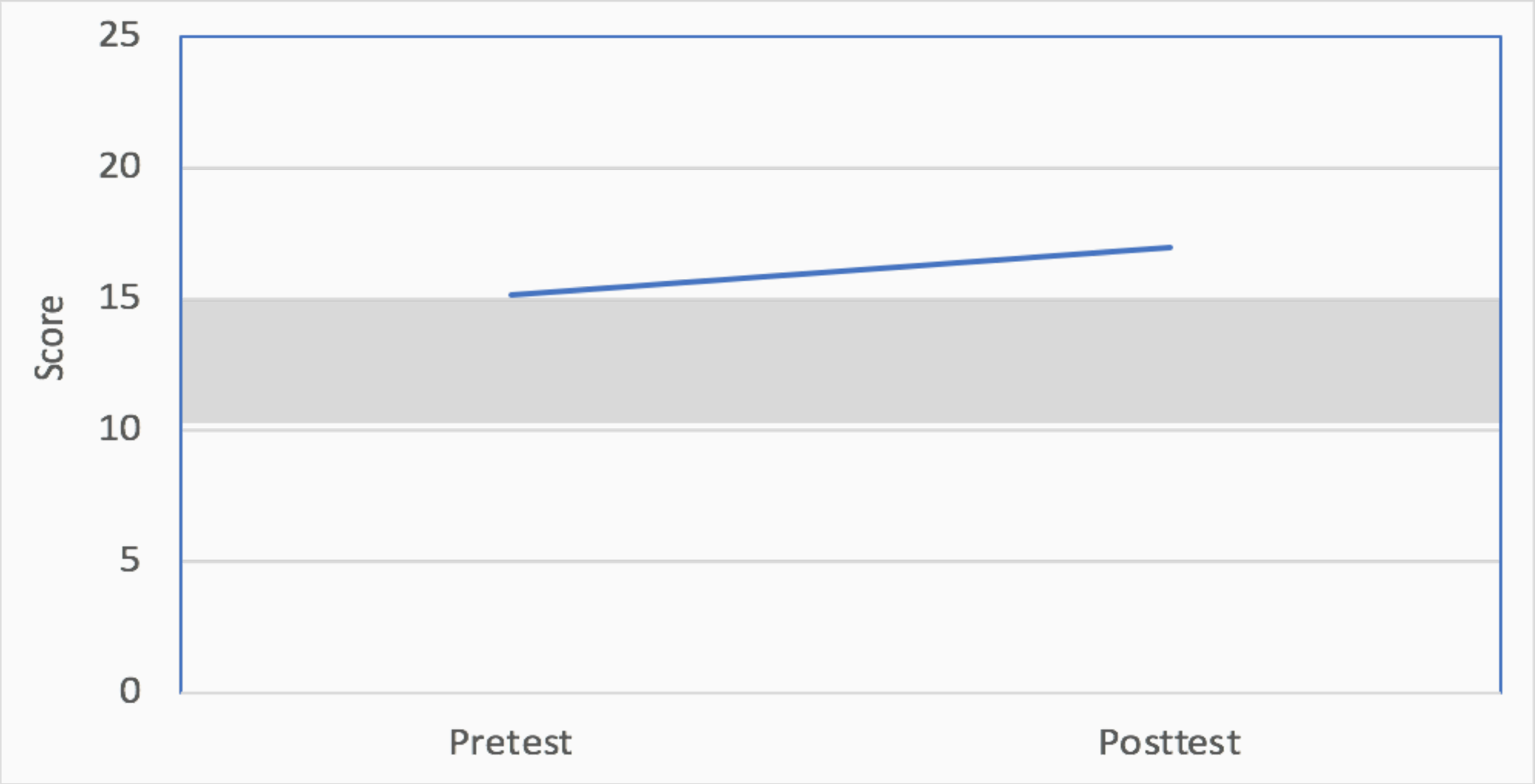
Captivate
Care

Clarify
Control
Consolidate

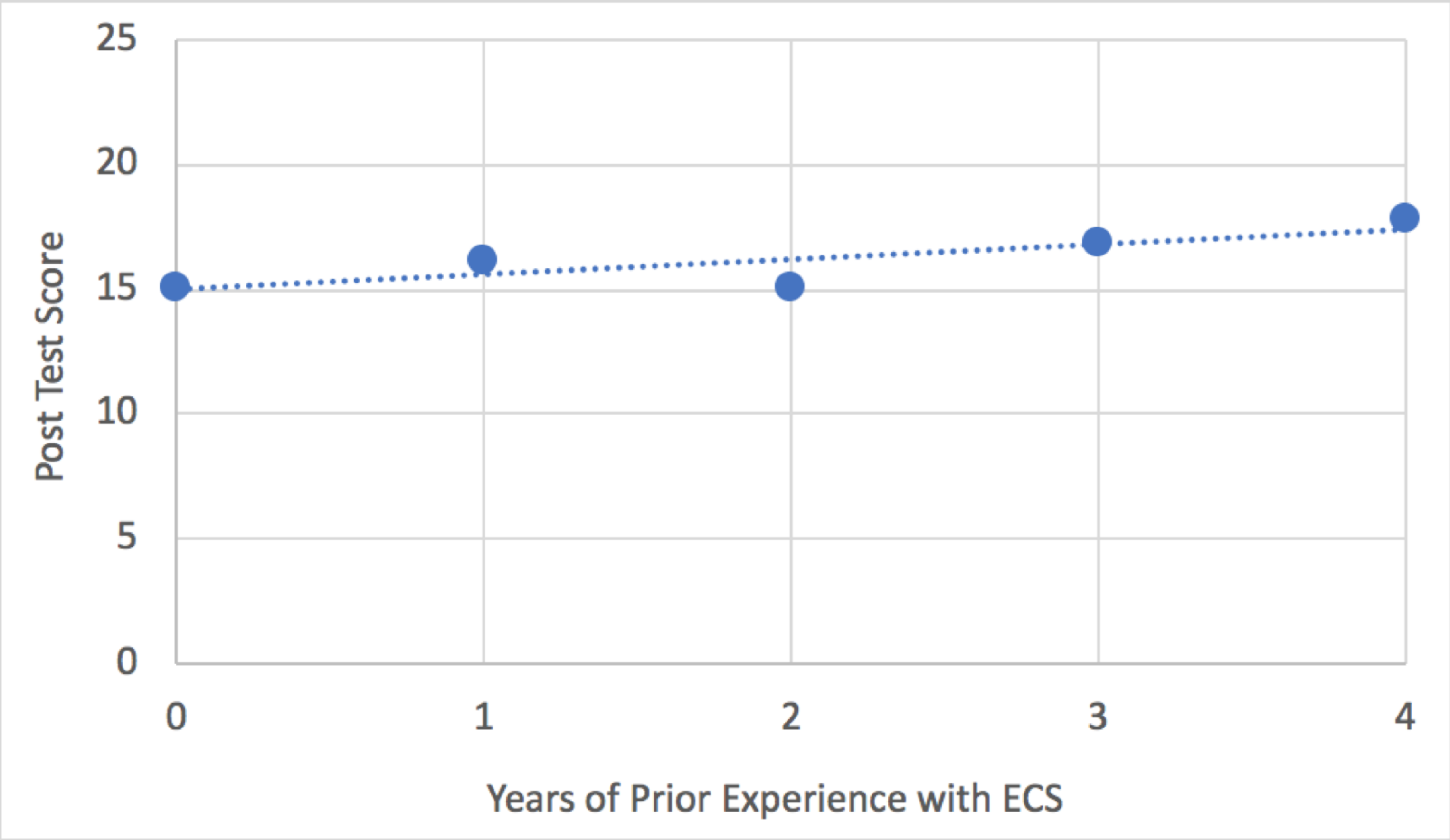
Demographics of Study Participants (16/17)

Demographics	CPS Research	CPS ECS	WI ECS - Research	WI
N	672	8302	234	9650
Female	40%	50%	22%	50%
Caucasian	43%	12%	75%	69%
African American	6%	29%	8%	11%
Hispanic	49%	50%	9%	12%
Asian	10%	7%	7%	3%

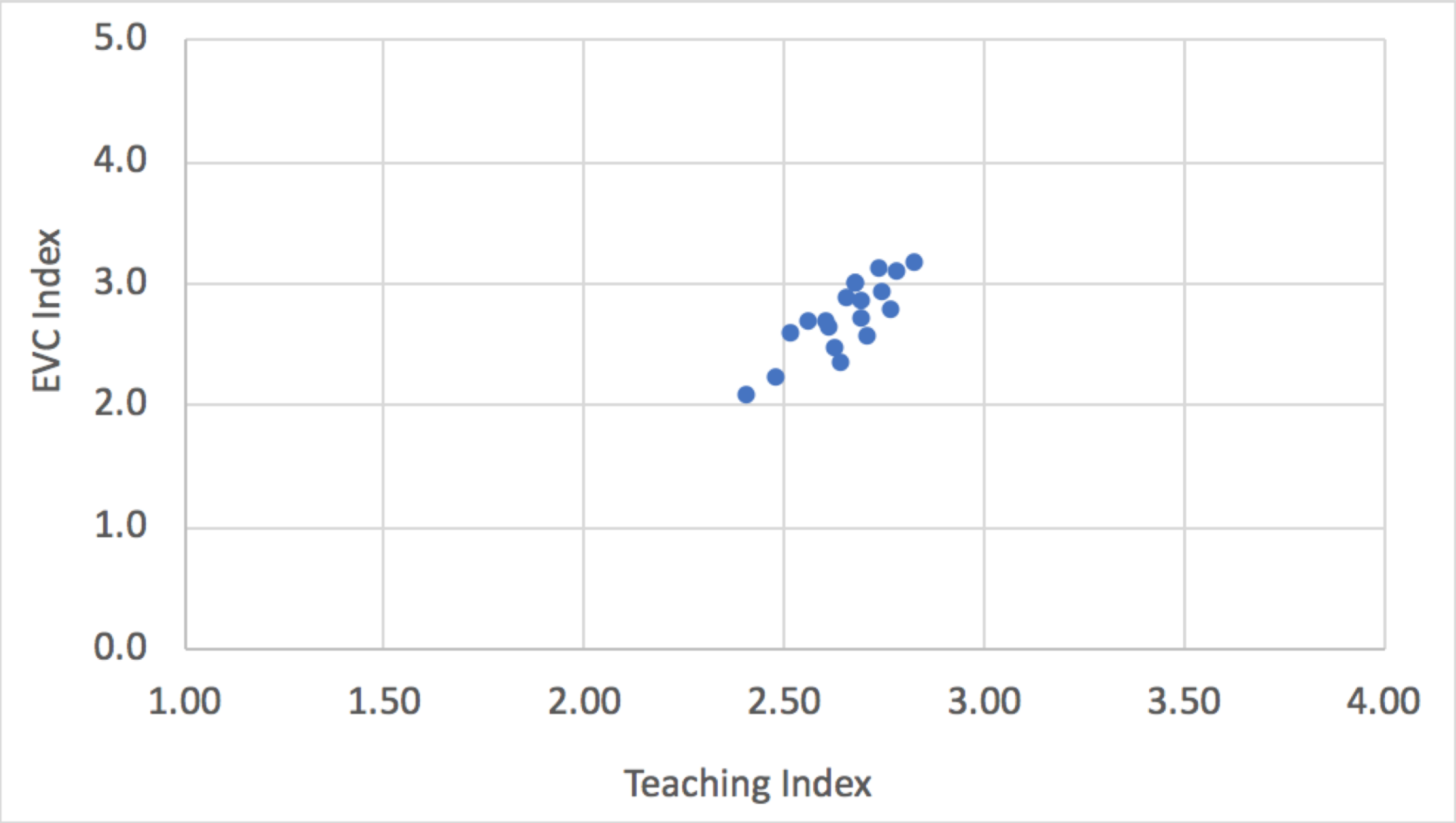
Learning Growth



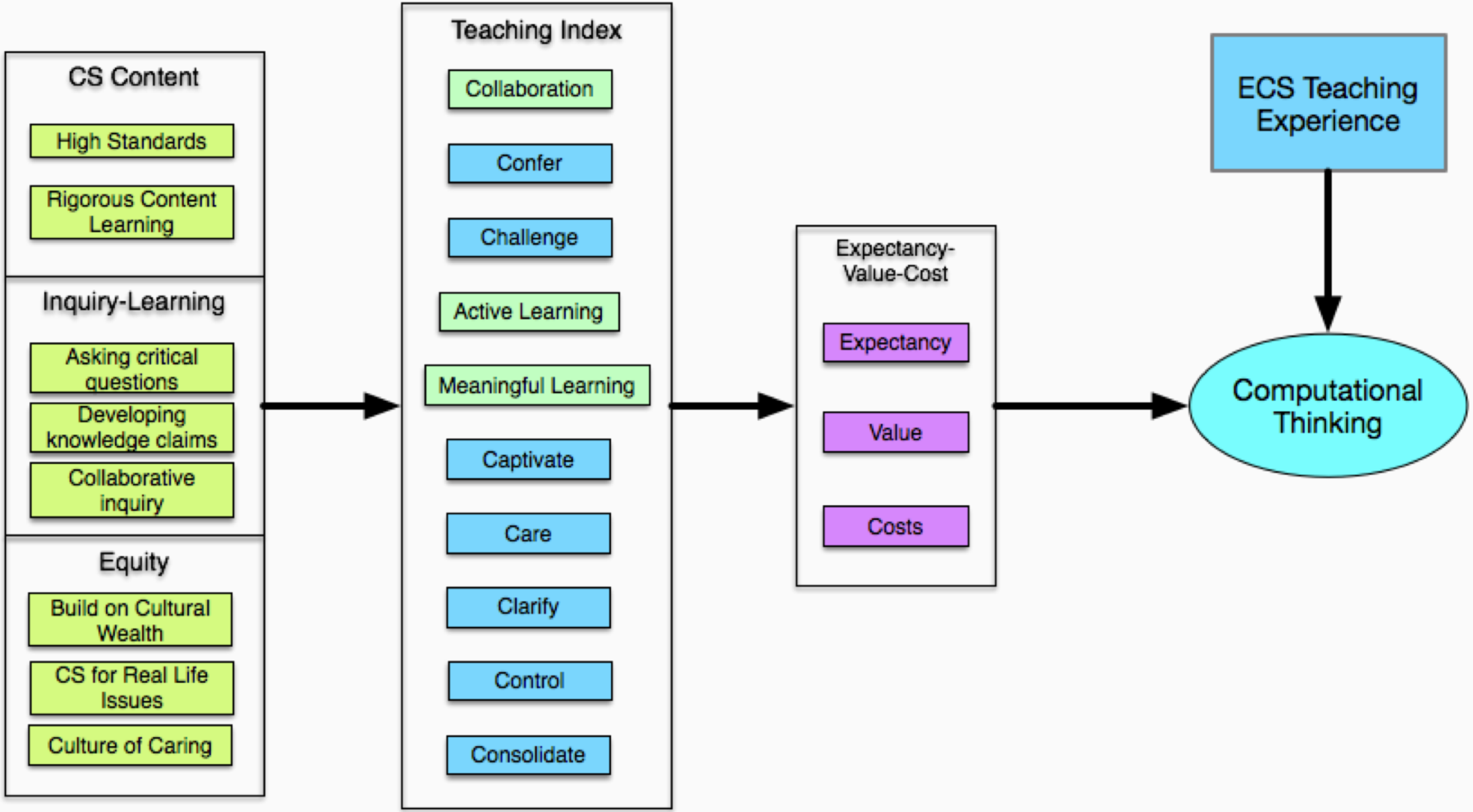
Influence of Teaching Experience on Learning Outcomes



Influence of Teaching Practices of Expectancy-Value-Cost



Conceptual Framework



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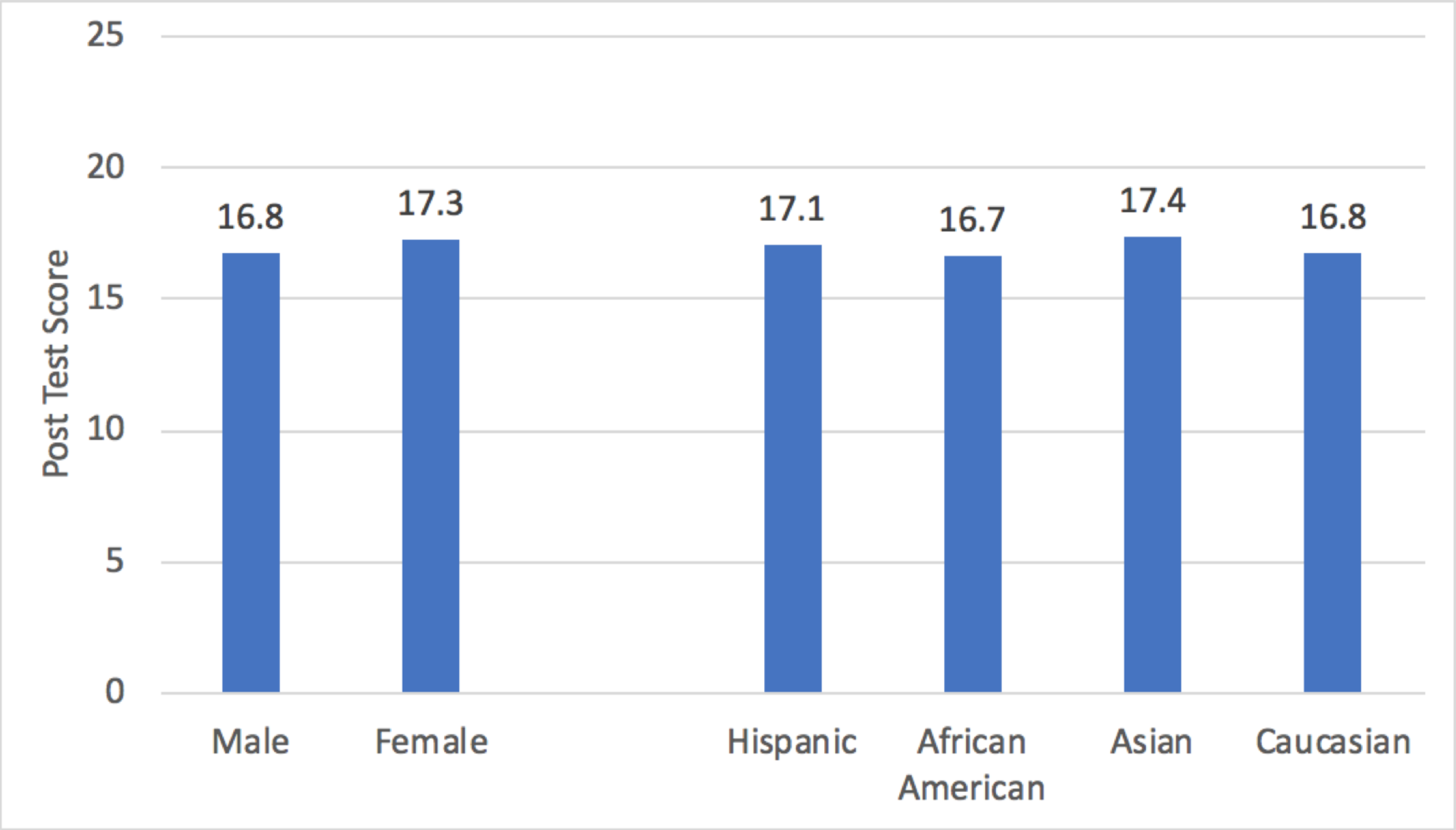

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