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Spatial Skills & Introductory Computing

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Spatial Skills & Introductory Computing

Steve Cooper

9/1/2016

Special thanks to Maya Israni^a, and Karen Wang^a, who worked with me on the project

a = Stanford undergraduate CS students

Who am I?

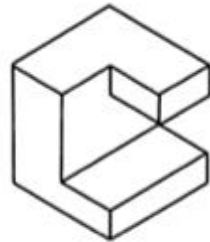
- Associate professor in CSE department
- Director of the Raikes School
- Previous work in CS education
 - Alice
 - CSTA



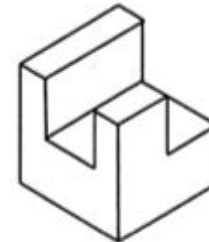
Spatial skills

- Spatial skills (which have been shown to be important success predictors in engineering) typically include:
 - **Mental rotation**
 - Paper folding
 - Map reading

What is mental rotation?



IS ROTATED TO

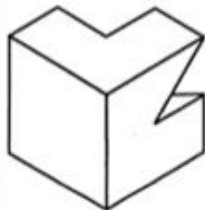


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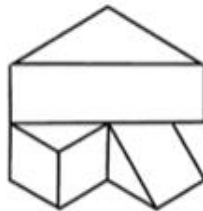


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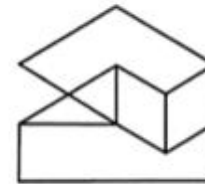
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The study

- Two Girl Code summer workshops
 - Each for 19 rising 12th grade girls, from Oakland, San Jose, and the Peninsula
 - Two-weeks, 40 hours per week
 - Cover nearly 1/2 Stanford's CS I course (CS106A)
 - Lots of coding practice, students were encouraged to work together
 - Explore careers in CS

Mental rotation topic coverage

- Isometric drawings (2 sessions)
 - Orthographic drawings (1 session)
 - Single & double object rotations (3)
 - Reflections & symmetry of objects (1)
 - Surfaces and solids of revolution (1)
-
- Coverage was for 45 minutes at the start of the day

Student demographics

School Income	Lower	Middle	Upper	
Session 1		10	4	5
Session 2		8	2	9
Race/Ethnicity	Hispanic	African American	Asian + White	
Session 1		9	3	7
Session 2		5	4	10

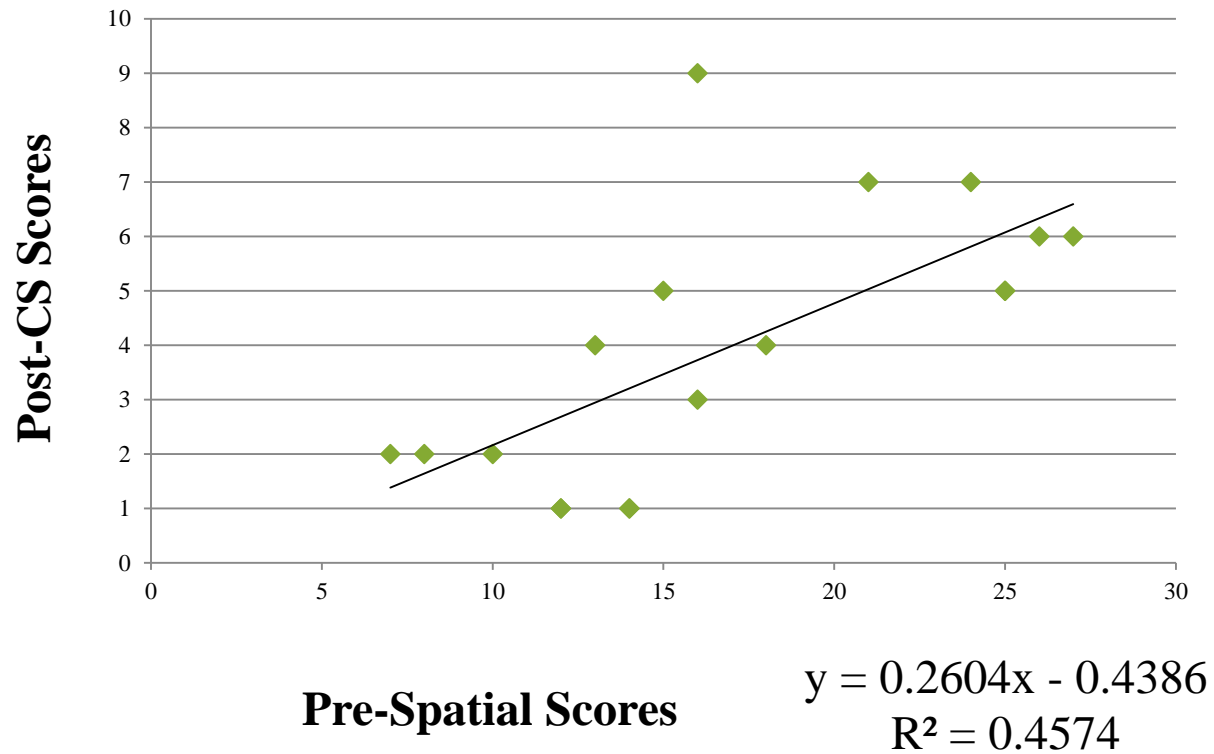
Our questions

- Is there a correlation between a student's spatial abilities and her ability in programming¹?
- If yes, can we increase programming success through the teaching of spatial skills?

¹ = Spatial abilities are measured through the R-PSVT, and CS programming ability is measured the 2009 AP CS MC questions

Correlation spatial vs. programming

Control: Pre-Spatial vs. Post-CS



Gains in spatial/programming

	Control Δ	Treatment Δ
CS	0.50 (0.23)	1.06 (0.07)
CS ID*	0.72 (0.11)	0.82 (p<0.05)
Spatial	0.89 (0.11)	2.63 (p<0.005)

Disaggregating by SES

Control	Lower	Middle + Upper	U	p
CS Δ	-1.56 (5.5)	2.56 (13.5)	4.5	p<0.001
CS ID* Δ	-0.78 (5.3)	3.00 (13.7)	3.0	p<0.001
Spatial Δ	1.20 (10.7)	0.56 (9.2)	38.0	0.28
Treatment	Lower	Middle + Upper	U	p
CS Δ	0.57 (8.4)	1.40 (9.5)	30.5	0.33
CS ID* Δ	0.57 (8.1)	1.09 (9.6)	29.0	0.28
Spatial Δ	2.38 (9.6)	2.82 (10.3)	41.0	0.40

Disaggregating by Race/Ethnicity

Control	Hispanic	African American	Asian + Caucasian	p
CS Δ	-1.63 (5.3)	0.33 (9.8)	3.00 (14.2)	p<0.01
CS ID* Δ	-0.88 (5.8)	0.00 (8.2)	2.86 (14.4)	p<0.01
Spatial Δ	1.00 (10.2)	1.67 (11.7)	0.43 (9.0)	0.78
Treatment	Hispanic	African American	Asian + Caucasian	p
CS Δ	1.20 (9.1)	-0.67 (6.5)	1.56 (9.5)	0.62
CS ID* Δ	0.80 (8.7)	0.00 (7.0)	0.80 (9.2)	0.69
Spatial Δ	1.80 (8.9)	4.00 (12.5)	2.50 (8.7)	0.59

Results/Caveats

Results

- Spatial training seemed to be correlated with better CS gains, and in particular helped Hispanic women and students from low SES backgrounds

Caveats

- We measured code reading, but taught code writing
- Differing student demographics for the 2 sessions
- Small n

What's next

- Working with a larger n
- With the CS4All initiative, we have the opportunity to explore a wider age range of students
- Investigating map reading in addition to/rather than mental rotation
 - Is there an something we can use for high school/college students?
 - How to teach it?
- Trying to understand why does teaching spatial skills help students in computing



Questions?