

Elementary Teachers' Self-Efficacy and Beliefs for Integrating Computing and Engineering Into Their Teaching

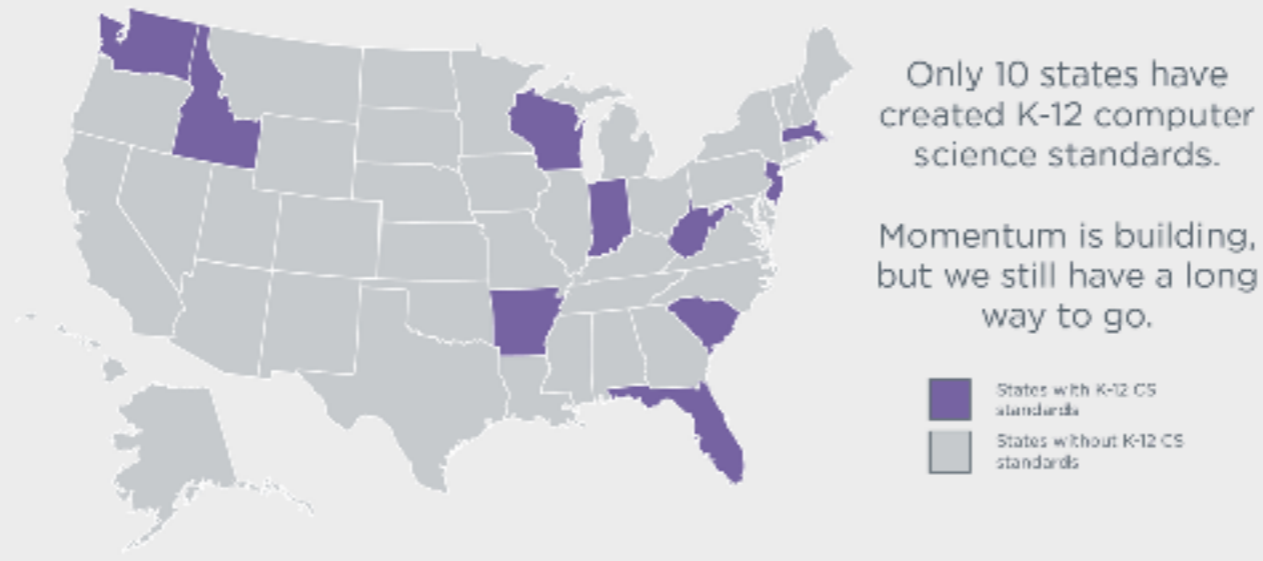
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Coding education has become compulsory in over 20 European countries, Australia, South Korea, and Israel.

The state of K-12 computer science standards



Progress is being made in the U.S. and K-12 computer science is quickly becoming a reality for tomorrow's teachers. In fact, 38 states now allow a computer science class in high school to count toward a core credit, often replacing a math or a language course.

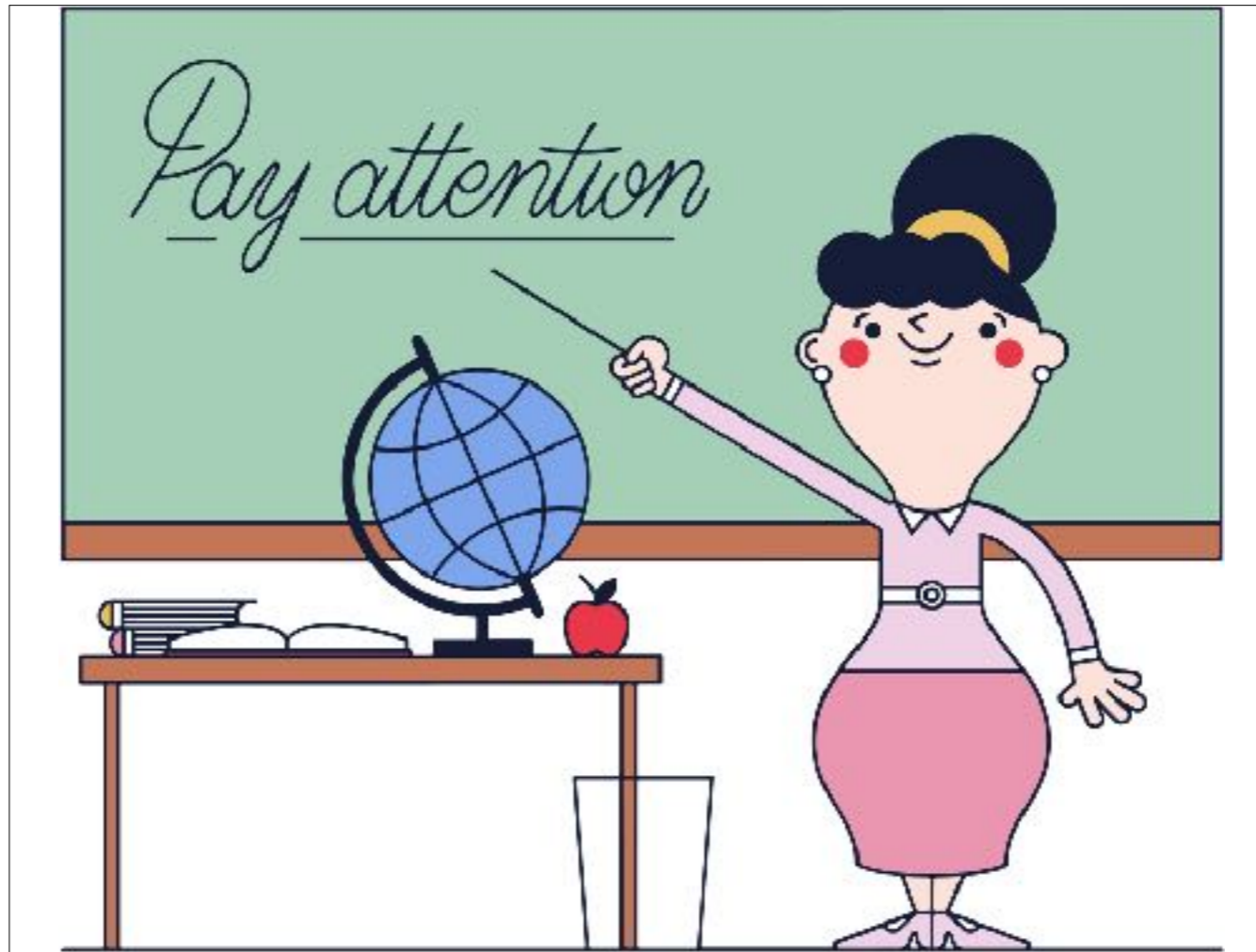
source: <https://code.org/promote>

**The engineering design process has been
“elevated to the same level as scientific inquiry”**

—Next Generation Science Standards



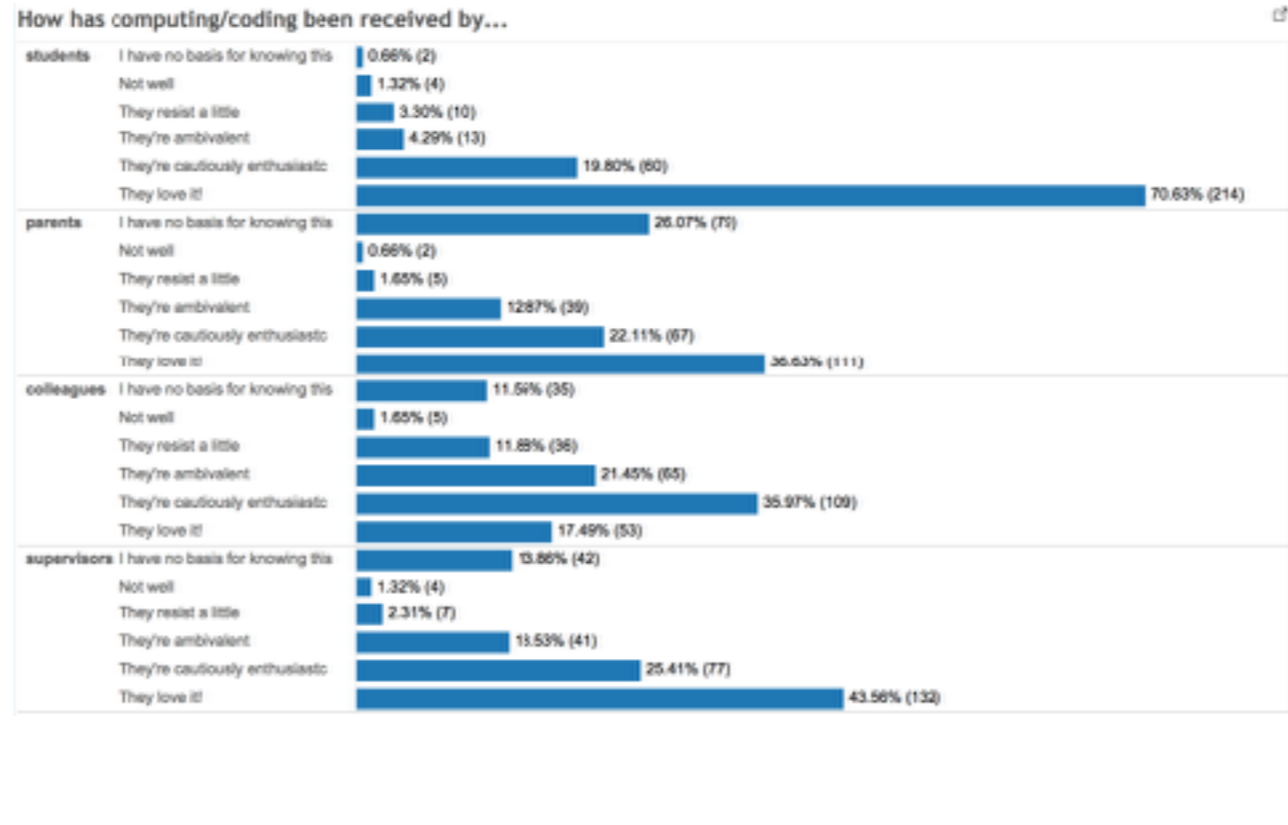
Many efforts to get computing to kids have happened in after-school spaces. But efforts are being made to make computer science available for all kids—not just those enrolled in after school programs. I used to run several after-school clubs and, while great, I realized that I would never be able to scale my efforts without 1 important player.



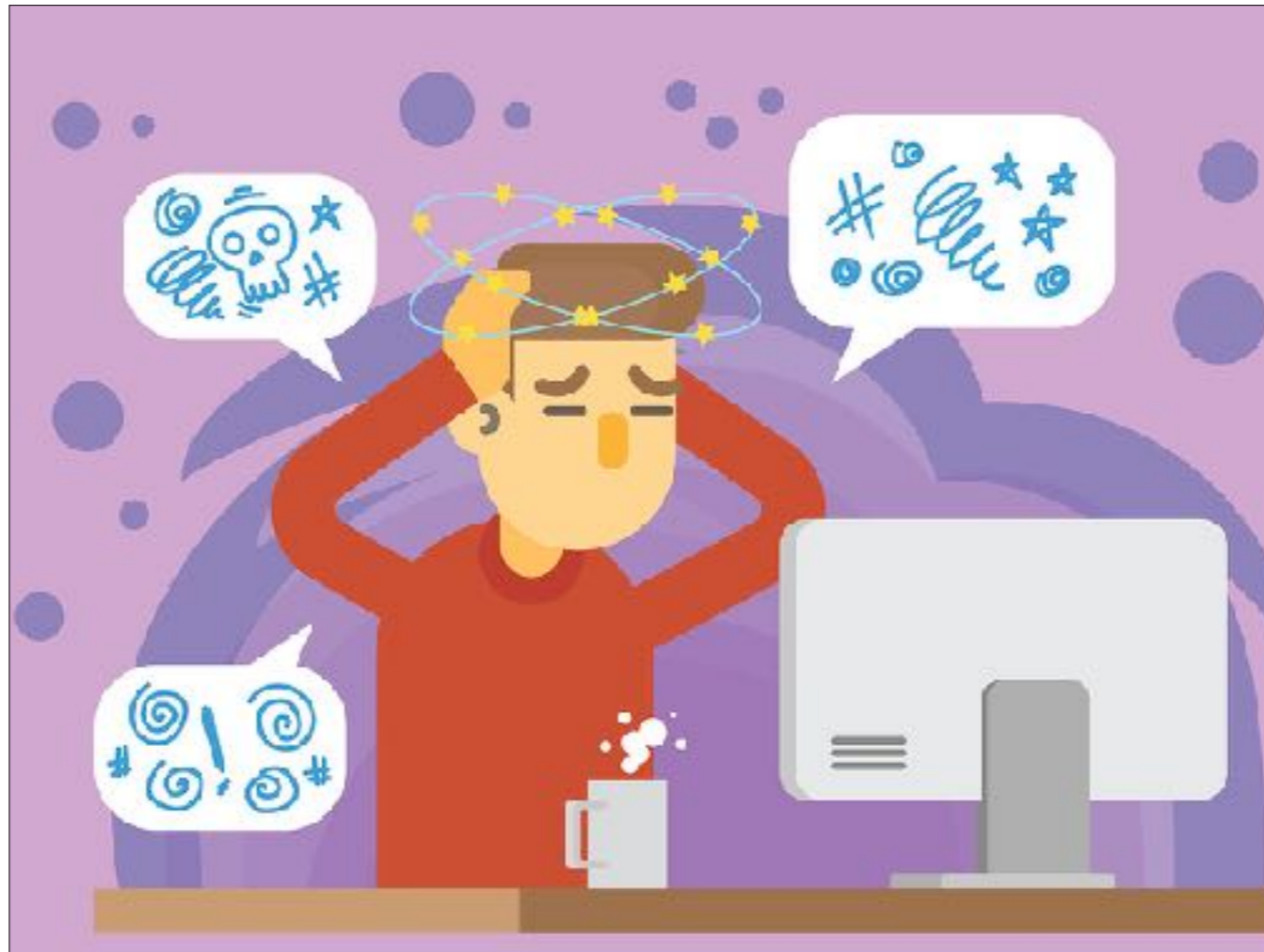
The teacher!

Image Source: vecteezy

How has coding been received?



Last year, we reported on a study on over 300 teachers who teach coding in K-8 in 23 different countries. The results indicate that, according to teachers, over 90% of students are enthusiastic about coding!



But many elementary teachers feel like this when they find out they're going to have to teach coding.

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Research Questions

- What are elementary teachers' beliefs about teaching engineering?
- What is elementary teachers' self-efficacy for teaching coding/computing?
- How do these change with training and experience?

Beliefs	Self-efficacy
Teacher practice is directed by their beliefs about a subject (Duffy & Anderson, 1984)	Perception of competence is a strong predictor of behavior (Bandura, 1986, 2010)
“A filter through which a host of instructional judgements are made” (Fang, 1996, p. 52)	Collective teacher efficacy has an effect size of 1.57 on student outcomes (Hattie, 2016)
Students tend to “inherit” a teacher’s belief about a subject. (Fang, 1996)	Self-Efficacy can be changed through mastery experiences (Bandura)

beliefs refer to the often deeply-held opinions about a subject, its importance, and how it ought to be taught

Making the BSEEE-T

- 30-item scale created based on BEST (from Boston Museum of Science), T-STEM-EL and our own experience, 15 items for beliefs, 15 for self-efficacy
- Sent to 300 K-6 teachers in 13 schools (153 responses)
- Exploratory Factor Analysis (N=153). Reduced to 18 items.
- Confirmatory Factor Analysis was performed with a different set of teachers (N=109) in 7 different schools.
- Final result: 12-item scale (7 beliefs; 5 self-efficacy)

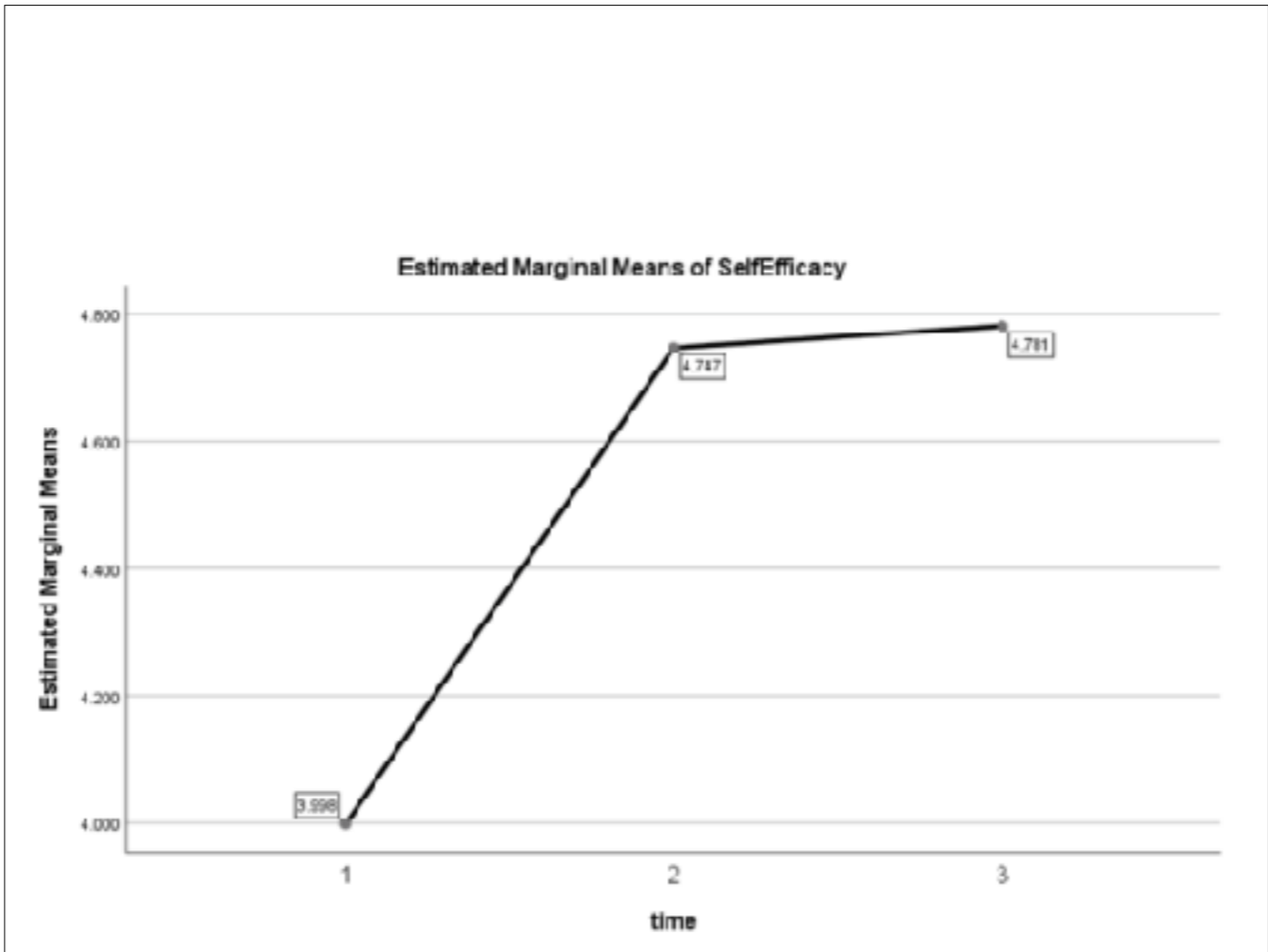
The final model consists of just 12 questions. This resulted in a measure that can be used with high reliability and low interference in teacher training.

Construct	Item	Item #	M	SD	Belief	Self-Effica
Belief	Engineering content and principles can be understood by elementary school children.	B11	5.08	0.73	0.779	
	Learning about engineering can help elementary students become more engaged in school.	B14	5.18	0.76	0.834	
	Engineering concepts should be taught to elementary school students.	B2	5.20	0.74	0.925	
	Engineering is a 21st century skill that is as important as "the basics" (Reading, Writing, Arithmetic).	B4	4.85	0.83	0.714	
	Providing more in-class engineering activities would enrich the overall learning of my students.	B5	5.17	0.74	0.826	
	Engineering content is an important part of the new science standards.	B8	5.06	0.67	0.829	
	Engineering concepts should be taught much more frequently in elementary school.	B9	4.87	0.71	0.901	
Self-Efficacy	I believe that I have the requisite science skills to integrate engineering content into my class lessons.	E5	4.02	1.07		0.687
	I can recognize and appreciate the engineering concepts in all subject areas.	E11	4.26	0.84		0.559
	I can describe the process of engineering design.	E13	3.63	1.18		0.546
	I believe that I have the requisite math skills to integrate engineering content into my class lessons.	E5	4.70	0.97		0.640
	I can create engineering activities at the appropriate level for my students.	E8	4.15	1.00		0.592

The final, validated 12-item BSEEE-T

Building a Measure for Computing Self-Efficacy

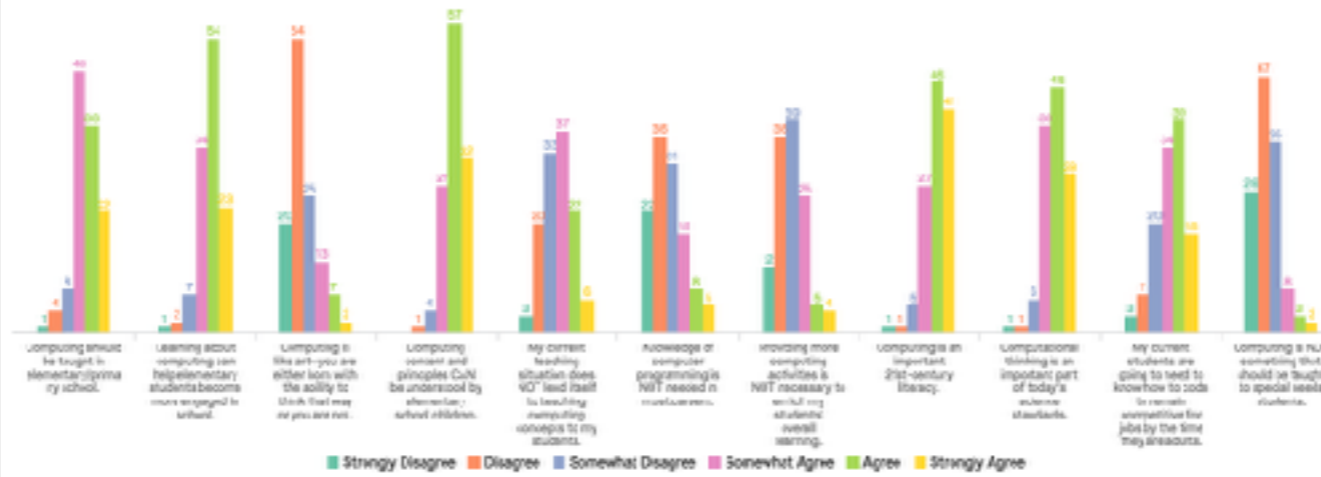
- Beliefs about the importance of teaching computing
- Self-efficacy for individual computing competence
- Teacher efficacy for computing confidence



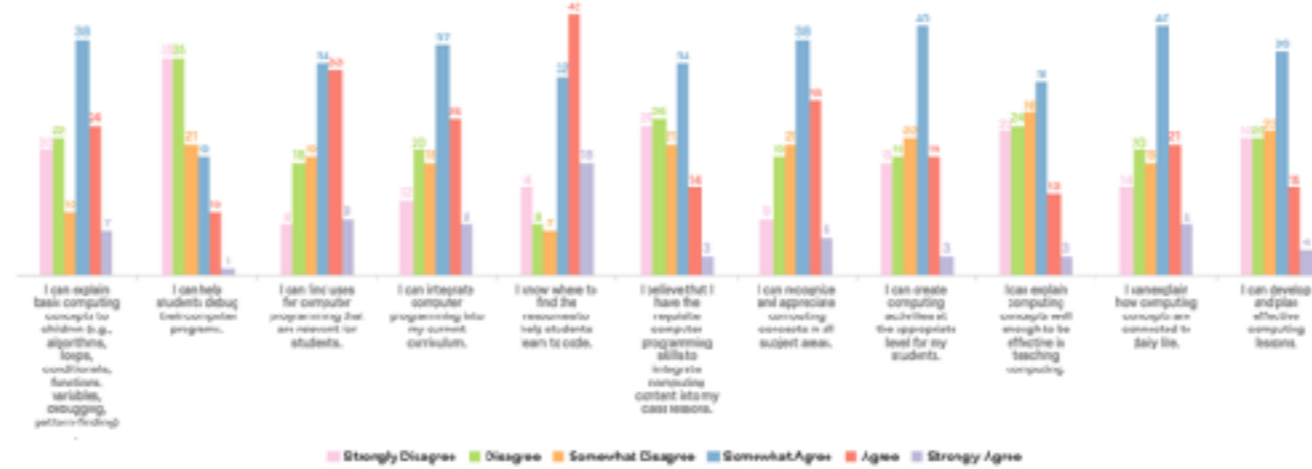
Constructing the scale

- Analyzed items from several self-efficacy studies in computer science (e.g., Dorn & Tew, 2015; Korkmaz, Çakir, & Özden, 2017; Kukul & Gökçearslan, 2017; Bean, Weese, Feldhasen, & Bell, 2015)
- Initial testing of items with:
 - preservice teachers
 - technology coaches

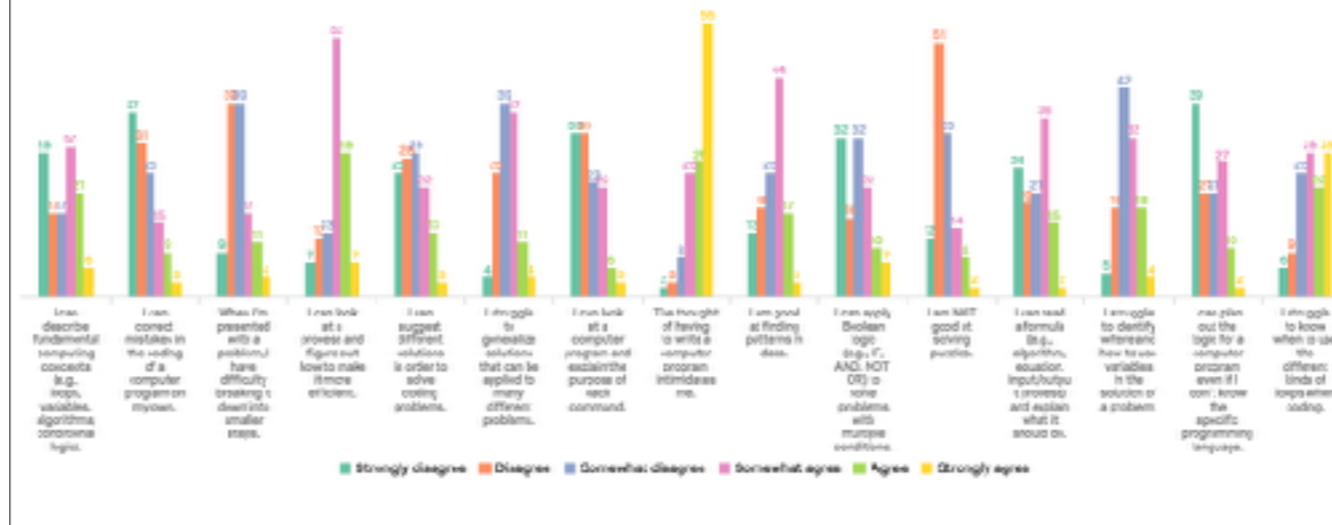
Beliefs about Computing (Preservice)



Computational Teaching Efficacy (Preservice)



Computational Self-Efficacy (Preservice)



Validating the scale

- Expert review
- Exploratory Factor Analysis
- Confirmatory Factor Analysis
- Long-term analysis