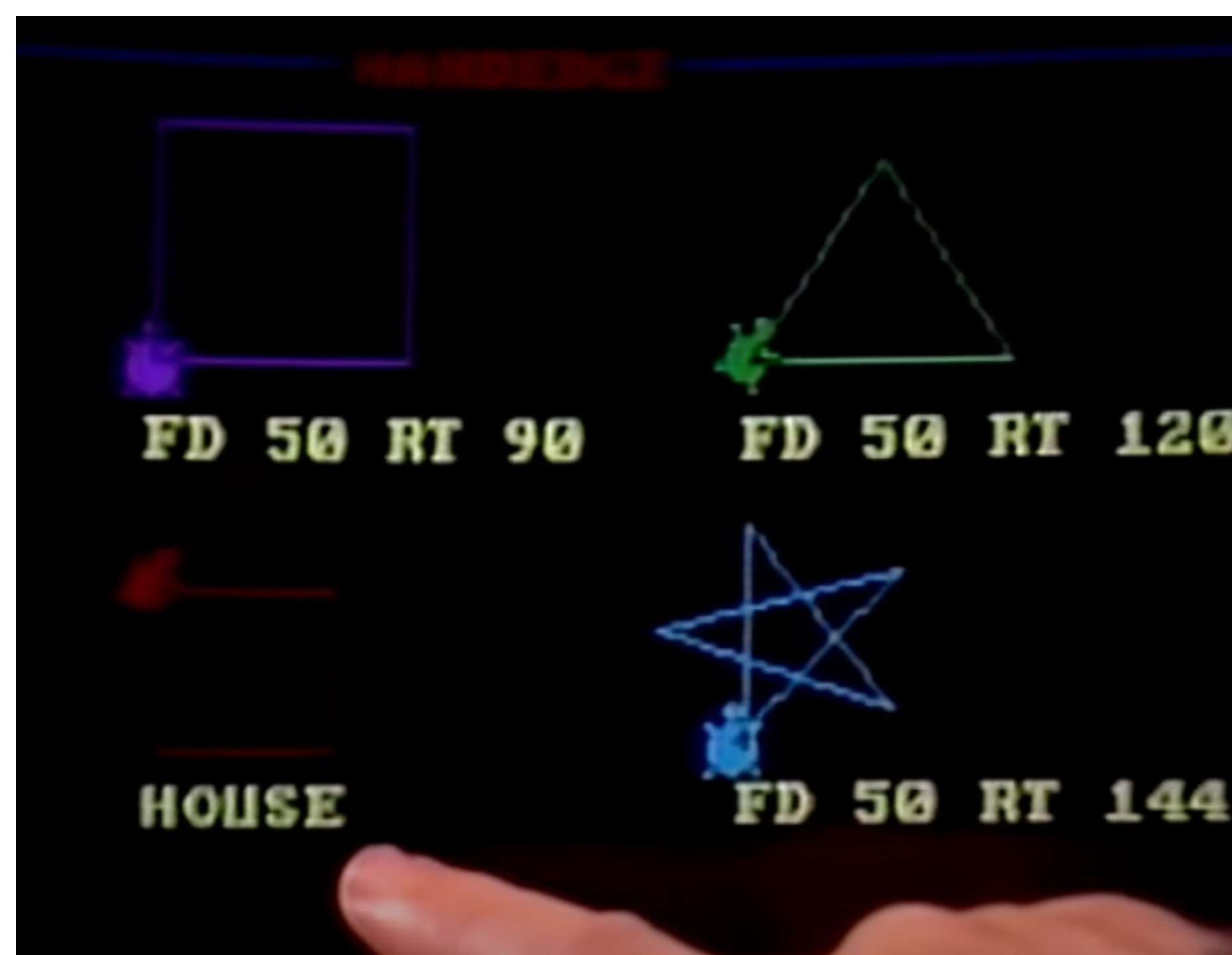




## Computational Thinking in Physics



- Papert: CT requires learners to create knowledge through constructing computing artifacts in a social context<sup>1</sup>
- Wing: CT is stating a problem so a computer can solve it.<sup>2</sup>

```

19 function draw(){
20   display();
21
22   a1 = g - a_drag(vy1, 9.0, 1.0);
23   vy = vy + a*dt;
24   y = y + vy*dt;
25
26   drawBox(x,y,vx,vy);
27   t = t + dt;
28 }

```

- Coding artifacts can be constructed using Euler-Cromer Modeling<sup>3</sup>
- CT modeling uses only some CS knowledge
- CS scaffolding can reduce cognitive load for physics students<sup>4</sup>

## Cognitive Load Scaffolding

Subgoal Labeling

Minimally Working Programs

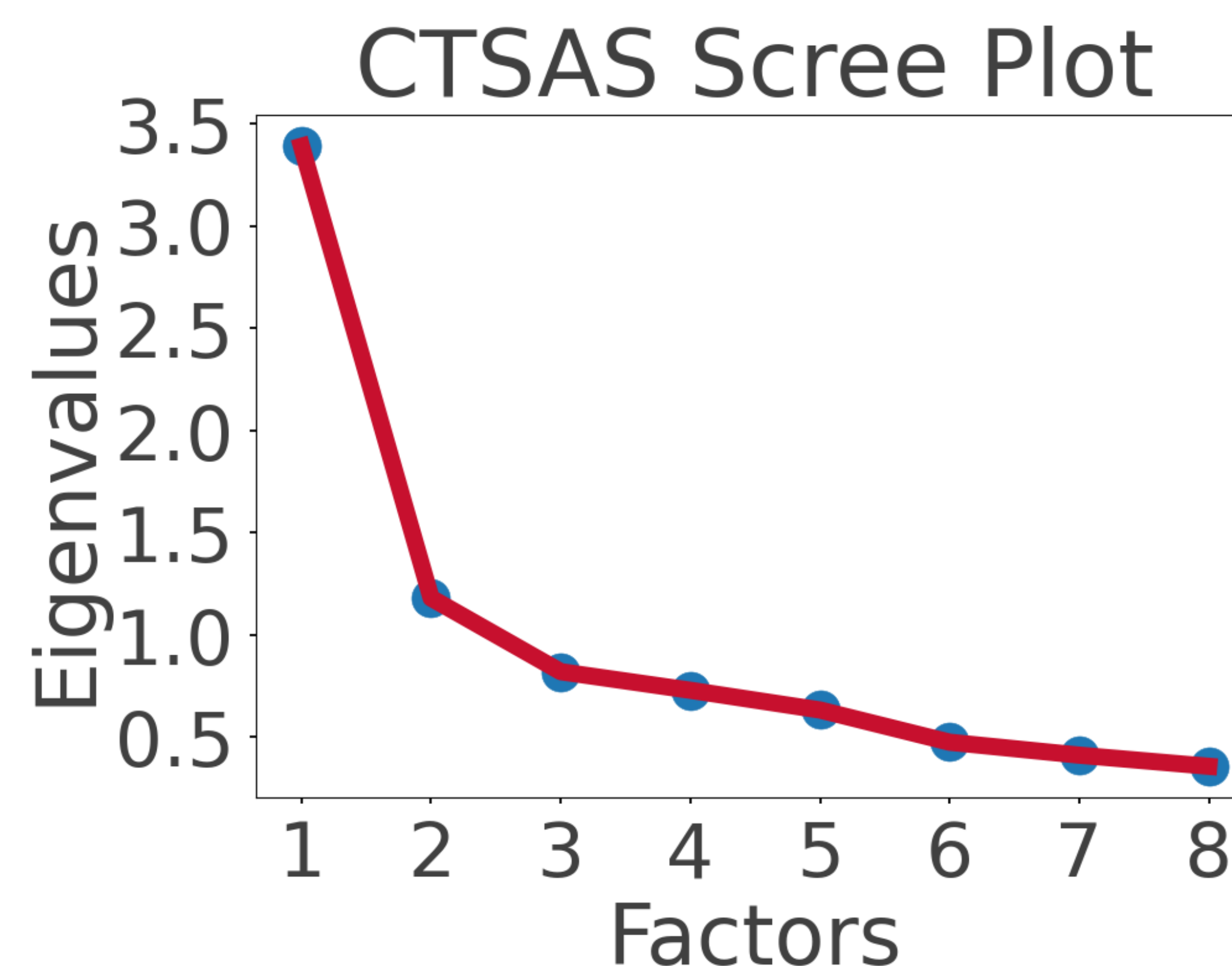
Worked Examples

## CT in Science Attitude Scale

- All students should learn computational thinking skills regardless of future career pathways.
- All students should use computational thinking to help learn science concepts and skills.
- Using code to model concepts improves my understanding of science ideas.
- Using a computer to analyze data should be a part of all science classes.
- Code-based science lab activities improve my science skills.
- Computational thinking activities help me learn science.
- I find coding-based science lab activities enjoyable.
- There is more to using computational thinking in science class than writing code.

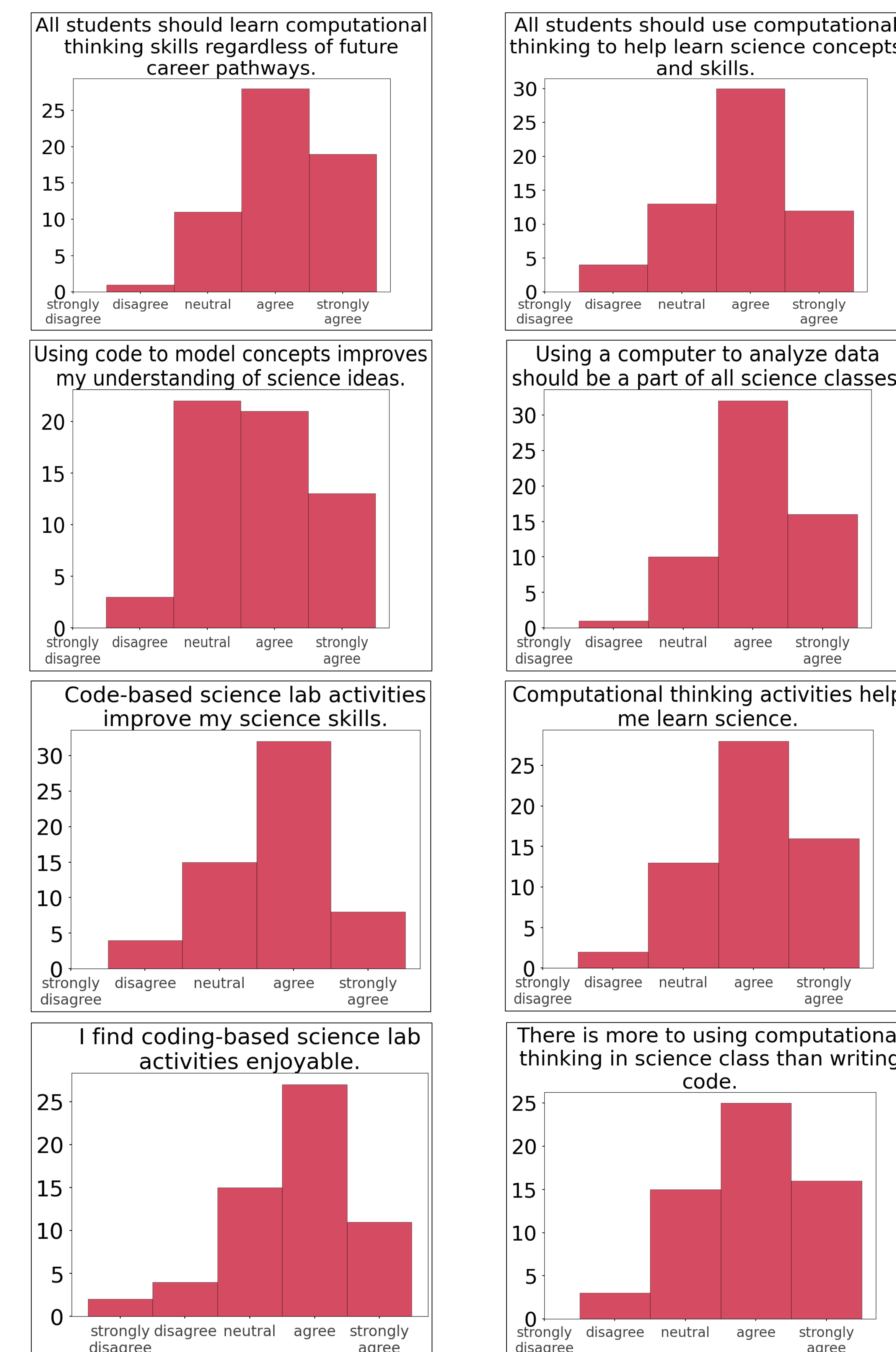
## Validation Study Results

- First iteration of CTSAS aimed to measure CT knowledge, self-efficacy, and CT equity
- Expectancy-Value Theory suggests self-efficacy and outcome expectancy a better fit



- Pilot study had 59 participants
- Principal component analysis: 2 constructs
- Cronbach's  $\alpha = 0.795$  (Acceptable<sup>5</sup>)

## Item Analysis



## Acknowledgments

CTSAS was developed and piloted as part of doctoral work at the University of Houston in the College of Education's Department of Curriculum and Instruction. Item development and testing would not have been possible without the help of UH CUIN faculty Dr. Sissy Wong, Dr. Jie Zhang, Ohio State University physics faculty Dr. Chris Orban, and my computer science education colleague Alice Fisher at Bellaire HS in Houston ISD, Houston, TX.

## References

- <sup>1</sup>Papert, S., & Harel, I. (1991). Constructionism. Ablex Pub. Corp.
- <sup>2</sup>Wing, J. M. (2017). <https://doi.org/10.17471/2499-4324/922>
- <sup>3</sup>Cromer, A. (1981). <https://doi.org/10.1119/1.12478>
- <sup>4</sup>Orban, C., et al. (2018). <https://doi.org/10.1119/1.5058449>
- <sup>5</sup>Taber, K. S. (2018). <https://doi.org/10.1007/s11165-016-9602-2>

More resources and data available at <https://jimmynewland.com/>

