

# Using Hand-held Visual Accelerometers and the CER Framework in Student-Centered Classrooms to Talk Through FCI Misconceptions.

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# Student-Centered Learning Environments

“Students drive their own and their peers’ learning, holding themselves accountable for reaching their learning targets, while the teacher shifts to the role of facilitator and verifies learning.”

Toth, M. D., & Sousa, D. A. (2019). *The Power of Student Teams: Achieving Social, Emotional, and Cognitive Learning in Every Classroom Through Academic Teaming*. West Palm Beach, FL.: Learning Sciences International.

Research has shown that Student-Centered Learning is associated with:

- an increase in students' perceived competence.<sup>1</sup>
- improvement in students' organization around a clear purpose.<sup>1</sup>
- students establishing secure connections with others.<sup>2</sup>
- student engagement in meaningful and relevant work.<sup>2</sup>
- increased student self-regulation.<sup>3</sup>
- students' increased capacity to learn.<sup>4</sup>

<sup>1</sup>Newmann, F. M., Wehlage, G. G., & Lamborn, S. D. (1992). The significance and sources of student achievement. In F. M. Newmann (Ed.), *Student engagement and achievement in American secondary schools*. New York, NY: Teachers College Press.

<sup>2</sup>Stipek, D. (1996). Motivation and instruction. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology*. New York, NY: Macmillan.

<sup>3</sup>Boekaerts, M., & Corno, L. (2005, April). Self-regulation in the classroom: A perspective on assessment and intervention. *Applied Psychology, 54*(2), 199-231.

<sup>4</sup>Claxton, G. (2007). Expanding young people's capacity to learn. *British Journal of Educational Studies, 2*(55), 115-134.

## CLAIM – EEVIDENCE – RREASONING FRAMEWORK<sup>1</sup>



## SCIENCE & ENGINEERING PRACTICES

### 7. Engaging in argument from evidence

Student explanations can be deconstructed into:

Increase  
in  
difficulty  
for  
students.<sup>2</sup>



- a **claim** that gives a stance in an argument,
- **evidence** that is based on relevant observations to support the claim, and
- **reasoning** that uses logic and scientific theories to link the cited evidence to the claim.

<sup>1</sup> McNeill, K., & Krajcik, J. (2011). *Supporting grade 5-8 students in constructing explanations in science: The claim, evidence and reasoning framework for talk and writing*. Boston, MA: Pearson Education.

<sup>2</sup> Gotwals, A. W., & Songer, N. B. (2013). Validity evidence for learning progression-based assessment items that fuse core disciplinary ideas and science practices. *Journal of Research in Science Teaching*. <https://doi.org/10.1002/tea.21083>

## FORCE CONCEPT INVENTORY<sup>1</sup> (1992)

### Source of Confusion

### Most People Think That...

**Motion**

if an object is moving, there must be a force making it move.

**Direction**

the direction of motion is the same as the direction of the forces.

**Size**

bigger objects (volume, mass, density) apply greater forces.

**Order**

when multiple forces act on an object, they happen one at a time.

**Visibility**

the source of a force has to be something that can be seen.

**Origin**

only moving objects can be the source of a force.

**Possession**

objects can get a force and keep it for a while.

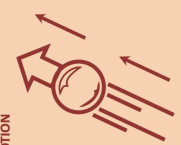
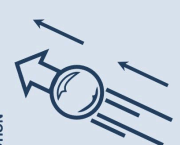

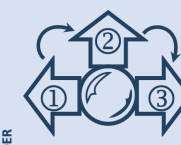


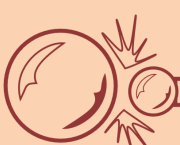





<sup>1</sup> Hestenes, D., Wells, M., and Swackhamer, G. (1992). Force Concept Inventory, The Physics Teacher 30, 141-151

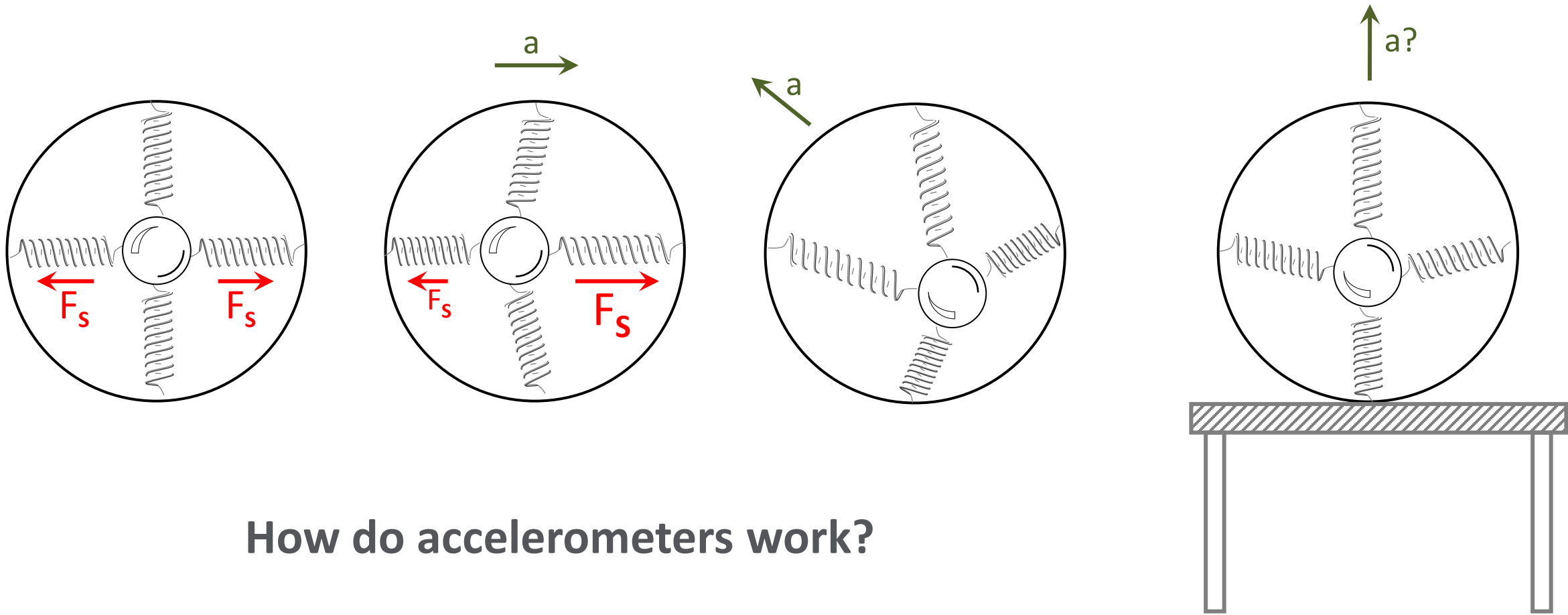
## MISCONCEPTION AS A CLAIM

### Flip Card Design:

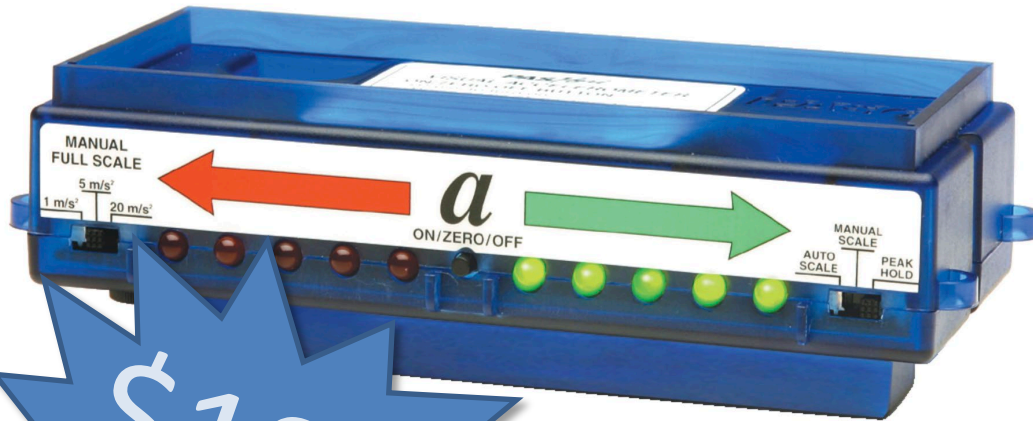
- De-emphasize right or wrong
- Make claim agree / disagree
- Add graphics
- Color code for cross-room monitoring.

 <p><b>MOST PEOPLE THINK THAT</b> <i>the source of a force must be something you can see.</i></p> <p><b>I DON'T AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>the source of a force must be something you can see.</i></p> <p><b>I AGREE</b></p>
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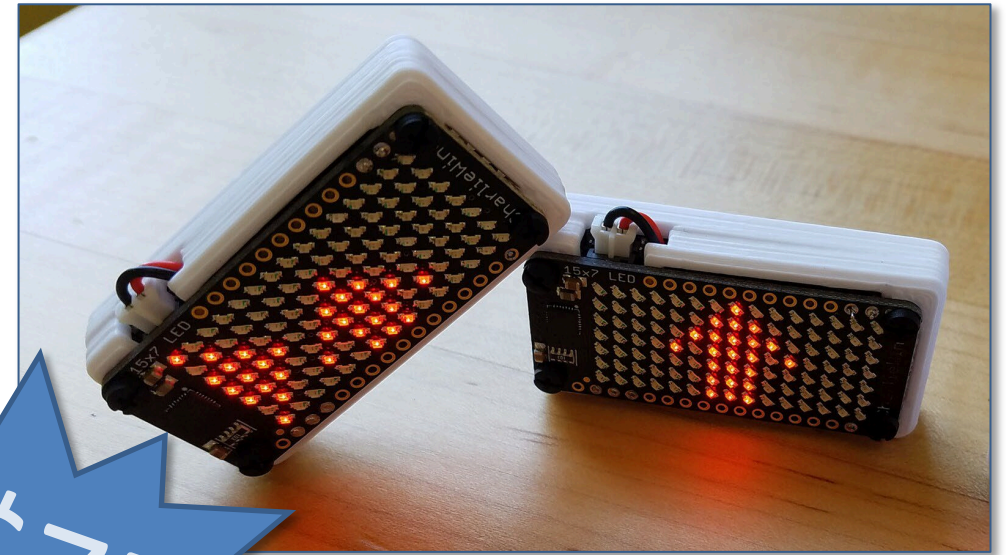
 <p><b>MOST PEOPLE THINK THAT</b> <i>the direction of motion indicates the direction of force.</i></p> <p><b>I DON'T AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>the direction of motion indicates the direction of force.</i></p> <p><b>I AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>when multiple forces act on an object, they happen one at a time.</i></p> <p><b>I DON'T AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>when multiple forces act on an object, they happen one at a time.</i></p> <p><b>I AGREE</b></p>
 <p><b>MOST PEOPLE THINK THAT</b> <i>only moving objects can be the source of a force.</i></p> <p><b>I DON'T AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>only moving objects can be the source of a force.</i></p> <p><b>I AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>bigger objects create bigger force.</i></p> <p><b>I DON'T AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>bigger objects create bigger force.</i></p> <p><b>I AGREE</b></p>
 <p><b>MOST PEOPLE THINK THAT</b> <i>objects can gain a force and keep it for a while.</i></p> <p><b>I DON'T AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>objects can gain a force and keep it for a while.</i></p> <p><b>I AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>if an object is moving, there must be a force making it move.</i></p> <p><b>I DON'T AGREE</b></p>	 <p><b>MOST PEOPLE THINK THAT</b> <i>if an object is moving, there must be a force making it move.</i></p> <p><b>I AGREE</b></p>



How do accelerometers work?



\$199

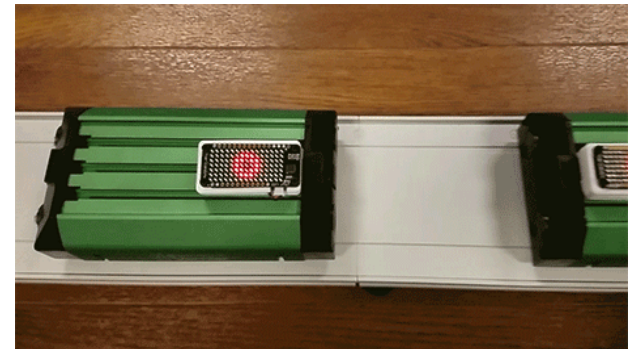
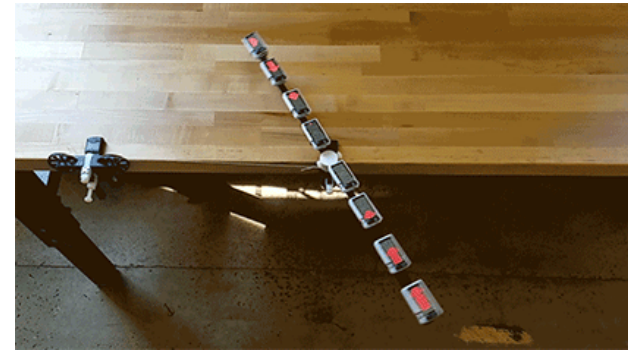
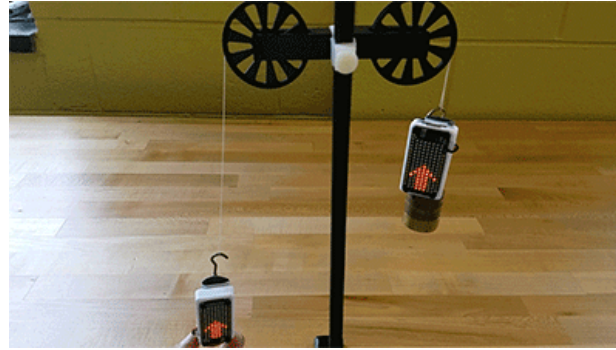
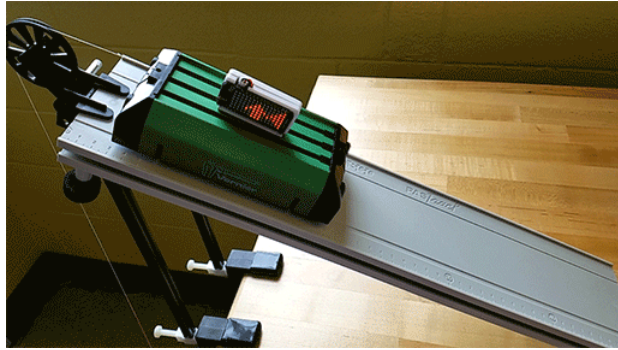


<\$75

DIY Project: [WagnerLabs.net/NormalProject/](http://WagnerLabs.net/NormalProject/)



In most situations, it does a good job of representing the direction and relative magnitude of the Normal force



Blog: [WagnerPhysics.net](http://WagnerPhysics.net)

## With Thought Partner(s):

1. Use FCI Flip Cards to make a CLAIM.
2. Use NORMALOMETER to find EVIDENCE.
3. Engage in argument to clearly articulate REASONING.