An Embodied Physics Lab on Center of Gravity

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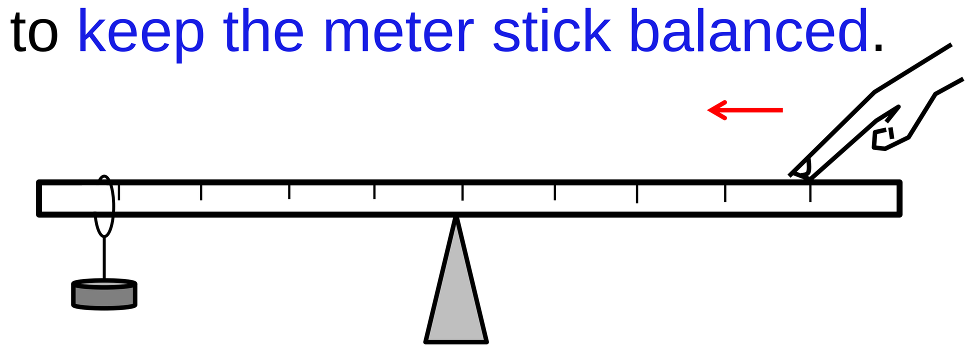
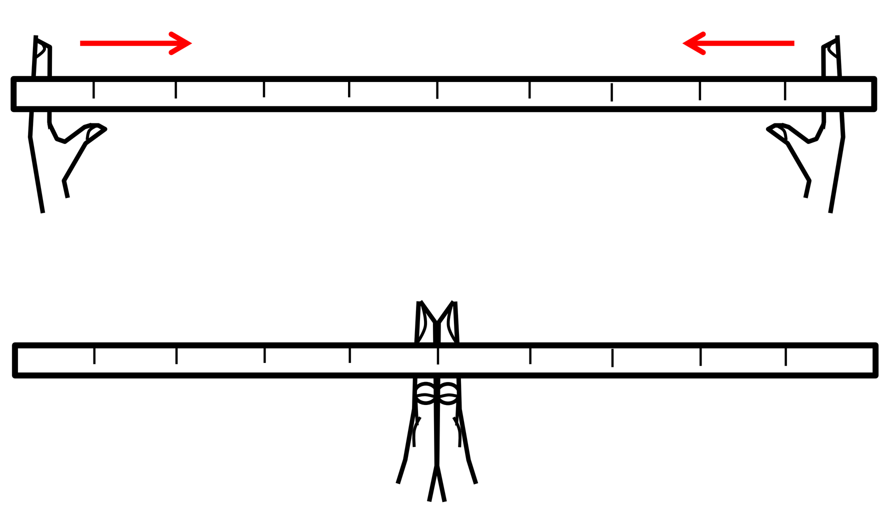
An Embodied Learning Approach

Embodied Learning: Students directly engage their sensorimotor system by balancing objects on their hands. These direct experiences can lead to recruitment of brain areas devoted to sensory and motor processing when students ***later*** reason about physics concepts they experienced. The students become the detectors.

1. Slide a finger to supply the force (and torque) necessary to keep the meter stick balanced.

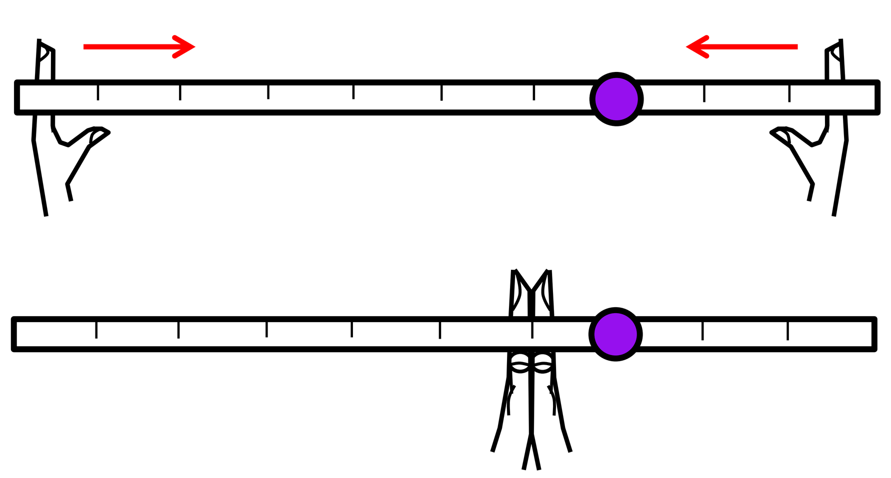


2. Slide fingers along the meter stick to locate the balance point, or Center of Gravity (CoG), of the meter stick.

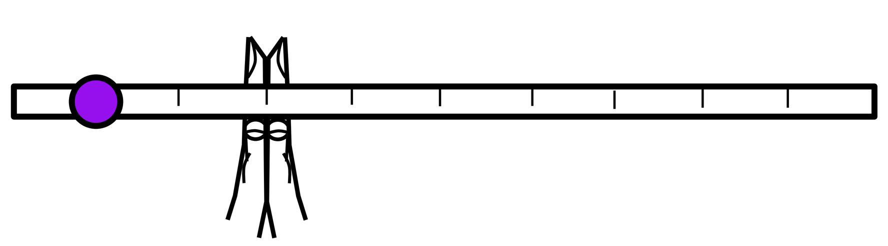


3. Add a 150 g mass to the meter stick.

Repeat "magic fingers" trick to locate the CoG of the system.

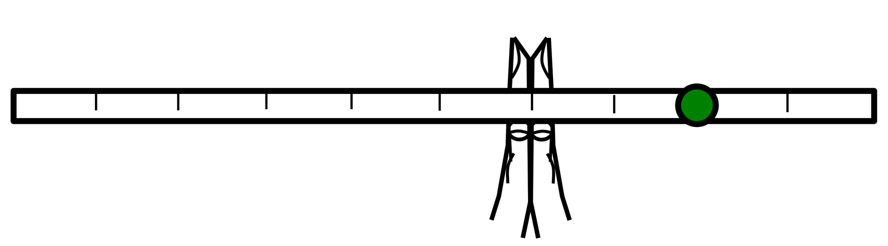


4. Repeat with the 150 g at a different location.



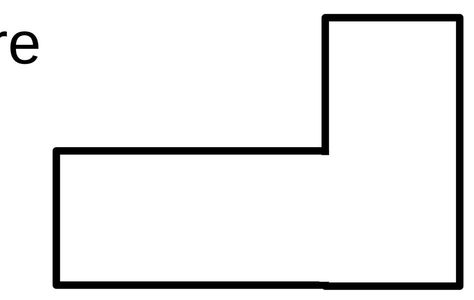
What is the mass of the meter stick?

5. What if you use a 75 g mass?



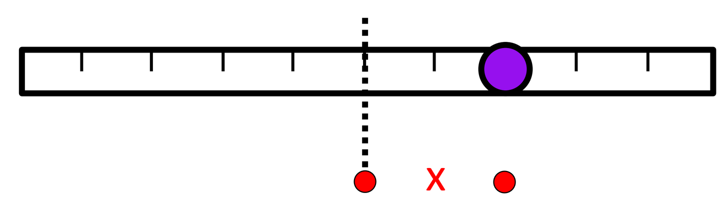
From One Dimension to Two

1. At the start of the lab, students are asked to predict the location of the CoG of an "L" shaped piece of cardboard.



2. Students work through the embodied activities shown on the left panel of this poster.

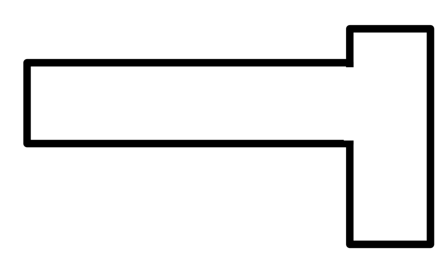
extended + discrete objects



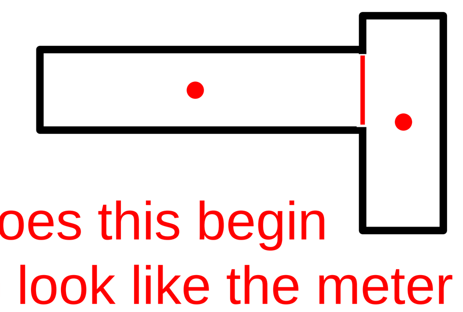
2 discrete objects & system CoG

Goal: Help students to visualize and represent the meter stick + mass as two discrete objects.

3. Students are given a "T" shaped piece of cardboard and asked to predict the CoG of the object.



4. Students are asked to draw a line to divide the "T" into two rectangles, and to draw two dots to represent the CoG of each rectangle. Again predict the CoG of the "T".

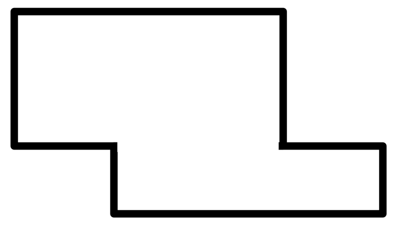


Does this begin to look like the meter stick + mass?

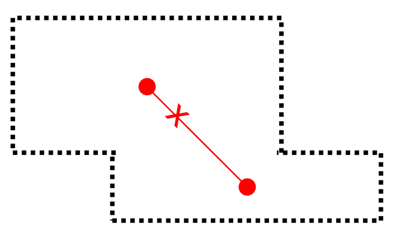
5. Students are guided to measure the areas (and/or masses) of the rectangles. The ratios of the areas are 1:2, 1:3 or 2:3. They are then asked to use this information to mark the CoG of the "T" on the cardboard and to test the prediction by balancing.

6. Students are asked to locate the CoG of the 2D object shown below (left).

Do students represent this extended object



by these discrete points?



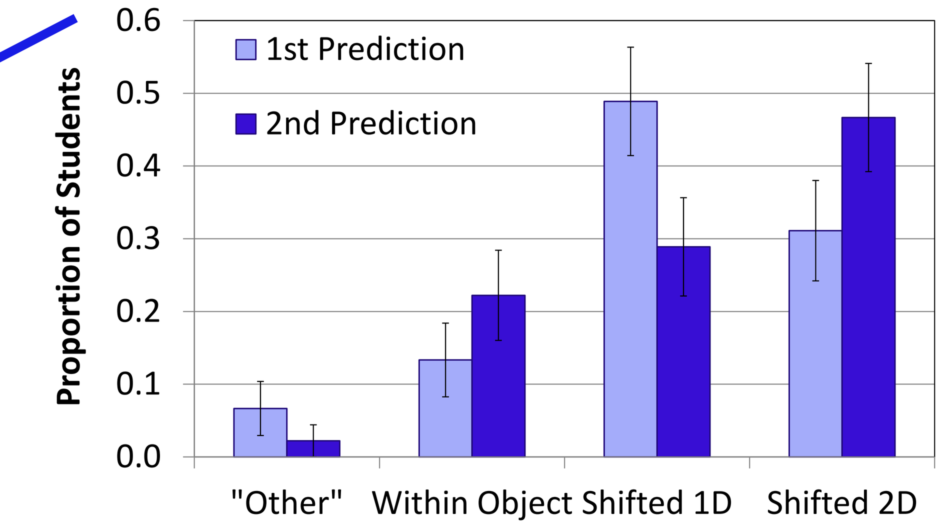
Student Performance

We performed a preliminary analysis of a random sample of 45 students in our algebra-based introductory physics course.

Questions: Do our lab activities prompt students to represent an extended, 2D object as a set of discrete points? Do our lab activities help to give meaning to the concept of CoG and to a method to determine the CoG?

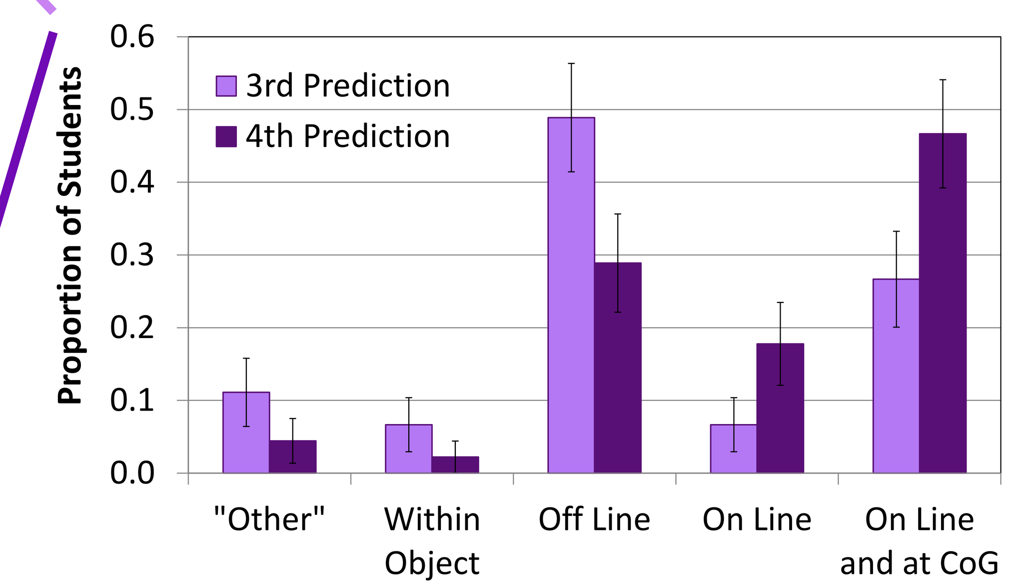
Student predictions for CoG of our extended objects

1. Before and after the meter stick balancing activity.



Students improve in locating the CoG, and in "shifting" the CoG appropriately in 2 dimensions.

2. Before and after the 2D balancing activity.



Students improve in locating the CoG on the line between the rectangle CoGs, and in shifting the CoG toward the larger mass (area).

Future: Do students gain understanding through embodied learning?

We will compare student performance on CoG related quiz and homework questions for students who have
(a) balanced objects on their hands (embodied), and
(b) balanced objects on a fulcrum (non-embodied).

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