PhET Tips for Teachers

Center and Variability

The ***Center and Variability*** simulation allows students to explore mean, median, range, IQR, and MAD by interacting with a small data set of distanced kicked.

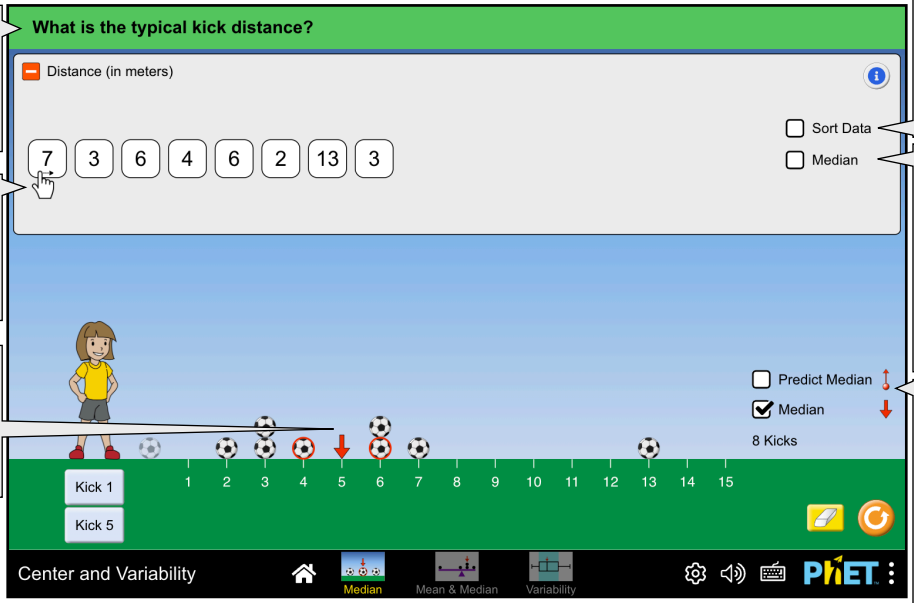
Median Screen

In the Median screen, students can develop an understanding of median with multiple representations, as well as see the impact a single data point has on the value of the median.

GUIDE exploration with informal vocab

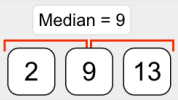
SORT the cards manually or with the checkbox

SEE the median value and location



AUTO-SORT cards continuously

SHOW median value



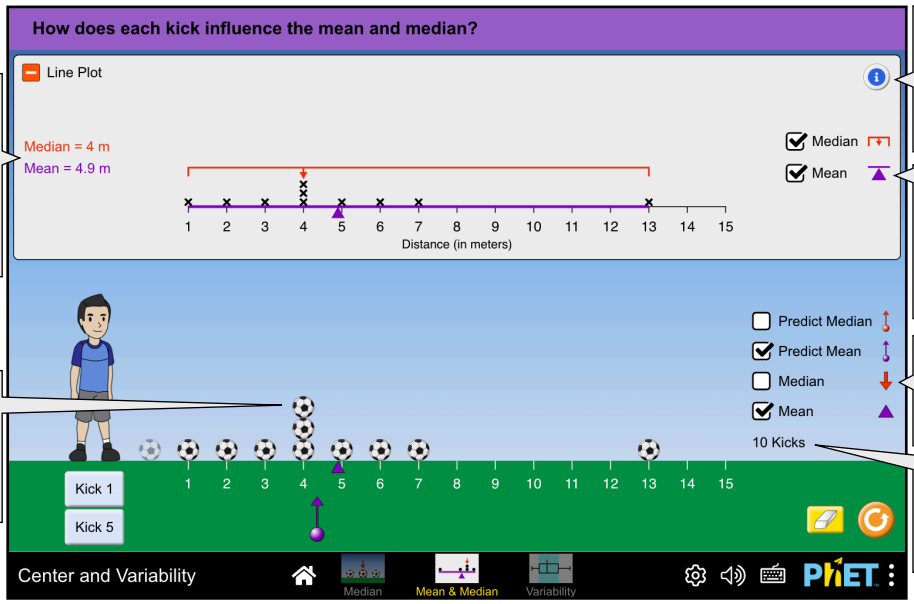
PREDICT the median prior to seeing the true median, then compare values

Mean & Median Screen

In the Mean & Median screen, students compare mean and median, and see how each is influenced by new data points or moving an individual data point.

COMPARE the mean and median as they update

DRAG a ball to a new distance once kicked



SHOW calculations and definitions

VISUALIZE the mean as balancing point

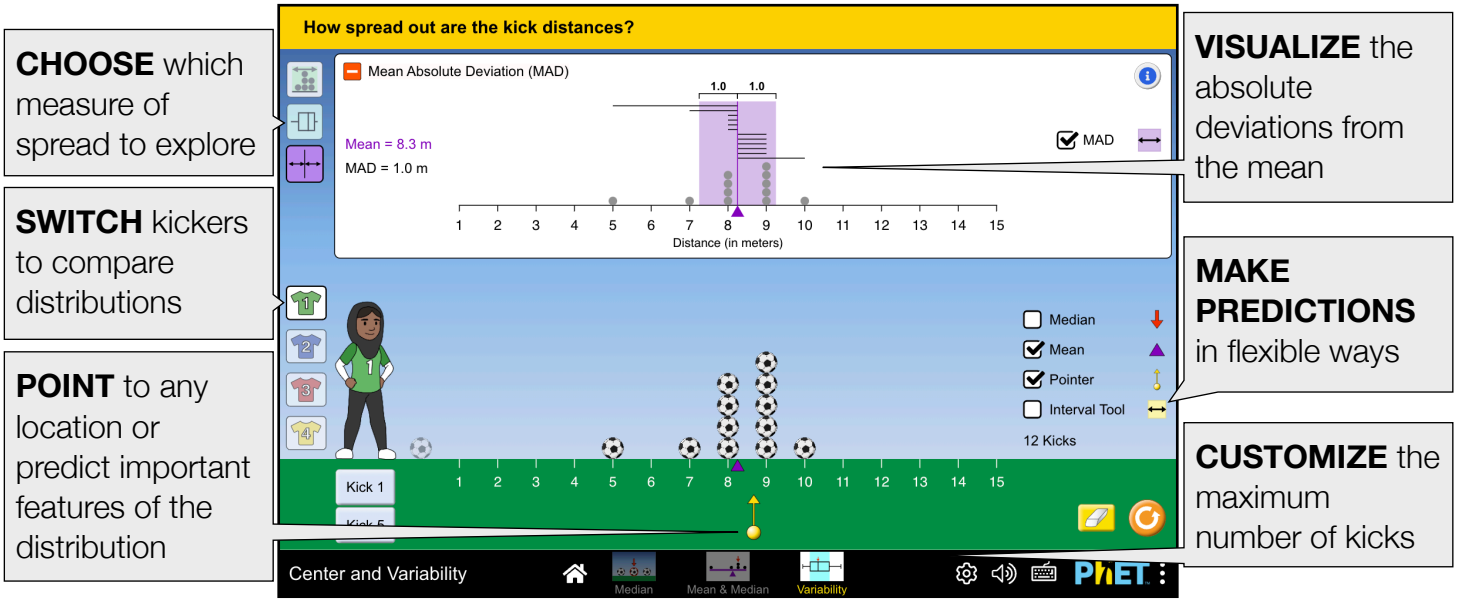
VISUALIZE the median as center

IDENTIFY total number of kicks

Carter and McGarry, August 2023

Variability Screen

In the Variability screen, students visually explore measures of spread in the context of comparing four kickers' unique data distributions.



Insights into Student Use

- Unless prompted or have kicked the maximum number of soccer balls, students may not notice they can drag a soccer ball to a new distance.
- The maximum number of kicks ranges from 5-30 (can be changed in the settings). The maximum number of kicks on the Median screen is 15, regardless of the setting. Students may notice the "Kick 5" button turns into "Kick 4" when there are only four balls left to be kicked, and so on.
- Students may not notice there is an 'Info' button on every screen. The info button contains definitions and calculations that may still need unpacking.

Suggestions for Use

- Allow students to openly play with the simulation prior to guiding them with challenge prompts.
- Encourage students to share their discoveries about the sim, what each button does, and general observations with each other to encourage confidence, sense-making, and agency.
- While the balls travel a random distance with each kick, the underlying model on screens 1 and 2 should produce a skewed data set (randomly chosen to be left- or a right- skewed). Take advantage of this and ask students to predict which is greater, the mean or median, using many trials of the maximum number of kicks. Students should notice the mean is pulled in the direction of the skew.
- On the Variability screen, encourage students to use the Interval Tool to make many predictions such as the range, the IQR, and with one edge of the interval tool is pinned at the mean, the MAD.
- On the Variability screen, ask students to use the Interval Tool to create a range where they think the next ball is likely to land. Have students explain their choice.

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Sample Challenge Prompts

- Predict the shape of a distribution where the mean and median are equal.
- Generalize a way to create a distribution where the mean is greater than the median.
- Does the median change when the cards are sorted versus unsorted? How can sorting the data help you find the median?
- Which measure of center (mean or median) is more impacted by a data point far away from the rest of the data?
- How many different distributions can you create where the MAD=0? The Range=0? The IQR=0? What common characteristic(s) do these distributions share?
- Develop a procedure for creating a distribution with a median of 7.
- How can you use the shape, center, and spread of a distribution to predict a likely range of values where a next ball might land?
- Can the median ever be outside the box in a boxplot? Why or why not?
- Create at least two different distributions for which the range is 8 and the mean is (equal to, greater than, less than) the median.

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '`?`' to the sim URL, and separating each query parameter with a '`&`'. The general URL pattern is:
`…html?queryParameter1&queryParameter2&queryParameter3`

For example, in Collision Lab, if you only want to include the 1st and 2nd screens (`screens=1,2`), with the 2nd screen open by default (`initialScreen=2`) use:
https://phet.colorado.edu/sims/html/collision-lab/latest/collision-lab_all.html?screens=1,2&initialScreen=2

To run this in Spanish (`locale=es`), the URL would become:
https://phet.colorado.edu/sims/html/collision-lab/latest/collision-lab_all.html?locale=es&screens=1,2&initialScreen=2

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Example Links
⚙ `maxKicks` - sets the maximum number of kicks to be a number between 5 and 30, inclusive in increments of 5. Note: the max number of kicks on the Median screen is 15.	`maxKicks=20`
⚙ `plotType` - sets the plot type on screens 2 and 3 to be a line plot (mark: x) or a dotplot (mark: ●)	`plotType=dotPlot`
⚙ `showOutliers` - changes the boxplot on the Variability screen to show outliers rather than including them in the whisker	`showOutliers`

`screens` - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the Help Center.	`screens=1`
	
	`screens=2,1`

Query Parameter and Description	Example Links
`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=1` `initialScreen=3`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
`audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
`cardMovementSoundPlaybackRate` - changes the playback rate of the cards as they move past each other. Default is `cardMovementSoundPlaybackRate=1.5`	`cardMovementSoundPlaybackRate=2`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`

See all published activities for Center and Variability here.
For more tips on using PhET sims with your students, see Tips for Using PhET.