Derivation of wave velocity
Modeling Methodology

Assumed prior knowledge: Students should be familiar with the basic parts of a transverse wave (crest, trough, amplitude, wavelength, period, medium, frequency). Students should be comfortable with the relationship between displacement, velocity, and time for an object moving at a constant velocity.

Phase 1: Have students observe wave pulses and oscillations on the http://phet.colorado.edu/simulations/sims.php?sim=Wave_on_a_String website. Be sure that they also observe the presence (not use) of the measuring tools (stopwatch and rulers).

Phase 2: Ask students what can be measured. (linear displacement, amplitude, wavelength, time, frequency).

Phase 3: Guide students into seeking to find a relationship between wavelength and frequency (perhaps by noting that these two quantities are unique to waves).

Phase 4: Note that the selector bar for frequency does not actually give the real frequency measured in hertz. Students need to be directed to measure the wave's actual frequency. (timing ten revolutions of the "oscillator", and dividing that time into 10).

Phase 5: Advise students to follow good experimental technique (multiple trials, controls, and a wide enough spread on their independent variable [aka "Rule of 5"]).

Phase 6: Advise students to experiment with settings for tension and damping, so that they will get usable data. Not all settings for these quantities yield equally usable data.

Phase 7: As students appear to be reaching the end of data collection, ask them to consider a way to measure the speed of the wave. This requires a little thinking on their part regarding the use of the on-line stopwatch, and when to start/stop measuring the wave. Advise them to make a few trials and average.

Teacher Note: Graphing this relationship yields an inverse relationship, which when linearized (wavelength vs. 1/frequency) should yield a slope very close to the speed of the wave, and should yield the equation: wavelength = (velocity)(1/frequency)

Extension: Ask students to repeat, or assign groups different values for the amplitude of the wave. Ask students to investigate the role of amplitude on a wave's speed. It is counter intuitive to many students that amplitude has no relationship with wave speed. This is because many equate amplitude with energy (and energy with speed), or some may think they know a relationship between the speed of water waves and amplitude.

Potential whiteboard review questions:

1. Does amplitude of the wave affect its speed?
2. What is damping, and does it affect the speed of a wave? Why?
3. Does wavelength affect wave speed? Does frequency?
4. Did you note any quantity that did affect the speed of the wave (tension and damping)
4. Is there a general statement that can be made regarding what does affect the velocity of a wave? (something akin to “changes in the medium”)
5. What does the slope of your equation represent?
6. What were sources of error in your experiment?