

Could less be more in the introductory kinematics lab?

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Three campuses
One university

A graphic of the state of Wisconsin with three small icons representing the campuses: UW Oshkosh, UW Fond du Lac, and UW Fox Valley.

Background

- My students did well on labs, but follow-up questions showed lack of understanding of both lab techniques and physics being investigated.
- I suspected that the computer interfaces were partly to blame: perhaps they helped students too much.
- I designed a “minimalist” interface to address this. (See previous talk: <http://tinyurl.com/LabSplits>)
- New interface clearly helped understanding of lab techniques—but were students actually learning physics any better?

Methodology: Overview

Original plan:

- Conduct study during/after free fall lab (“picket fence” falling through photogate) early in semester.
- Some students (randomly chose) use traditional interface/software; others use minimalist. (Same lab instructions.)
- Check kinematic comprehension with questions from FCI, immediately after lab and later on tests.



Methodology: Overview

Plan after getting through IRB approval:

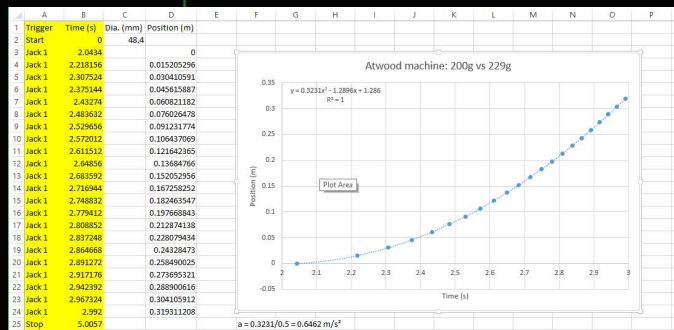
- Conduct study during Atwood lab (weights hanging from opposite sides of spoked pulley with photogate) late in the semester.
- Some students (randomly chosen) use traditional interface/software; others use minimalist. (Same lab instructions.)
- Check kinematic comprehension with six questions from FCI and TUG-K, immediately after lab only.



Methodology: Population

- UW—Fond du Lac is a two-year ~~institution~~ campus with an *access and transfer* mission:
 - High number of underprepared students
 - Few/no physics majors; most students are pre-engineering or health fields
- “Stacked” first-semester physics lab:
 - 11 in algebra/trig-based physics; 6 in calculus-based
 - Most weeks: each class did different labs in same room
- One absence, one opt-out → N=15

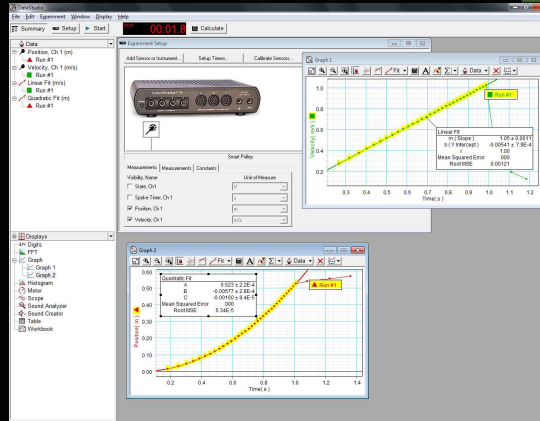
Methodology: Intervention



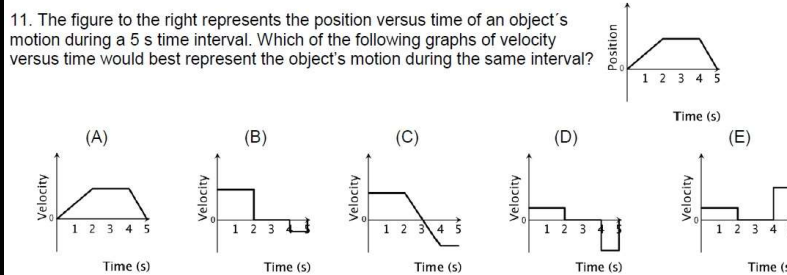
- Interface dumps beam interruption times into *Excel* (yellow)
- Students were told simply to create a plot of position vs. time, and determine acceleration from that.

Methodology: Control

- Commercial interface and proprietary software
- Same instructions, but students can create plots by drag and drop
 - Even the pulley diameter and number of spokes are preprogrammed



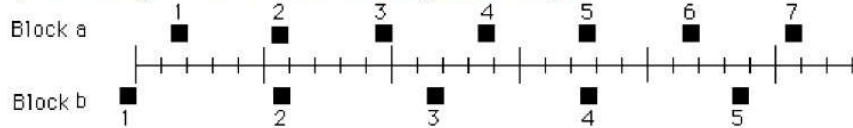
Methodology: Instrument



Four questions from the *Test of Understanding Graphs in Kinematics*, on determining one kinematic time plot from another (a topic covered in class).

Methodology: Instrument

2. The positions of two blocks at successive 0.20-second time intervals are represented by the numbered squares in the figure below. The blocks are moving toward the right.



The accelerations of the blocks are related as follows:

- A The acceleration of "a" is greater than the acceleration of "b".
- B The acceleration of "a" equals the acceleration of "b". Both accelerations are greater than zero.
- C The acceleration of "b" is greater than the acceleration of "a".
- D The acceleration of "a" equals the acceleration of "b". Both accelerations are zero.
- E Not enough information is given to answer the question.

Two questions from the *Force Concept Inventory*, dealing with motions diagrams (a topic not covered in class).

% of questions answered correctly

Interface used	Motion diag. questions	Time plot questions	All questions
Traditional	14.29%	39.29%	30.95%
Minimalist	18.75%	37.50%	31.25%
Combined	16.67%	38.33%	31.11%

- No obvious correlation with interface type overall.
- Much stronger correlation with question type suggests students relied on classroom learning, not lab.
- Minimalist interface might have helped with material not covered in class (motion diagrams).

Future directions

- Run statistics on existing data
 - (was unsealed on January 2, 2019)
 - Significance unlikely with $N=15$, small differences
- New study
 - Recruit other teacher to increase N ?
 - Make instrument part of a test? (Gives students incentive to get right answers.)
 - Make sure students use the same interface exclusively (until after completing instrument)?
 - Better instrument?

- Further information at <http://tinyurl.com/LabSplits>

- *LabSplits* construction details
- This talk and earlier ones

- Support for this project:

- UW—Fond du Lac Foundation
- UW Colleges transition fund
- UW System Office of Professional and Instructional Development (OPID)

