Chaoyang School District Professional Development Course May 19-30 2015

Teaching Math & Science With Technology in the 21st Century

UBC Faculty of Education THE UNIVERSITY OF BRITISH COLUMBIA

EDCP DEPARTMENT OF curriculum & pedagogy

朝陽區 朝阳区

Dr. Marina Milner-Bolotin

Day 3 - May, 2015

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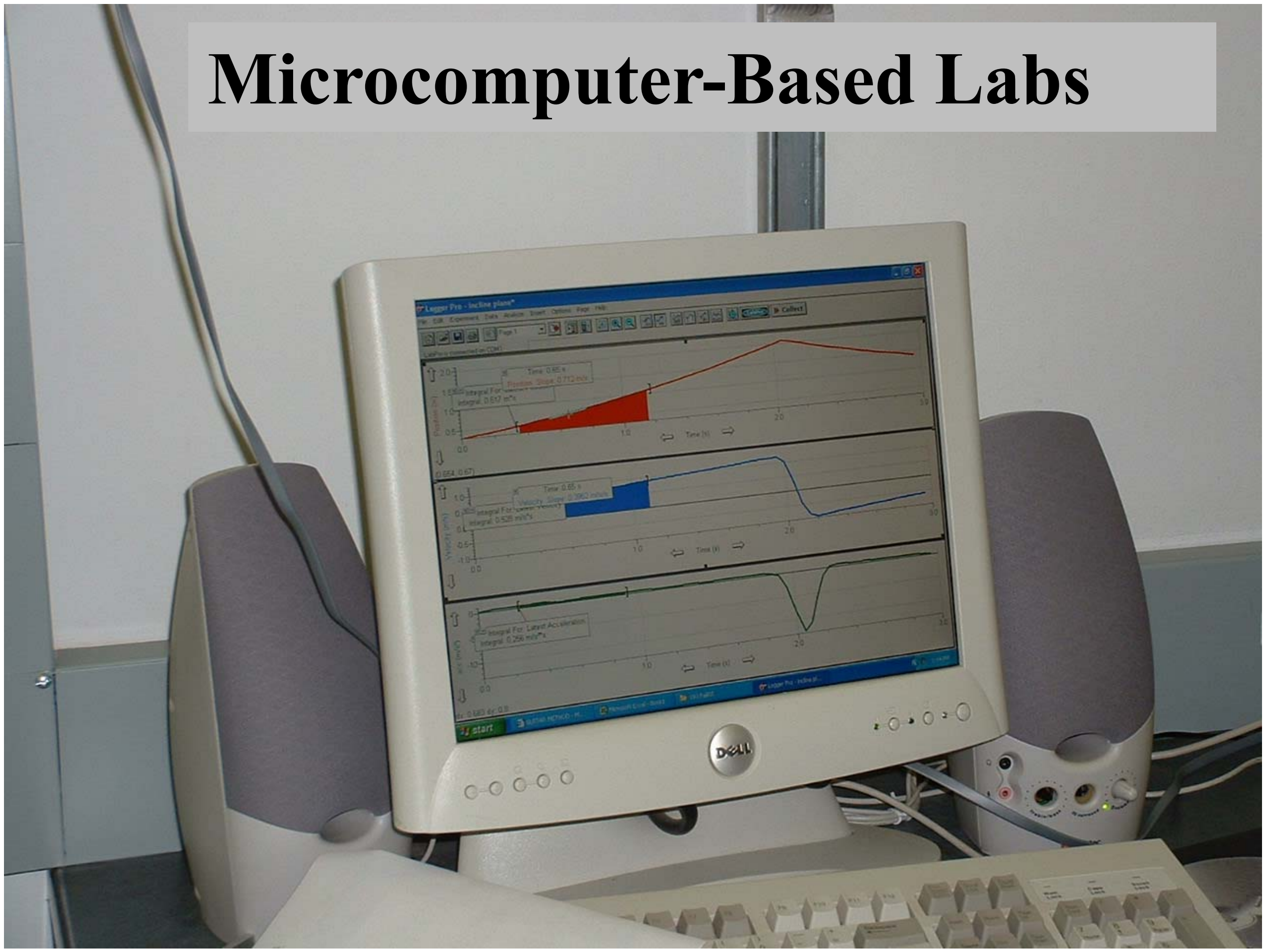


Using available equipment to collect and analyze real time data:

Motion detectors, force- temperature-, current probes…

I Course Tentative Schedule

Day	Technology	
1	Student engagement: Clickers, multimedia	✔
2	Peer Instruction and PeerWise: inquiry via questioning; Exploring GeoGebra	✔
3	Data collection and analysis; mathematics modeling with Desmos	✔
4	Computer simulations, games, and online learning environments	
5	Summary and projects' presentations	

Agenda for the Day

I. Motion matching game

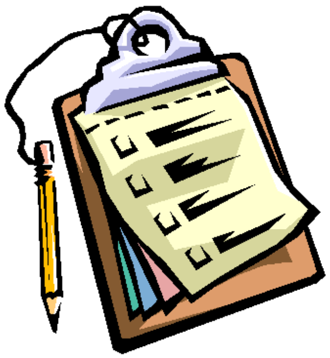
II. Live data collection and analysis with Vernier

III. Exploring Vernier Video Analysis

IV. Introducing Desmos graphing calculator

V. Group activity: Designing modeling lessons with GeoGebra, Desmos or Vernier

VI. Summary of the day



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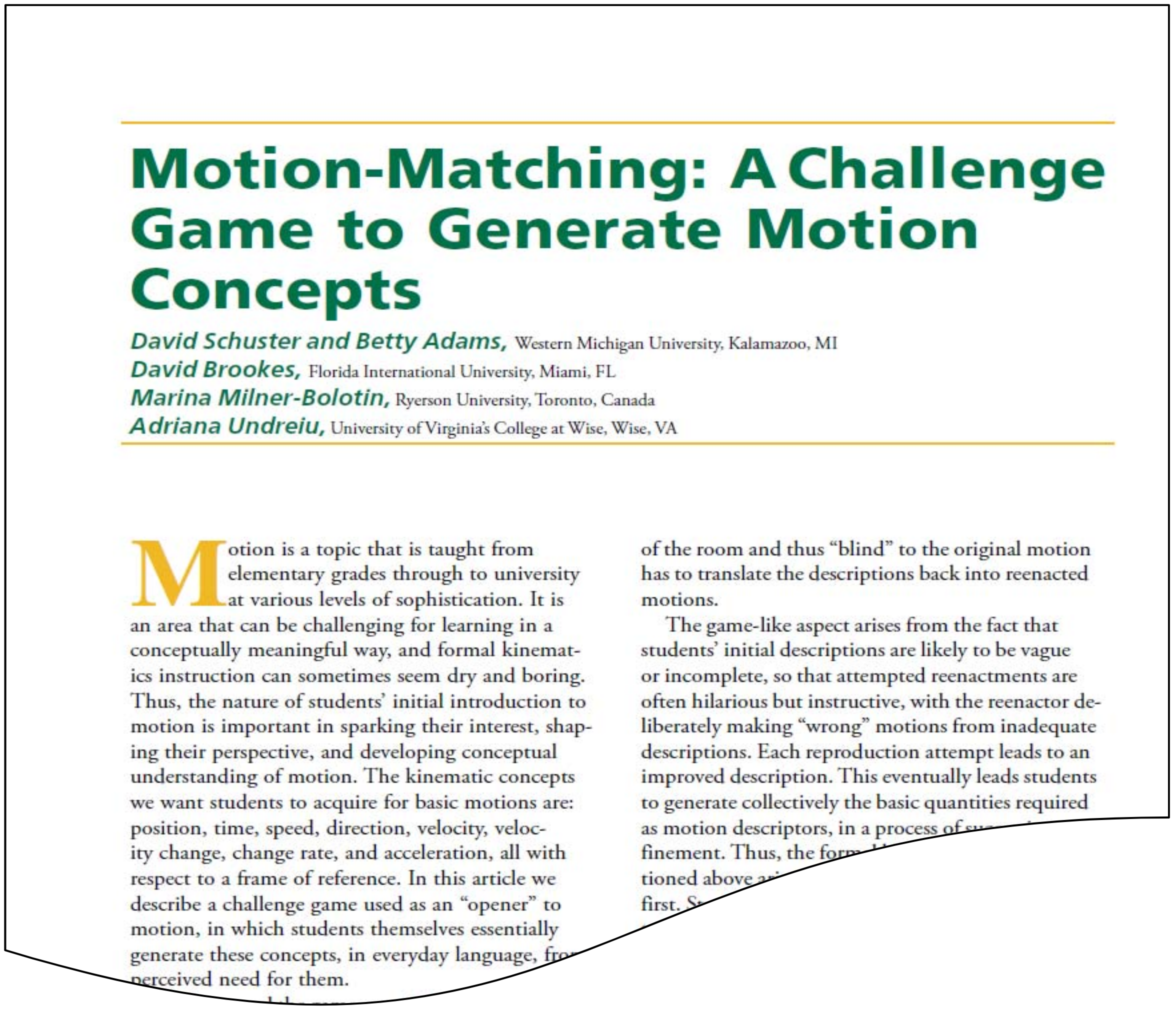
I Motion Matching Game



Motion-Matching: A Challenge Game to Generate Motion Concepts

David Schuster and Betty Adams, Western Michigan University, Kalamazoo, MI
David Brookes, Florida International University, Miami, FL
Marina Milner-Bolotin, Ryerson University, Toronto, Canada
Adriana Undreiu, University of Virginia's College at Wise, Wise, VA

Motion is a topic that is taught from elementary grades through to university at various levels of sophistication. It is an area that can be challenging for learning in a conceptually meaningful way, and formal kinematics instruction can sometimes seem dry and boring. Thus, the nature of students' initial introduction to motion is important in sparking their interest, shaping their perspective, and developing conceptual understanding of motion. The kinematic concepts we want students to acquire for basic motions are: position, time, speed, direction, velocity, velocity change, change rate, and acceleration, all with respect to a frame of reference. In this article we describe a challenge game used as an "opener" to motion, in which students themselves essentially generate these concepts, in everyday language, fro... perceived need for them.

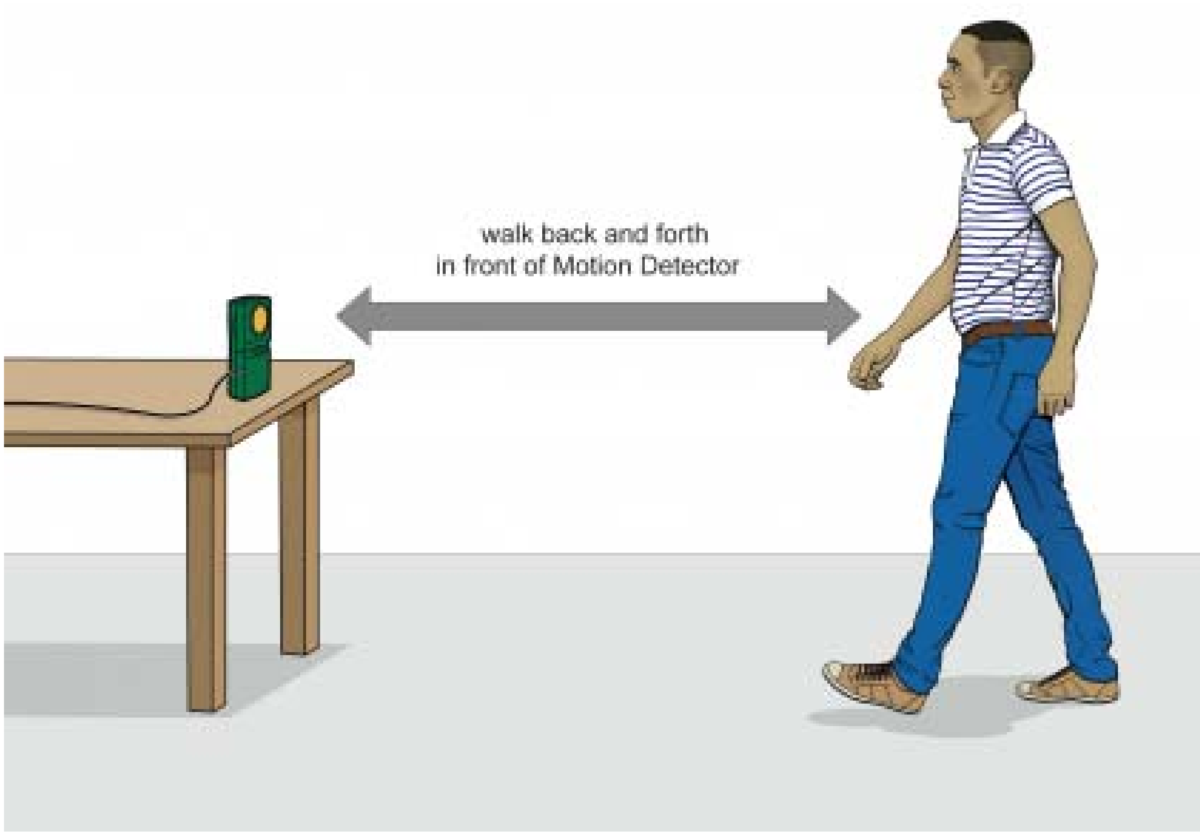
of the room and thus "blind" to the original motion has to translate the descriptions back into reenacted motions.

The game-like aspect arises from the fact that students' initial descriptions are likely to be vague or incomplete, so that attempted reenactments are often hilarious but instructive, with the reenactor deliberately making "wrong" motions from inadequate descriptions. Each reproduction attempt leads to an improved description. This eventually leads students to generate collectively the basic quantities required as motion descriptors, in a process of su... finement. Thus, the form... tioned above ari... first. S...

Schuster, D., Undreiu, A., Adams, B., Brookes, D., & Milner-Bolotin, M. (2009). Motion-Matching: A Challenge Game to Generate Motion Concepts. *The Physics Teacher,* 47(7), 381-385.

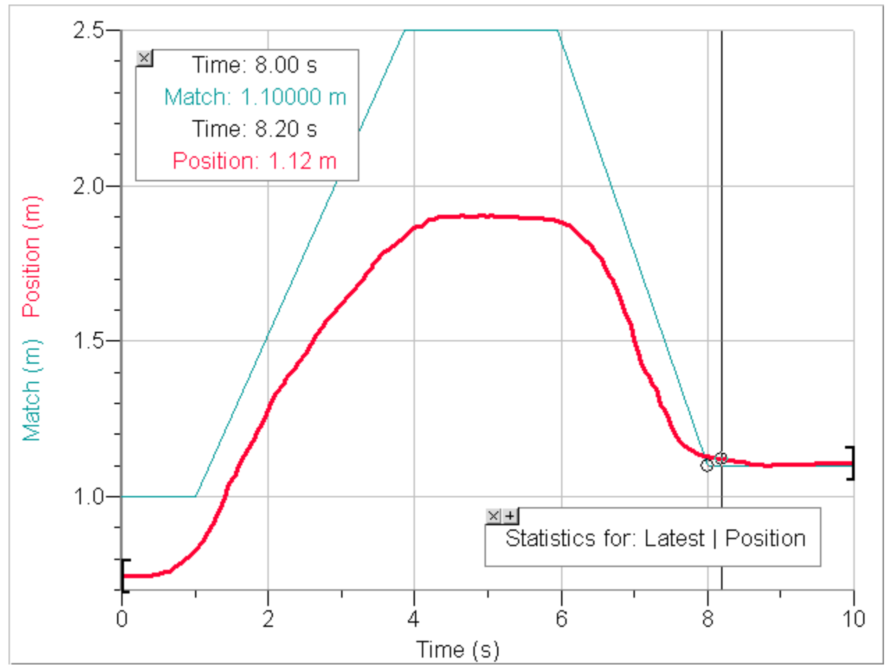
I

Motion Matching Activity: Playing with Vernier



I

Motion Matching Activity: Playing with Vernier

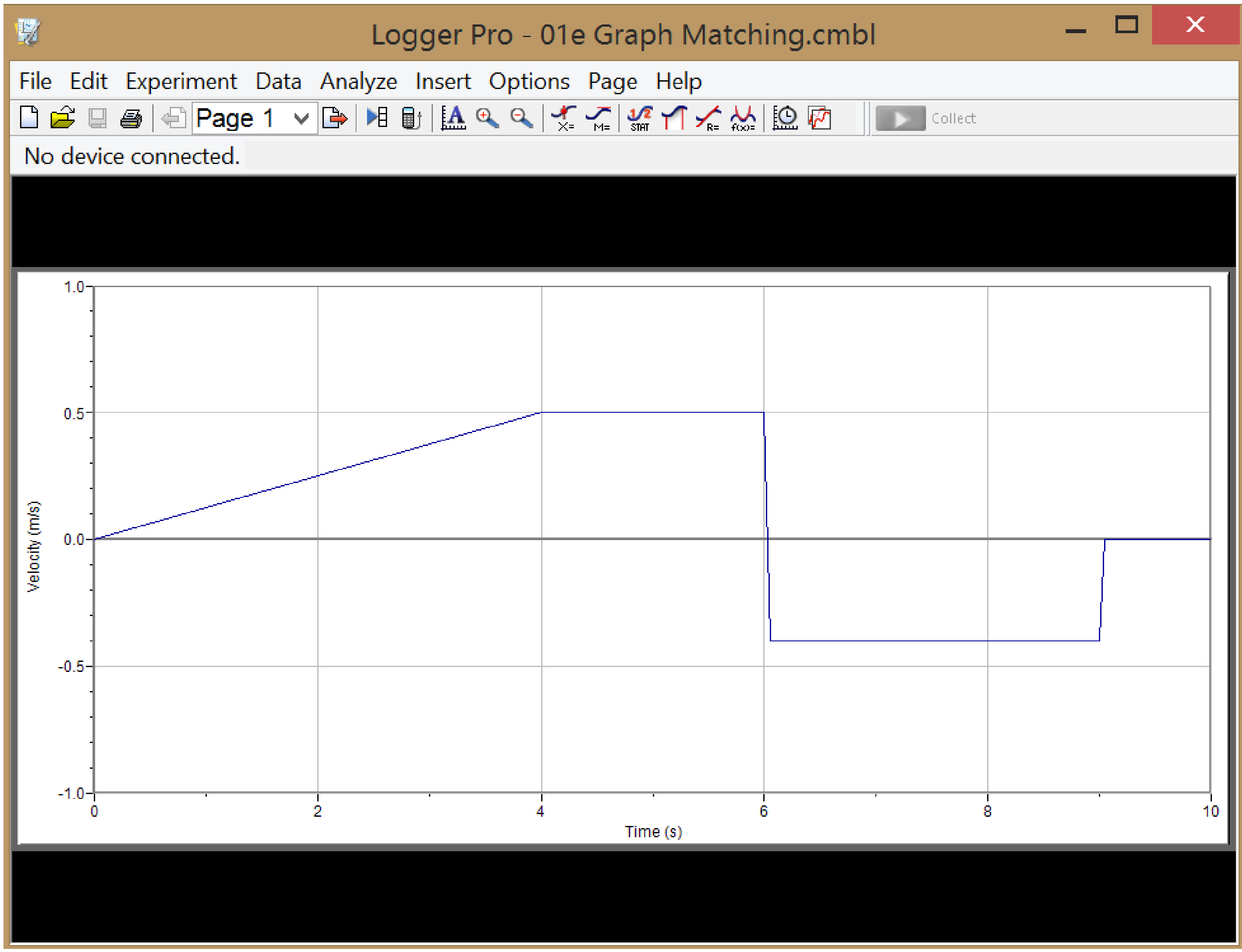


Motion detector records girl's positions at different times

I

Motion Matching Activity: Playing with Vernier

How do you need to move to match a given motion graph?



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VI. Summary of the day

II Live Data Collection & Analysis with Vernier

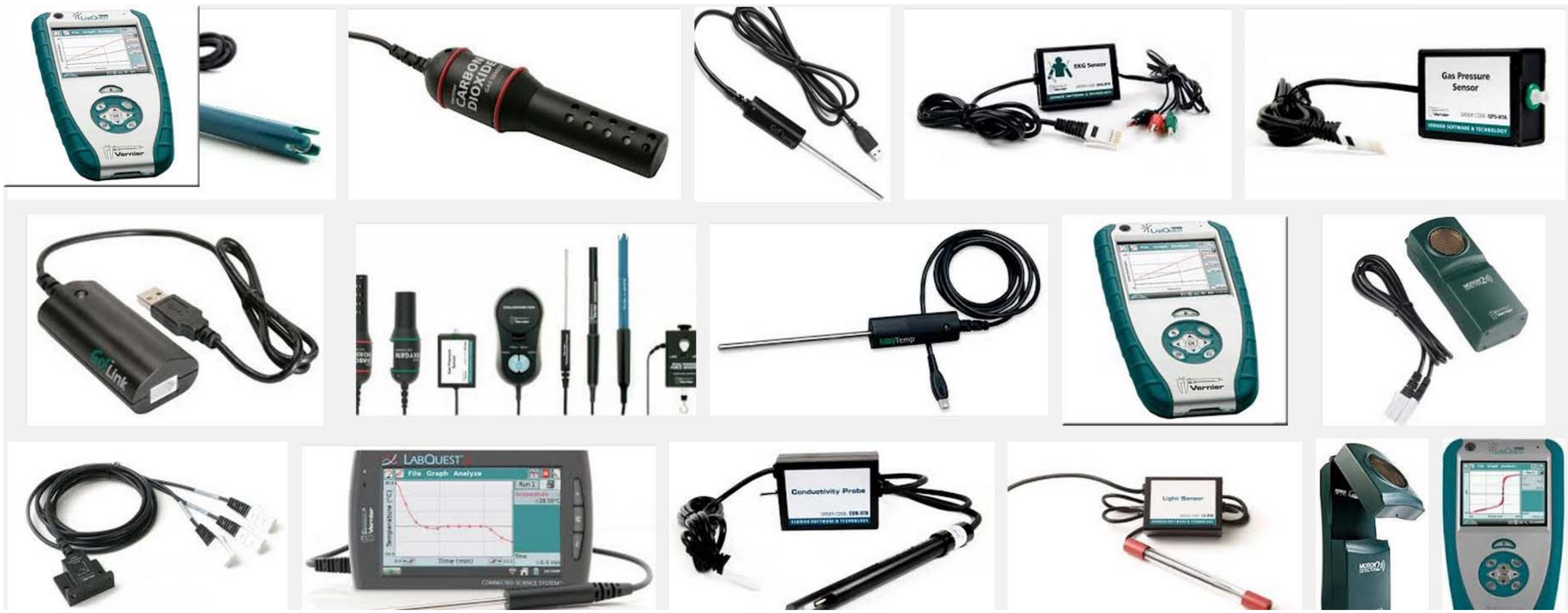
2008, The Physics Teacher, 46(8), 494-500.

Physics Exam Problems Reconsidered: *Using Logger Pro to Evaluate Student Understanding of Physics*

Marina Milner-Bolotin, Ryerson University, Toronto, ON

Rachel Moll, The University of British Columbia, Vancouver, BC

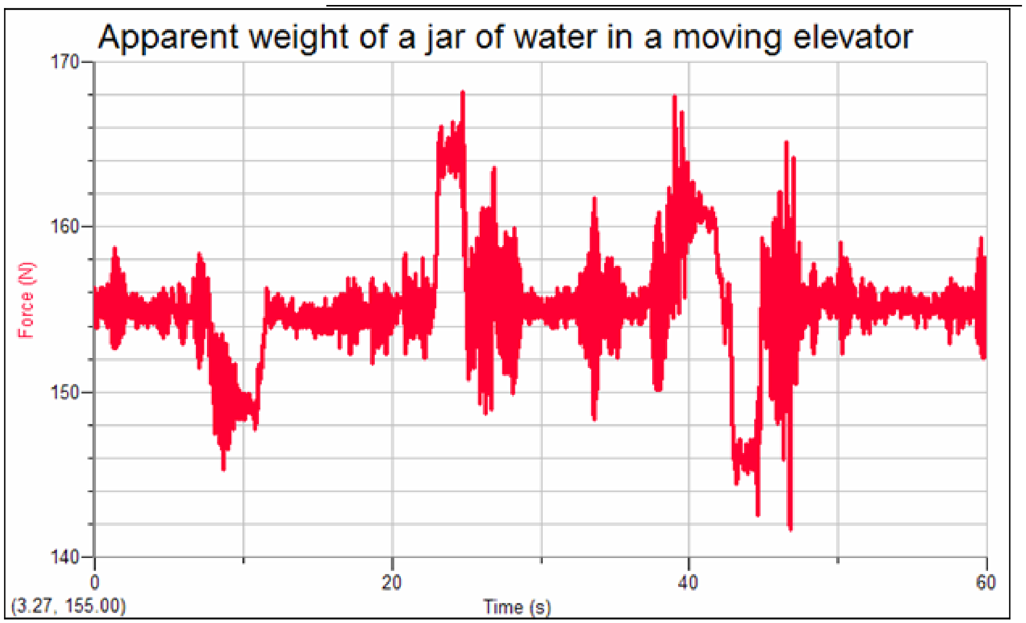
II Exploring Vernier Sensors

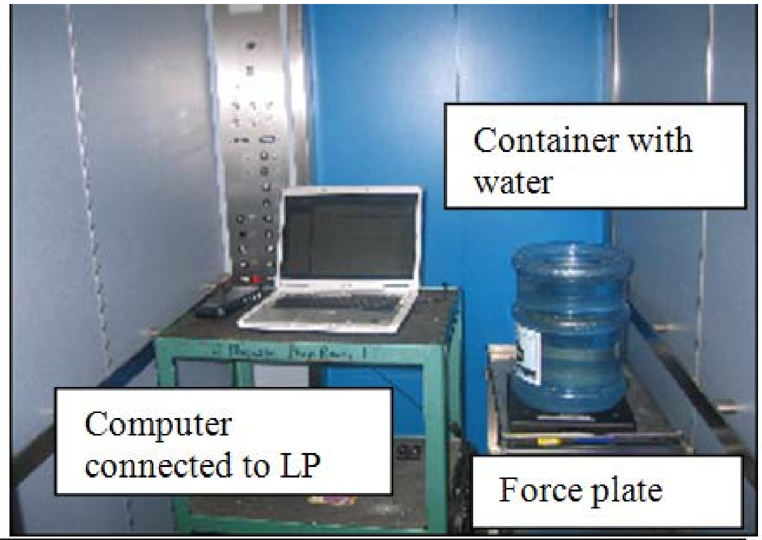


A hands-on activity with motion detector, force probe and temperature probe

II Making Science Relevant

Why do you sometimes feel lighter and sometimes heavier in an elevator?





A water jar was placed on a force plate inside a moving elevator: weight and apparent weight problem

II Reconsidering Assessment

Your friend analyzed a video clip of a basketball shot using a Logger *Pro* Video Analysis feature. However she was not certain how to find the acceleration of free fall from his analysis and turned to you for advice. What is the **reasonable experimental value** of the **magnitude** of the acceleration of free fall your friend should report during the next class?

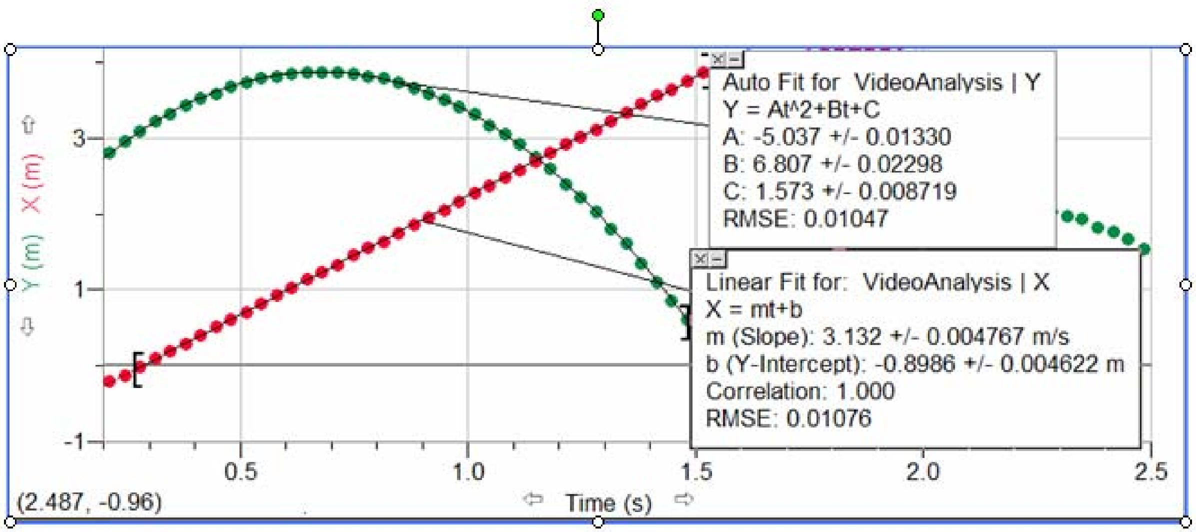
a) 5.037 m/s^2

b) 6.807 m/s^2

c) 9.823 m/s^2

d) 10.074 m/s^2

e) 10.10 m/s^2



II Doing Science…

Group activity

1. What hands-on activities are your students engaged in your math and science classes?
2. What are the opportunities for students to do science?
3. How do we make science relevant?

II Introducing Interactive Lecture Experiments

2007, Journal of College Science Teaching, 36(4), 45-49.

Can Students Learn from Lecture Demonstrations?

The Role and Place of Interactive Lecture Experiments in Large Introductory Science Courses

By Marina Milner-Bolotin, Andrzej

Using live data collection to give students an opportunity to test hypotheses, make predictions and experience science as a process of discovery, not as a collection of facts

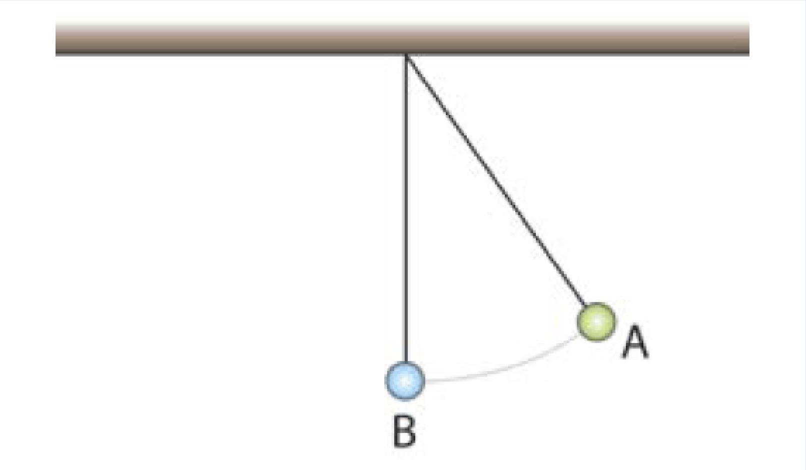
II Conceptual Physics

A 0.2-kg pendulum bob is attached to a string 1.2 m long. The bob is released at the point A as shown in the picture. The tension in the string as the bob passes its lowest position is about (use g = 10 m/s2):

(A) 0.00 N (B) 0.70 N (C) 1.30 N (D) 2.00 N (E) 2.70 N

FIGURE 2

Tension in a pendulum's string exam problem.

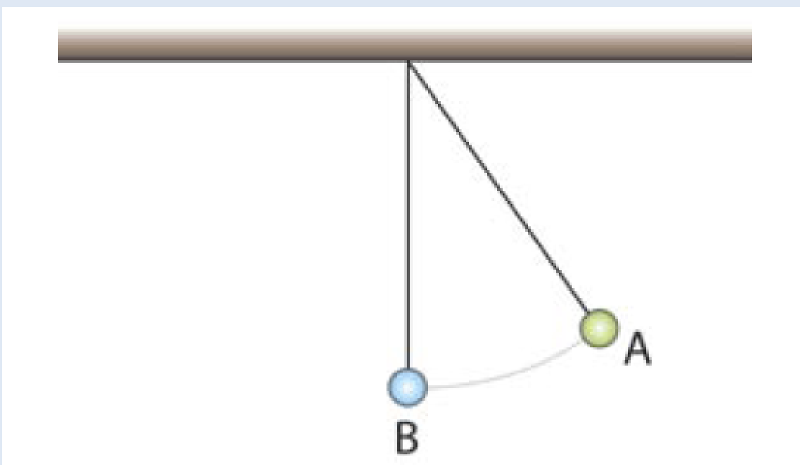


II Thinking Like Scientists

A 0.2-kg pendulum bob is attached to a string 1.2 m long. The bob is released at the point A as shown in the picture. The tension in the string as the bob passes its lowest position is about (use g = 10 m/s2):

(A) 0.00 N (B) 0.70 N (C) 1.30 N (D) 2.00 N (E) 2.70 N

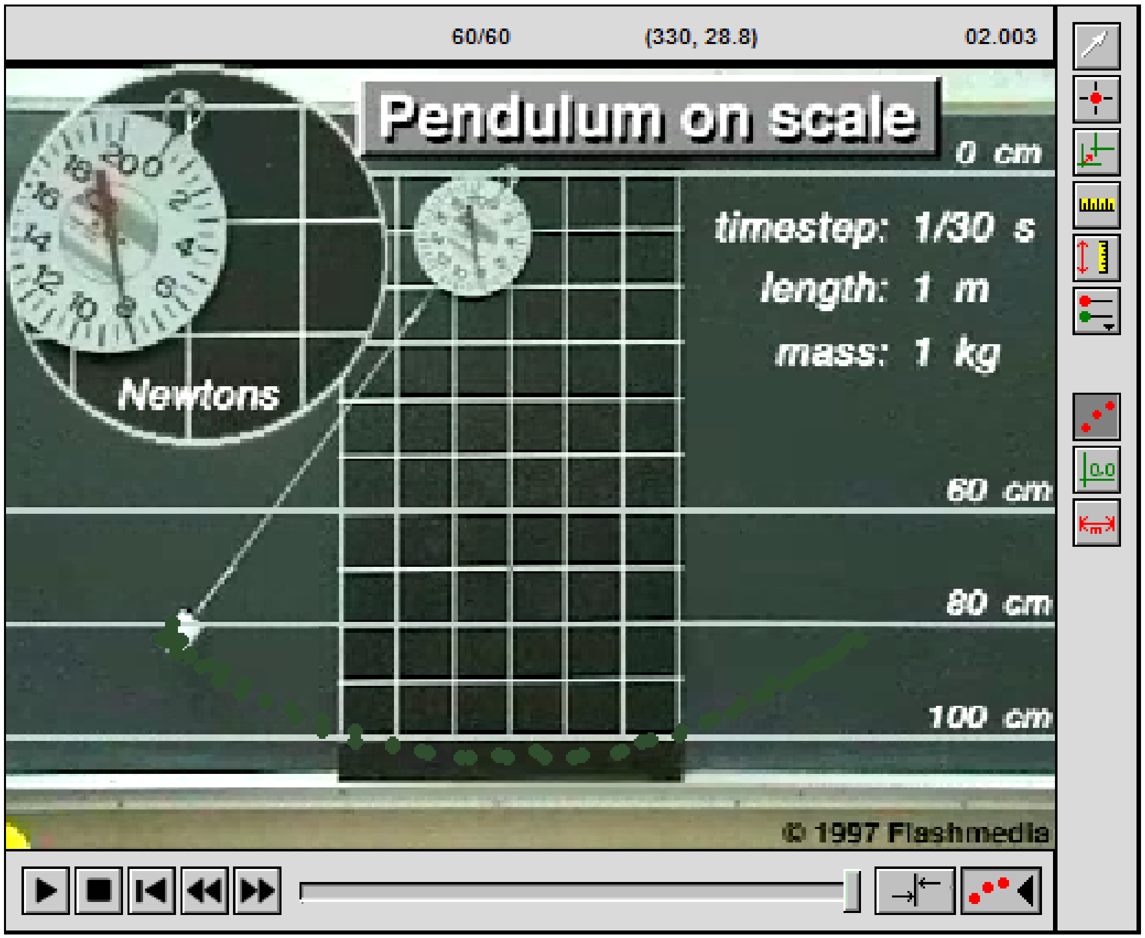
Tension in a pendulum's string exam problem.



Only 25% of the students chose the correct response. 59% chose the incorrect response (D).

M. Milner-Bolotin et al, Journal of College Science Teaching, January-February 2007, pp.45-49.

II Interactive Lecture Experiment



Traditional lecture demonstrations are replaced by Interactive Lecture Experiments

Students use Logger Pro Video Analysis to analyze the motion of a pendulum.

They work in groups, define the problem solving strategy, collect necessary data, come up with the analysis and solution and then check if their answer is meaningful.

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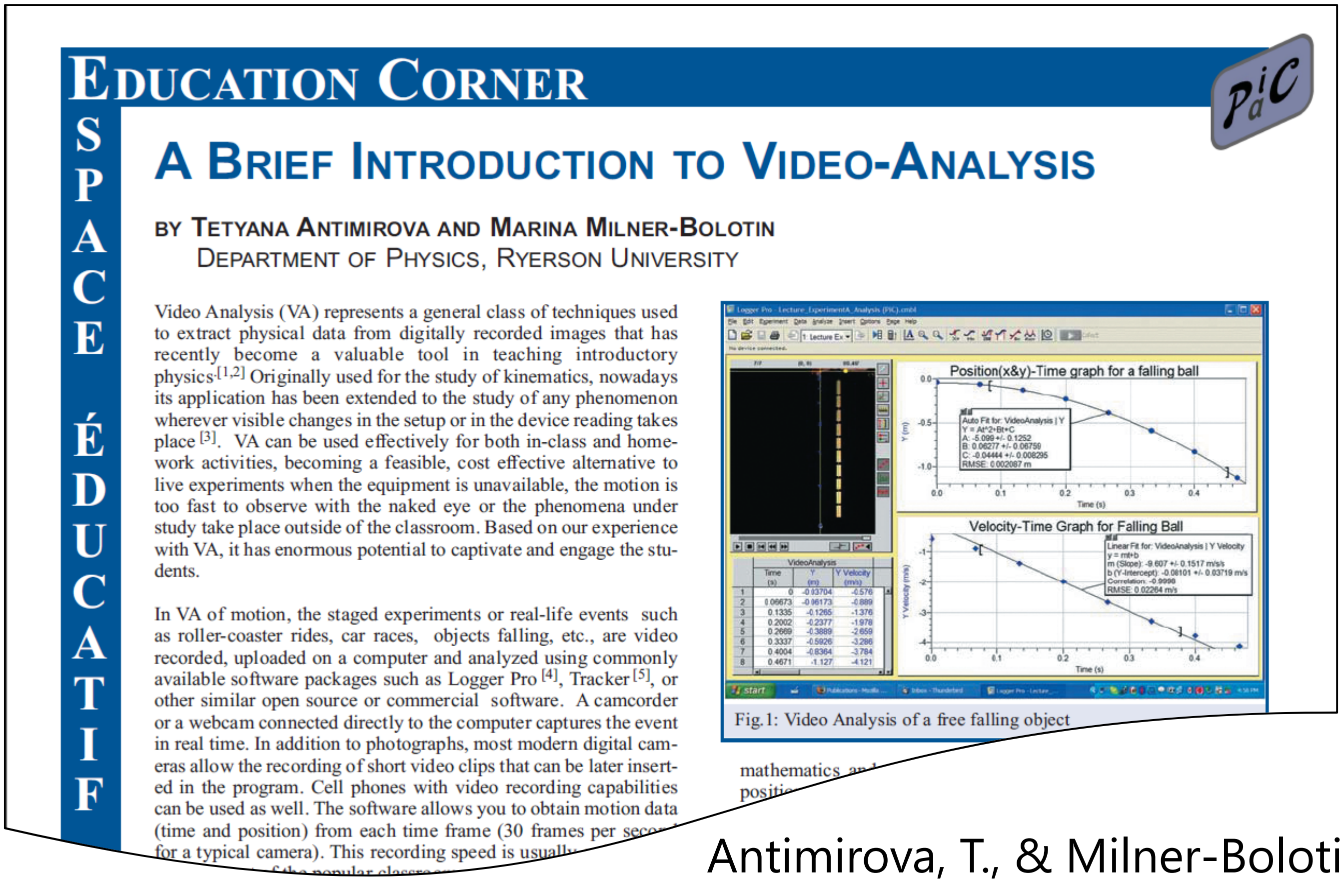
III Introducing Vernier Video Analysis



EDUCATION CORNER

SPACE ÉDUCATIF

A BRIEF INTRODUCTION TO VIDEO-ANALYSIS

BY TETYANA ANTIMIROVA AND MARINA MILNER-BOLOTIN
DEPARTMENT OF PHYSICS, RYERSON UNIVERSITY

Video Analysis (VA) represents a general class of techniques used to extract physical data from digitally recorded images that has recently become a valuable tool in teaching introductory physics[1,2] Originally used for the study of kinematics, nowadays its application has been extended to the study of any phenomenon wherever visible changes in the setup or in the device reading takes place [3]. VA can be used effectively for both in-class and home-work activities, becoming a feasible, cost effective alternative to live experiments when the equipment is unavailable, the motion is too fast to observe with the naked eye or the phenomena under study take place outside of the classroom. Based on our experience with VA, it has enormous potential to captivate and engage the students.

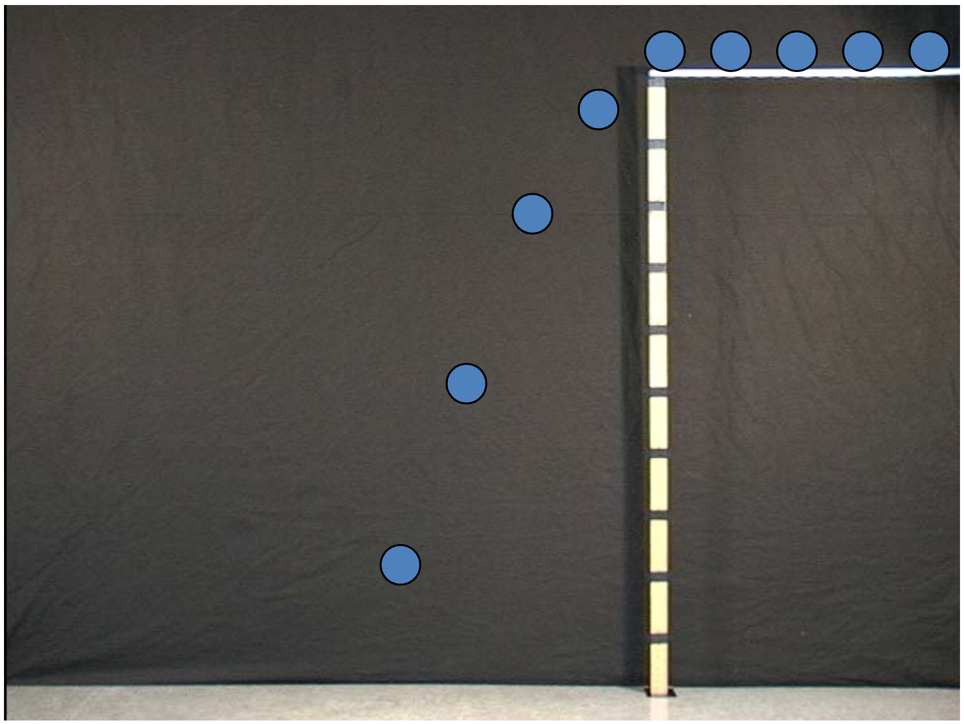
In VA of motion, the staged experiments or real-life events such as roller-coaster rides, car races, objects falling, etc., are video recorded, uploaded on a computer and analyzed using commonly available software packages such as Logger Pro [4], Tracker [5], or other similar open source or commercial software. A camcorder or a webcam connected directly to the computer captures the event in real time. In addition to photographs, most modern digital cameras allow the recording of short video clips that can be later inserted in the program. Cell phones with video recording capabilities can be used as well. The software allows you to obtain motion data (time and position) from each time frame (30 frames per seco…
for a typical camera). This recording speed is usually…

Fig.1: Video Analysis of a free falling object

mathematics an…
positi…

Antimirova, T., & Milner-Bolotin, M. (2009). A Brief Introduction to Video Analysis. *Physics in Canada*, 65 (April-May), 74.

III Introducing Vernier Video Analysis



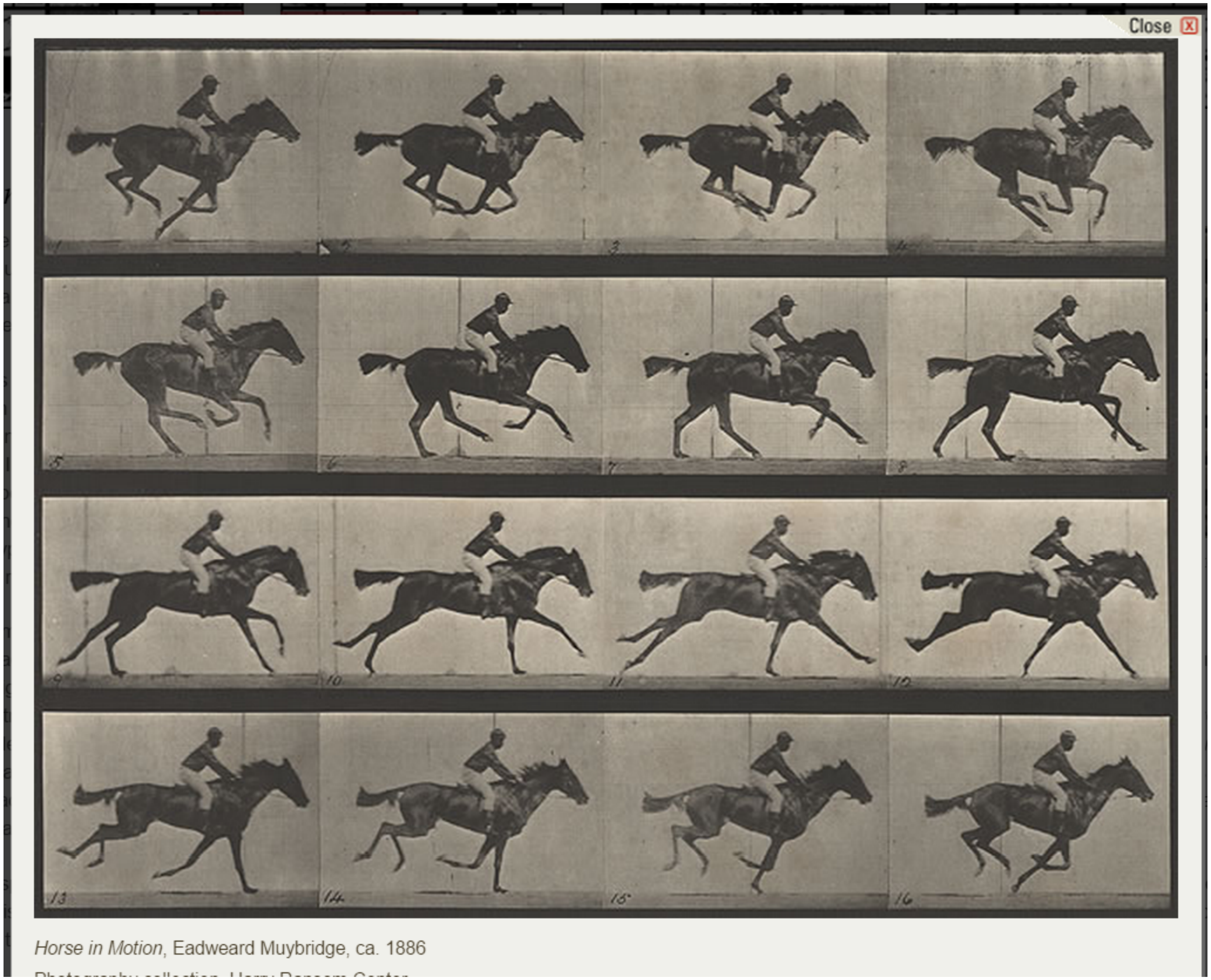
Video-analysis feature of Logger Pro allows to analysis fast occurring motion.

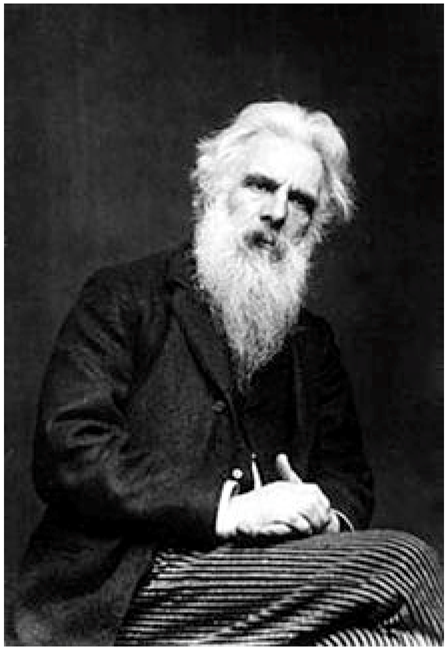
Synchronizing video with live collected data makes it even more effective!

III What is Video Analysis?

- Video Analysis (VA) allows to extract physical data from digitally recorded images
- Originally used for kinematics
- Any phenomenon where visible changes in the setup or in the device reading takes place can be studied using VA

III History of Video Analysis





Horse in Motion, Eadweard Muybridge (1830-1904), ca. 1886

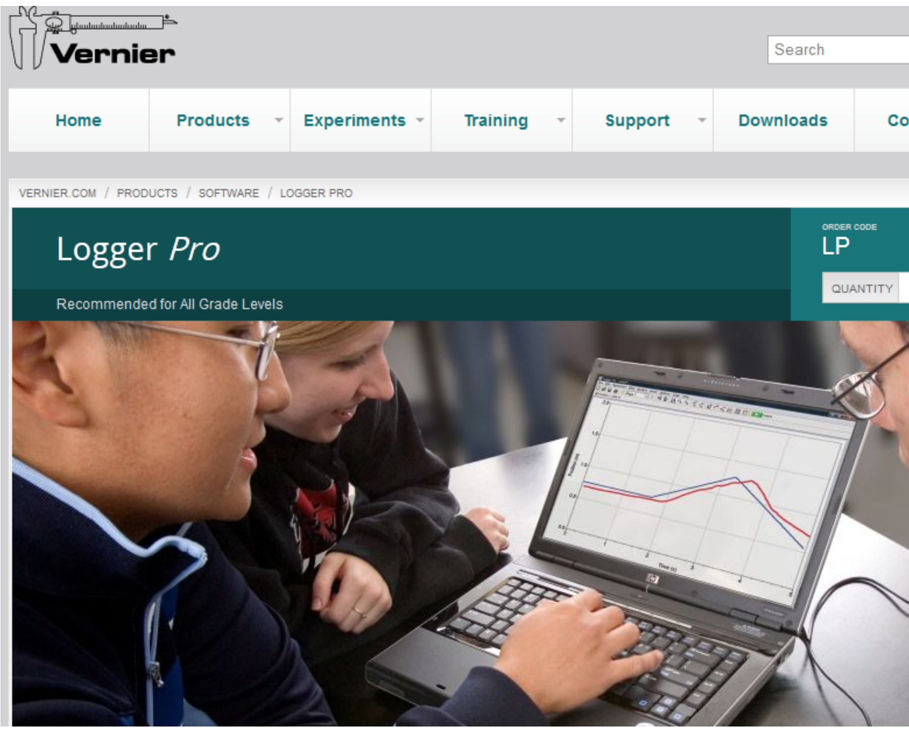
III Equipment

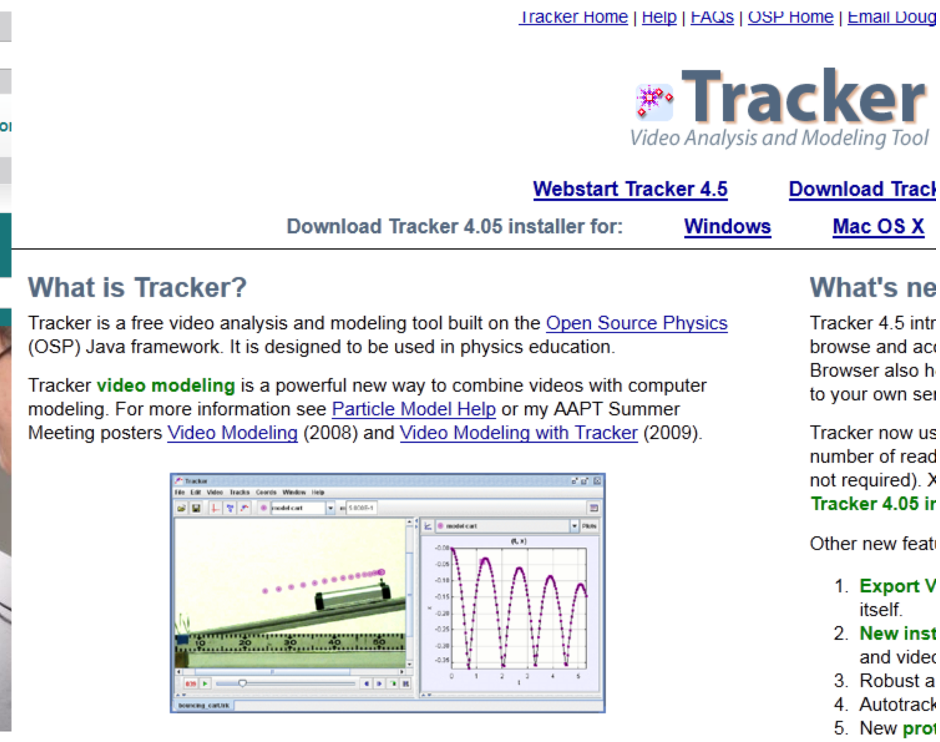
- A **camcorder** or a webcam connected directly to the computer (to capture real-time event)
- Most modern digital cameras (including cell phone) allow recording of short video clips for later analysis

III Video Analysis

- **Recording:** Experiments or real-life events (i.e. roller-coaster rides, car races, falling objects) are video recorded, and uploaded on a computer.
- **Analysis:** Software (Logger *Pro*, Tracker, etc.) is used for motion analysis:
  - Time & position data are obtained from each frame
  - Then the data are analyzed using the software

III Video Analysis Software





Vernier Logger Pro: www.vernier.com

Tracker – video analysis tool http://www.cabrillo.edu/~dbrown/tracker/

III Advantages of Video Analysis

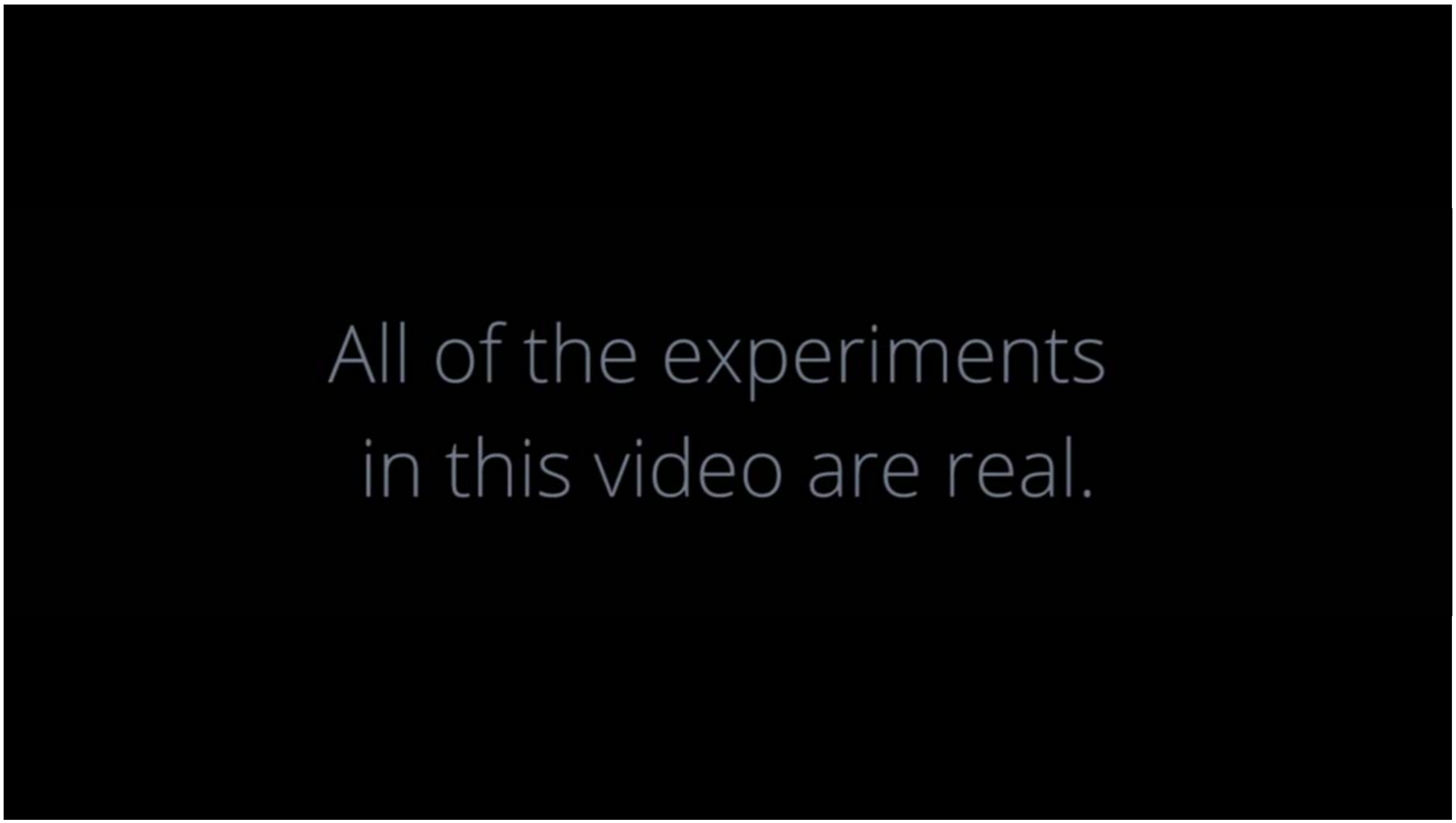
- Easy to learn: for both students and teachers
- Cost-effective alternative to live experiments
- Excellent for fast motion that is too fast for a naked eye
- Excellent to analyze events occurring outside of the classroom
- Has enormous potential to engage students
- Data for modeling that comes from real experiments (see Tracker resources)

III Video Analysis Activity

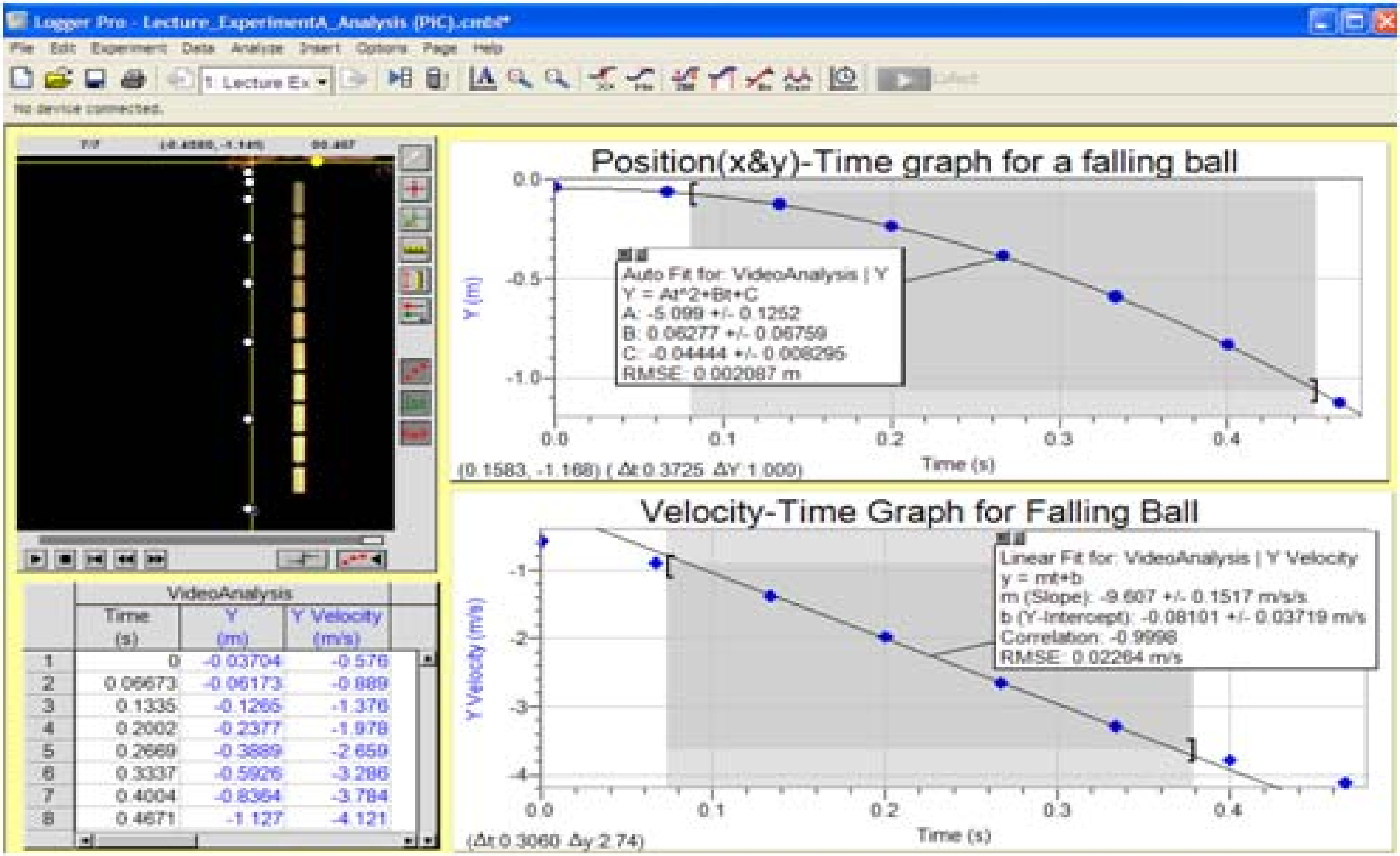
Group activity

1. We will record motion and analyse it in class
2. We will use Video Analysis activities from the Live Data Project web site
3. We will design a possible video analysis activity for your classrooms

Science Relaxation

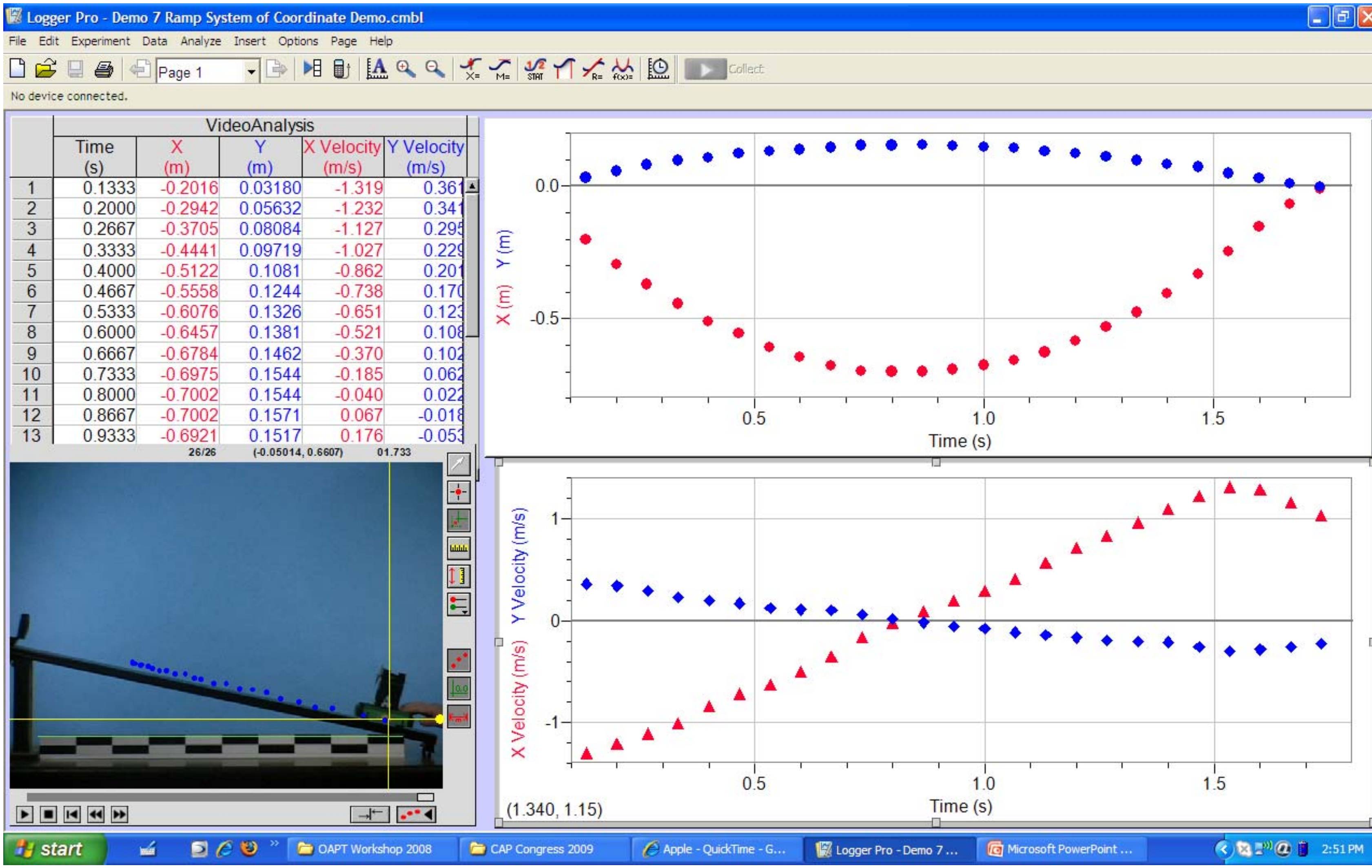


IV Example 1 of Interactive Lecture Experiments: Free Fall

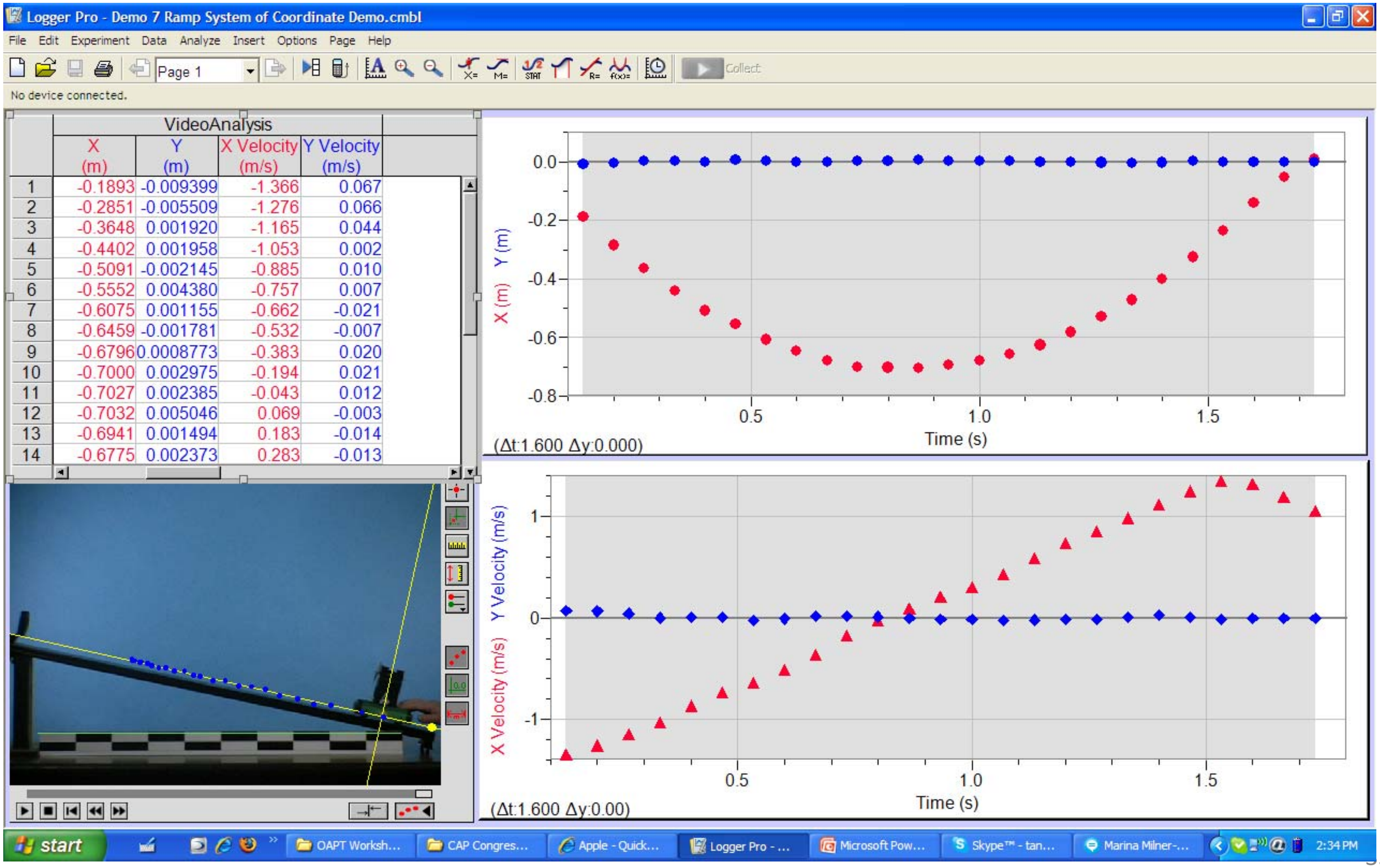


	Time (s)	Y (m)	Y Velocity (m/s)
1	0	-0.03704	-0.576
2	0.06673	-0.06173	-0.889
3	0.1335	-0.1265	-1.376
4	0.2002	-0.2377	-1.978
5	0.2669	-0.3889	-2.659
6	0.3337	-0.5926	-3.286
7	0.4004	-0.8364	-3.784
8	0.4671	-1.127	-4.121

IV Example 2 of Interactive Lecture Experiments: Cart on a Ramp



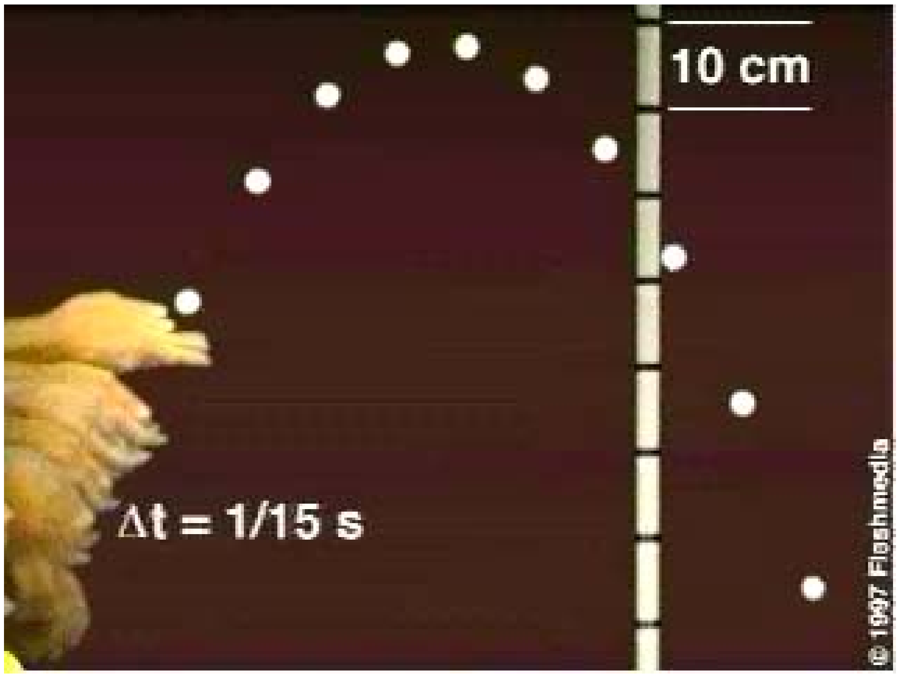
IV Example 3 of Interactive Lecture Experiments: Cart on a Ramp rotated axis



	X (m)	Y (m)	X Velocity (m/s)	Y Velocity (m/s)
1	-0.1893	-0.009399	-1.366	0.067
2	-0.2851	-0.005509	-1.276	0.066
3	-0.3648	0.001920	-1.165	0.044
4	-0.4402	0.001958	-1.053	0.002
5	-0.5091	-0.002145	-0.885	0.010
6	-0.5552	0.004380	-0.757	0.007
7	-0.6075	0.001155	-0.662	-0.021
8	-0.6459	-0.001781	-0.532	-0.007
9	-0.6796	0.0008773	-0.383	0.020
10	-0.7000	0.002975	-0.194	0.021
11	-0.7027	0.002385	-0.043	0.012
12	-0.7032	0.005046	0.069	-0.003
13	-0.6941	0.001494	0.183	-0.014
14	-0.6775	0.002373	0.283	-0.013

II

Interactive Lecture Experiment: Group Activity



Task: Determine the acceleration of free fall from your own video analysis of a tossed out ball

Use laptops on your tables to figure it out! It is your turn now!

FREE
resources

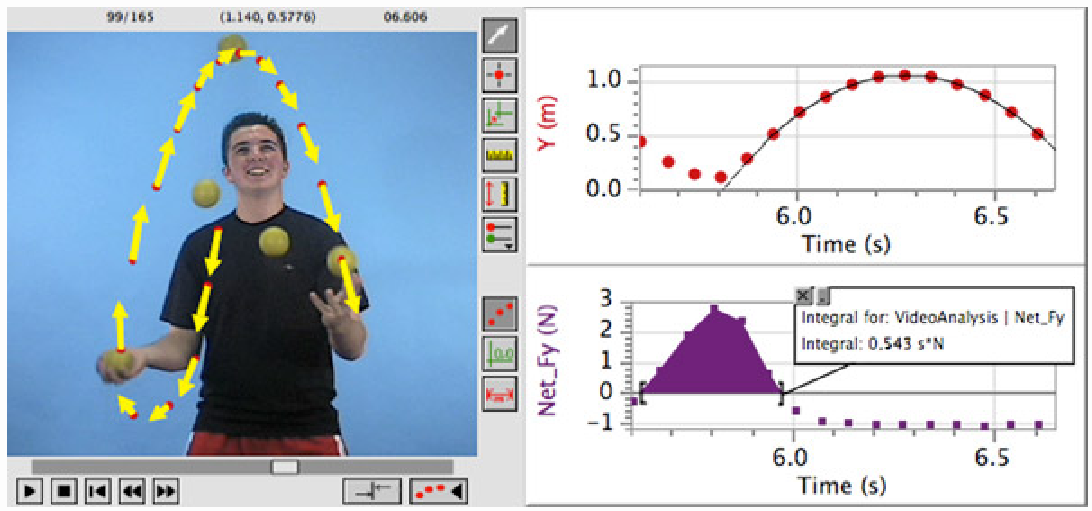
FREE Physics Movie Collection for Physics Teaching

http://livephoto.rit.edu/LPVideos/loop/

LivePhoto Physics Project

LivePhoto Physics

Mechanics Videos | Other Videos | FAQ and Info | Workshops | LivePhot

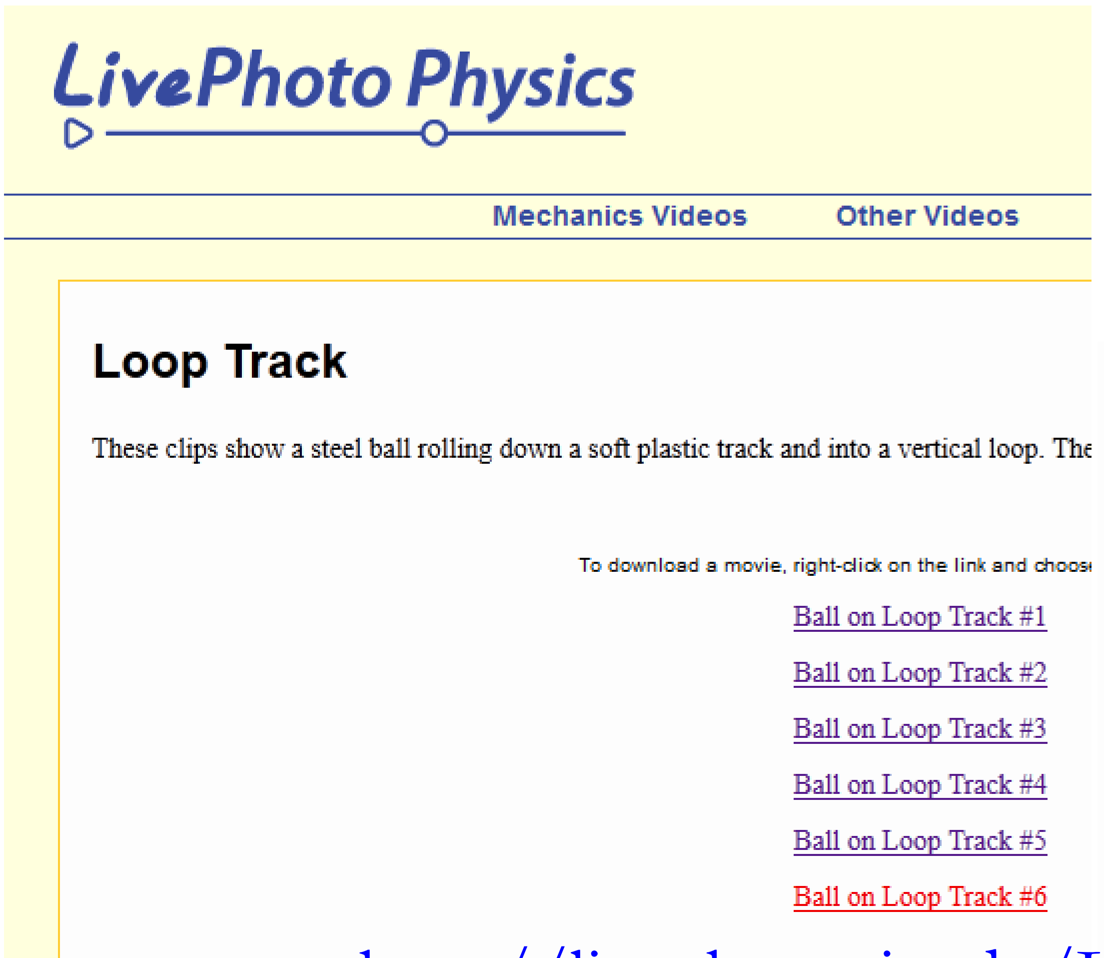


Short videos, often just 20 to 30 frames in length, can be extremely useful in teaching physics and other sciences. Not still photographs, but too short to be considered movies, these "live photos" are designed for analysis in a computer. Positions of objects in the video frame can be measured by pointing a mouse and clicking. The data can be graphed, analyzed in spreadsheets, compared to theoretical models, and even used to display vectors or points superimposed on the original video.

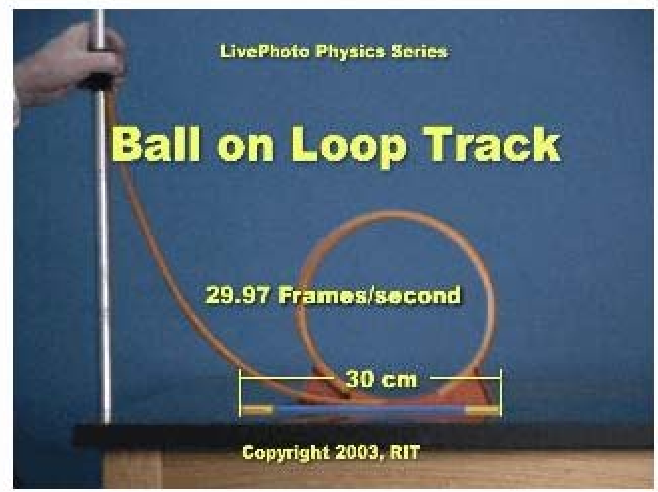
FREE resources

FREE resources

LivePhoto Project Example



Excellent movies to use for Video Analysis in your physics class

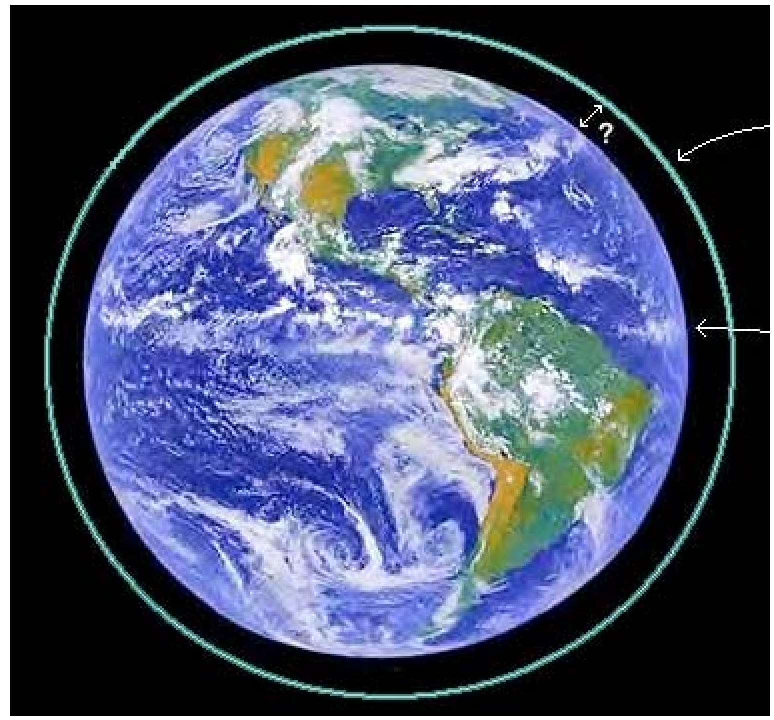


http://livephoto.rit.edu/LPVideos/loop/

III Break: Mental Exercise

III Break: Mental Exercise

By how much a rope tied around the equator of the Earth must be lengthened so there is a one meter gap at all points between the rope and the Earth if the rope is made to hover. Chose the best answer.



(a) ~ 1 m (b) ~ 10 m (c) ~1000 m
(d) ~ 1 km (e) ~ 10 km

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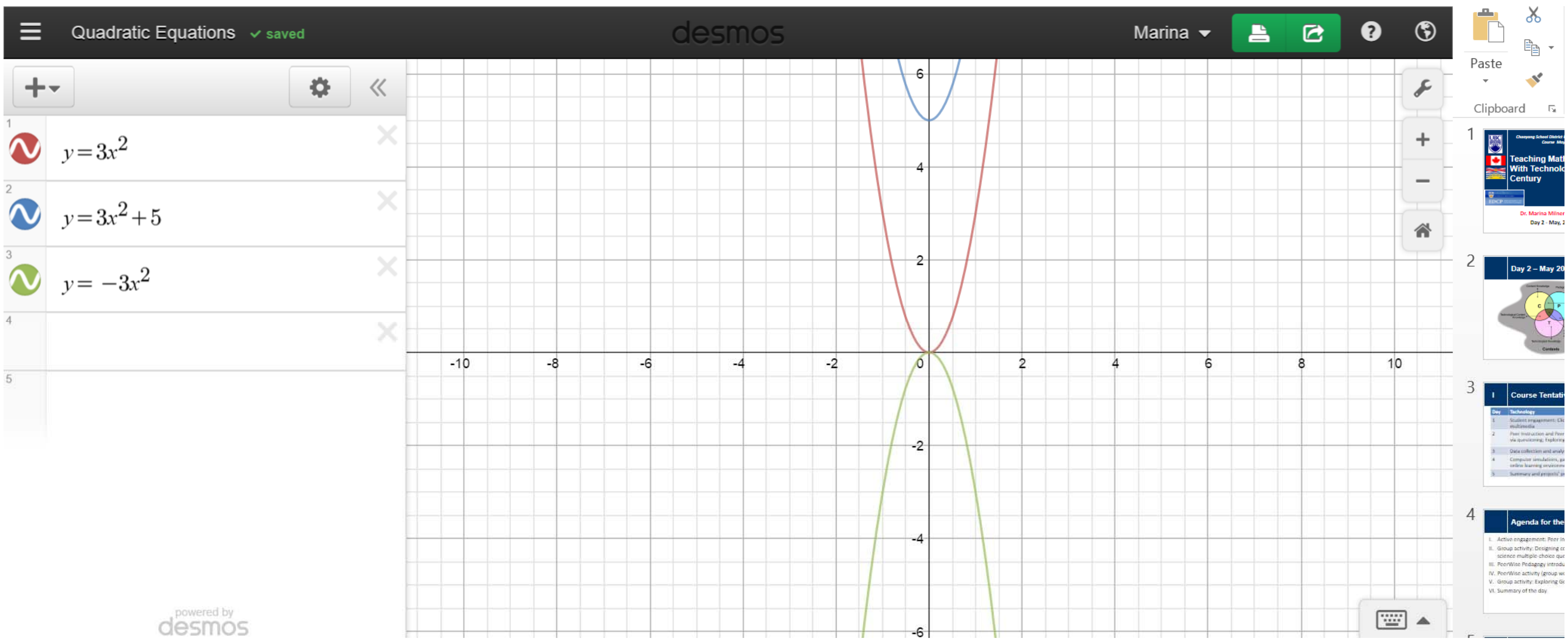
VI. Summary of the day

IV Introducing Desmos Graphing Calculator



IV Desmos Graphing Calculator

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VI. Summary of the day

V

Designing Lessons: Group activity (45 min)

Group activity

1. While working with a partner, plan a lesson that will use any of the tools discussed here
2. Pair up with another group and share the lesson with them

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Day 3: Feedback 1

How satisfied are you with the day?

1 3 5

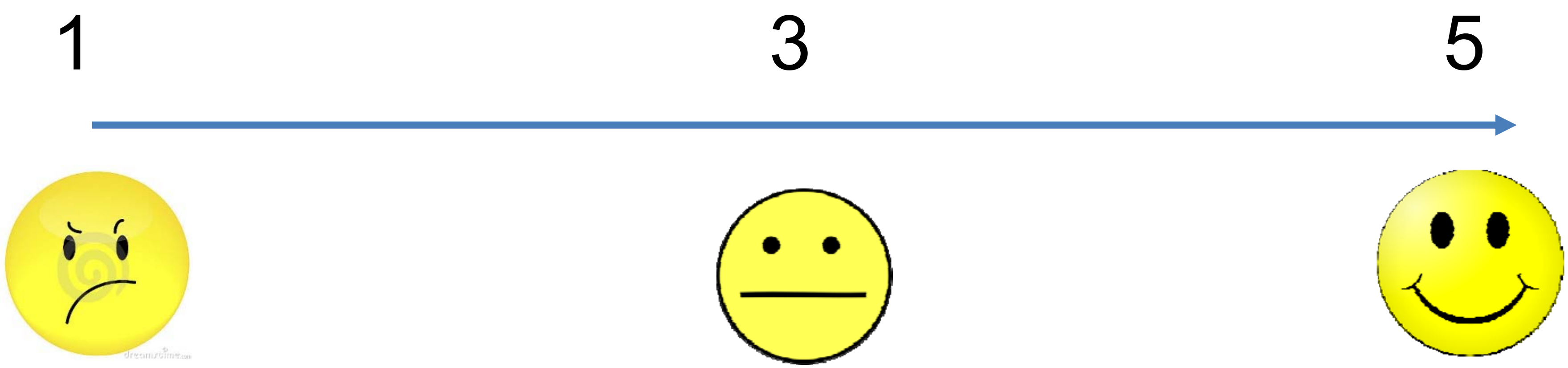
Day 3: Feedback 2

Do you feel you have learned new ideas for math and science teaching?

1 3 5

Day 3: Feedback 3

Are you looking forward to Day 2?



Day 3: Feedback 4

What was the pace of the day?

1 3 5

Day 3: Feedback 5

What was the amount of information for you today?

1 3 5