Mar 9th, 10:00 AM - 10:20 AM

Methodology and/or Technology: Making Difference in Improving Students' Problem Solving Skills

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Making Difference in Improving Students' Problem Solving Skills

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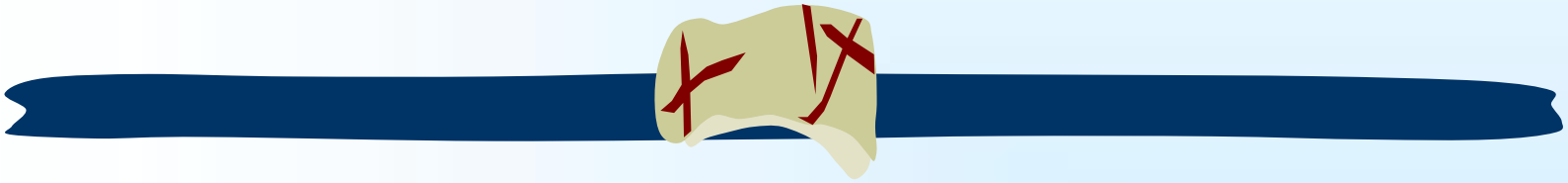


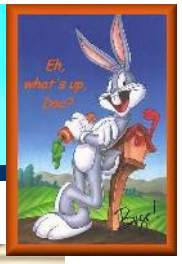
Georgia Scholarship of STEM Teaching and Learning

March 2012

Georgia Southern University

Motivation

Eh, what's down Doc?



Session Goals

1. DEMO

- to demonstrate the instructor-student classroom interaction dynamics enabled or facilitated by **DyKnow software and pen-input computers**.

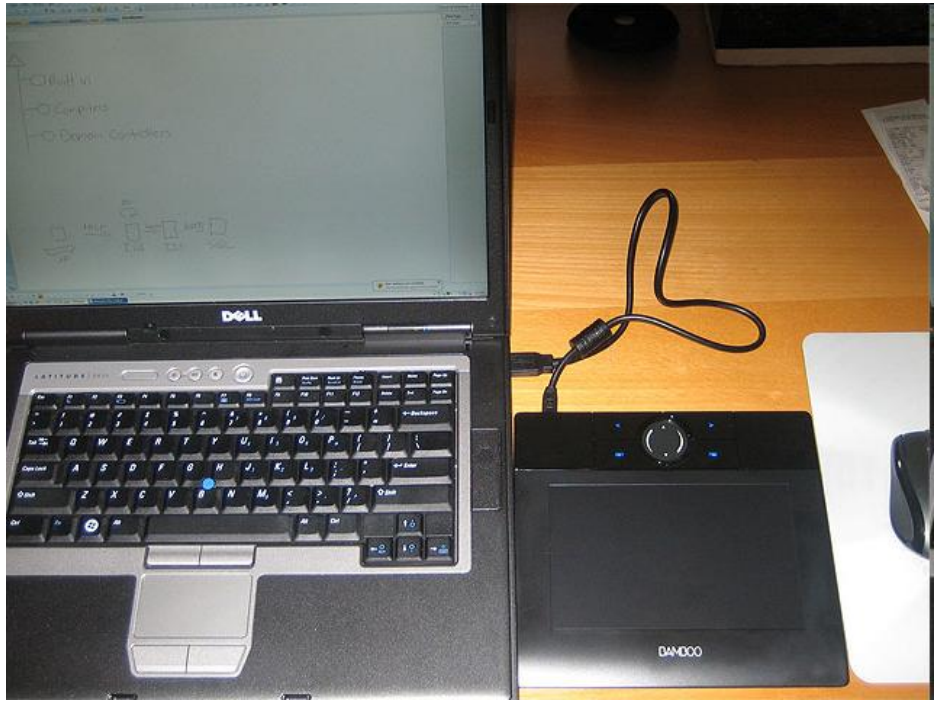
2. SELECTED RESEACH

- to present selected research findings associated with **student learning** with this technology.

Pen-Input Computing

- Tablet PC

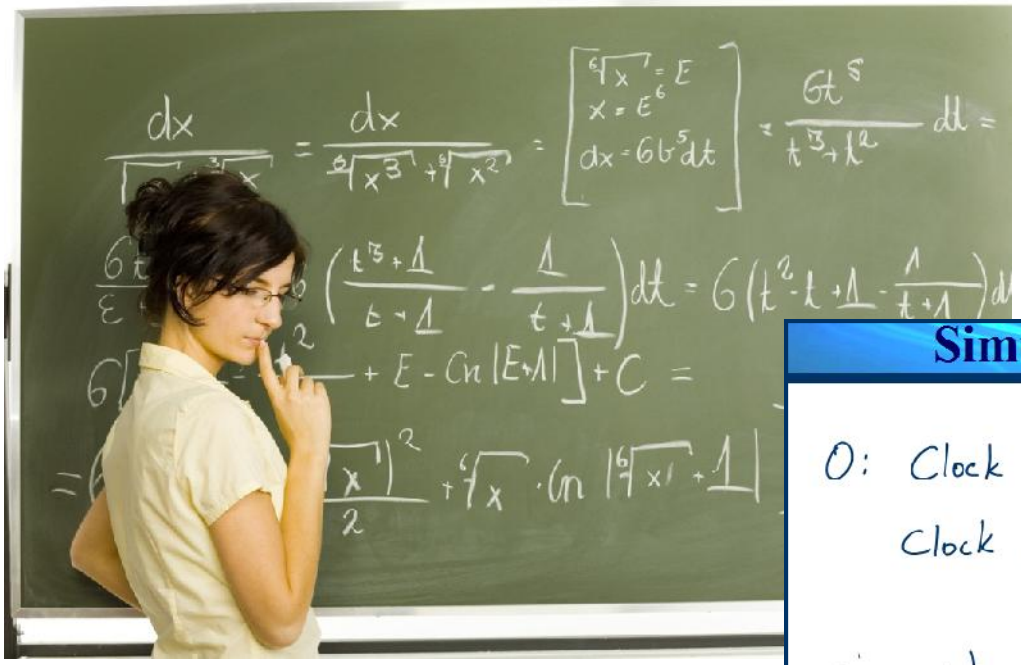
Laptop w/ Wacom Bamboo



http://www.adopenstatic.com/cs/blogs/ken/archive/2007/11/28/14503.aspx

+ Slate Devices / iPad

Pen in STEM



Simultaneity and clock Synchronization

O: Clock 1 at $x_1 = 0$; Starts at $t_1 = \frac{L}{2c}$

Clock 2 at $x_2 = L$; Starts at $t_2 = \frac{L}{2c}$

O: $$t_1' = \frac{t_1 - \frac{u}{c^2} x_1}{\sqrt{1 - \frac{u^2}{c^2}}} = \gamma\left(\frac{L}{2c} - 0\right) = \gamma \cdot \frac{L}{2c}$$

$$t_2' = \frac{t_2 - \frac{u}{c^2} x_2}{\sqrt{1 - \frac{u^2}{c^2}}} = \gamma\left(\frac{L}{2c} - \frac{u}{c^2} \cdot L\right)$$

$$\Delta t' = t_1' - t_2' = \gamma \cdot \frac{uL}{c^2}$$

- Eg: A Young's interference experiment is performed with blue-green argon laser light. The separation between the slits is 0.500 mm, and the interference pattern on a screen 3.30m away shows the first maximum 3.40mm from the center of the pattern. What is the wavelength of argon laser light?

$d = 0.500\,mm$

$D = 3.30\,m$

$y_{1\,Bright} = 3.4\,mm \quad (m=1)$

$\lambda = ?$

$$y_{bright} = \frac{\lambda D}{d}\, m$$

$m = 0, \pm 1, \pm 2$

$$\lambda = \frac{y_m d}{m D} = 515\ nm$$

Better:

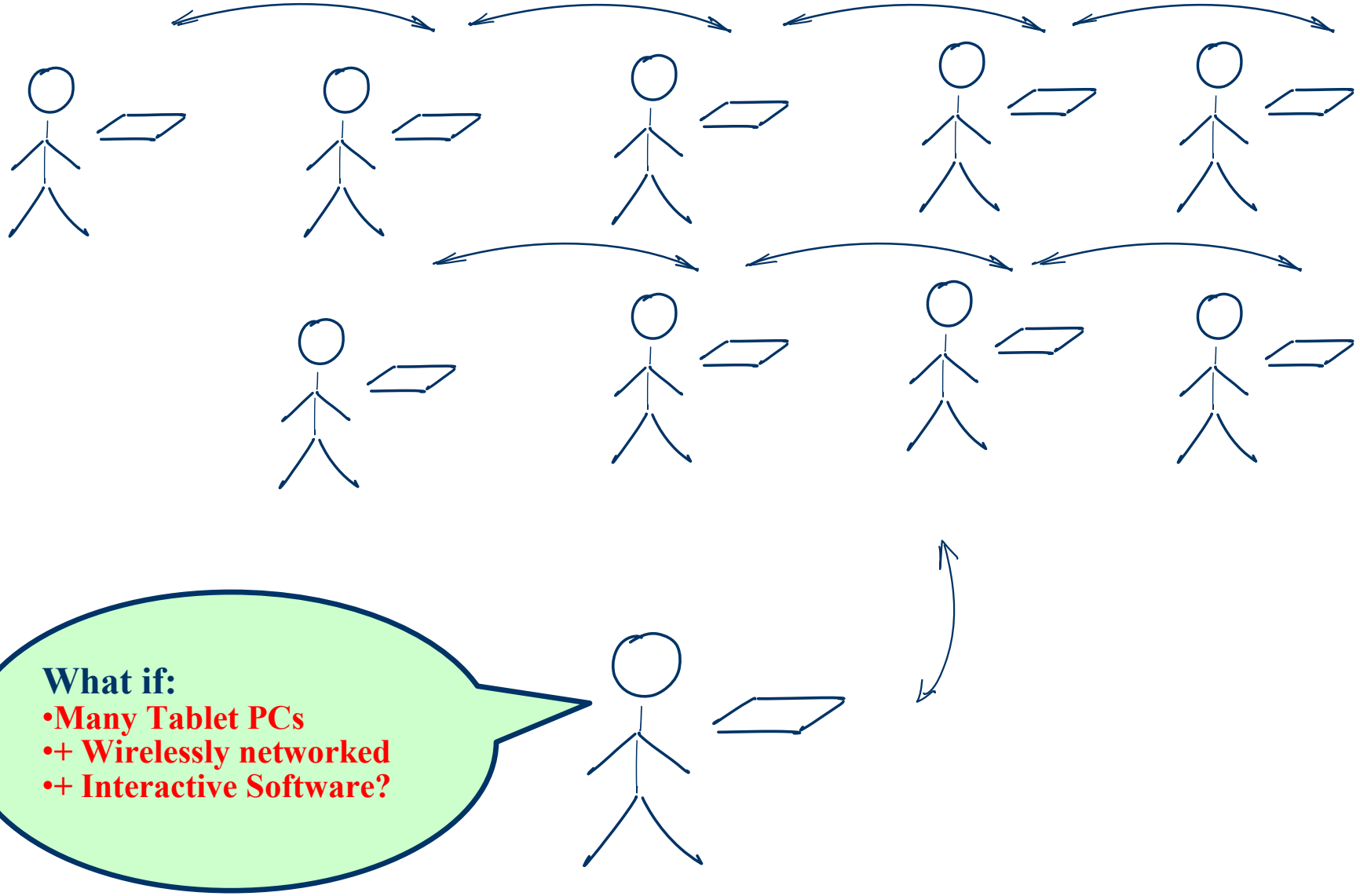
For max: $d\sin\theta = n\lambda$

$$\lambda = \frac{d\sin\theta}{n} = \frac{0.500 \times 10^{-3}\,m \cdot \sin\theta}{1}$$

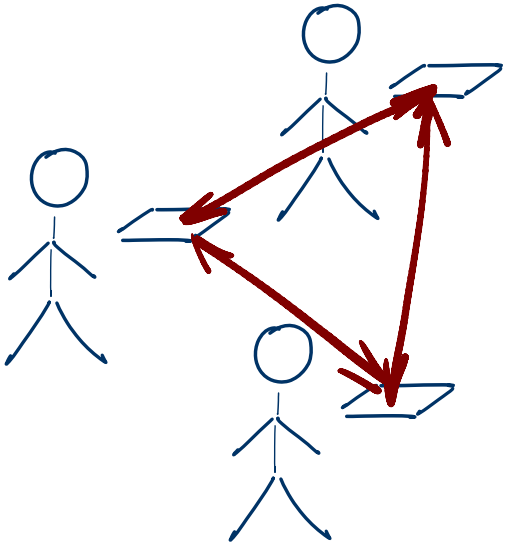
θ from

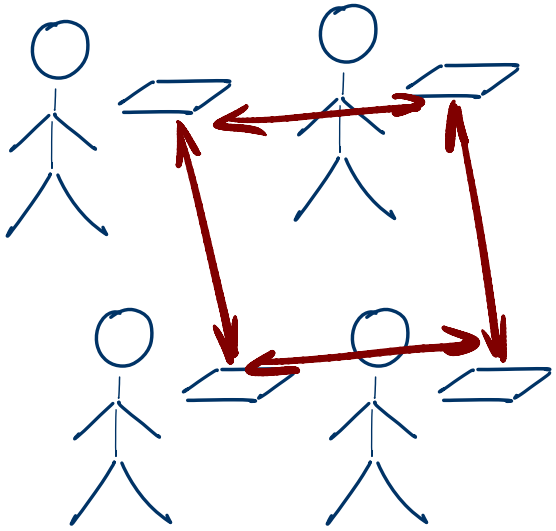
$$\tan\theta = \frac{y}{D} = \frac{3.4 \times 10^{-3}\,m}{3.31\,m}$$

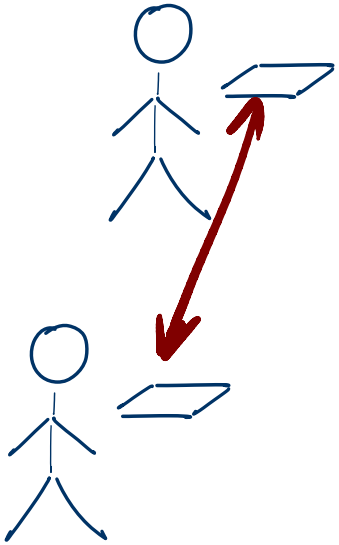
Above "Ordinary" Usage



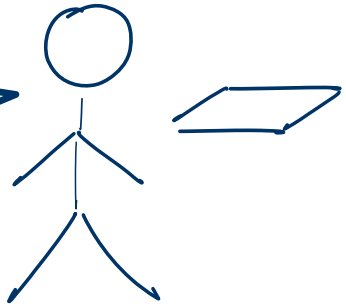
Integrating Engagement, Collaboration and IN class learning







What if:
- **Many Tablet PCs**
- **+ Wirelessly networked**
- **+ Interactive Software?**



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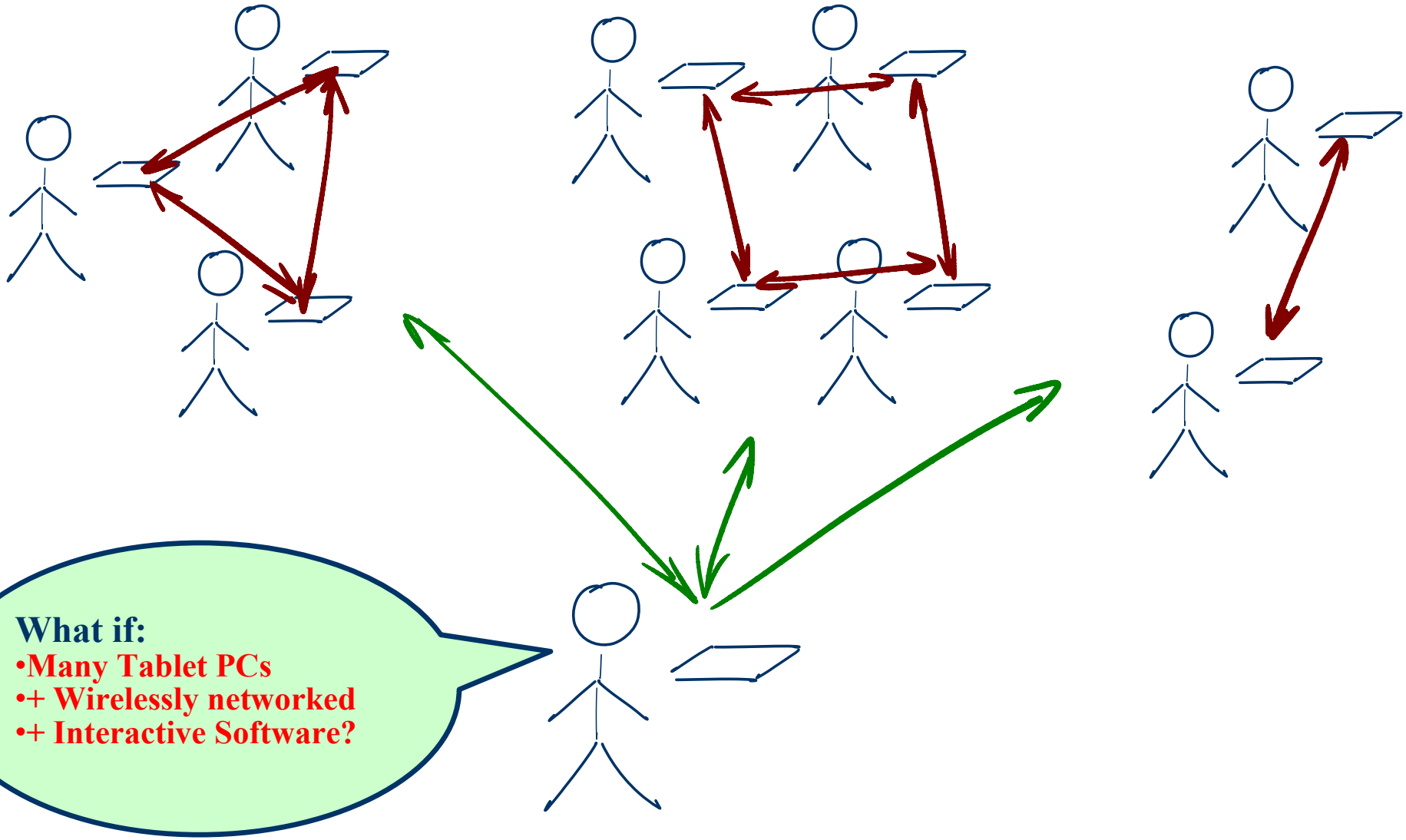

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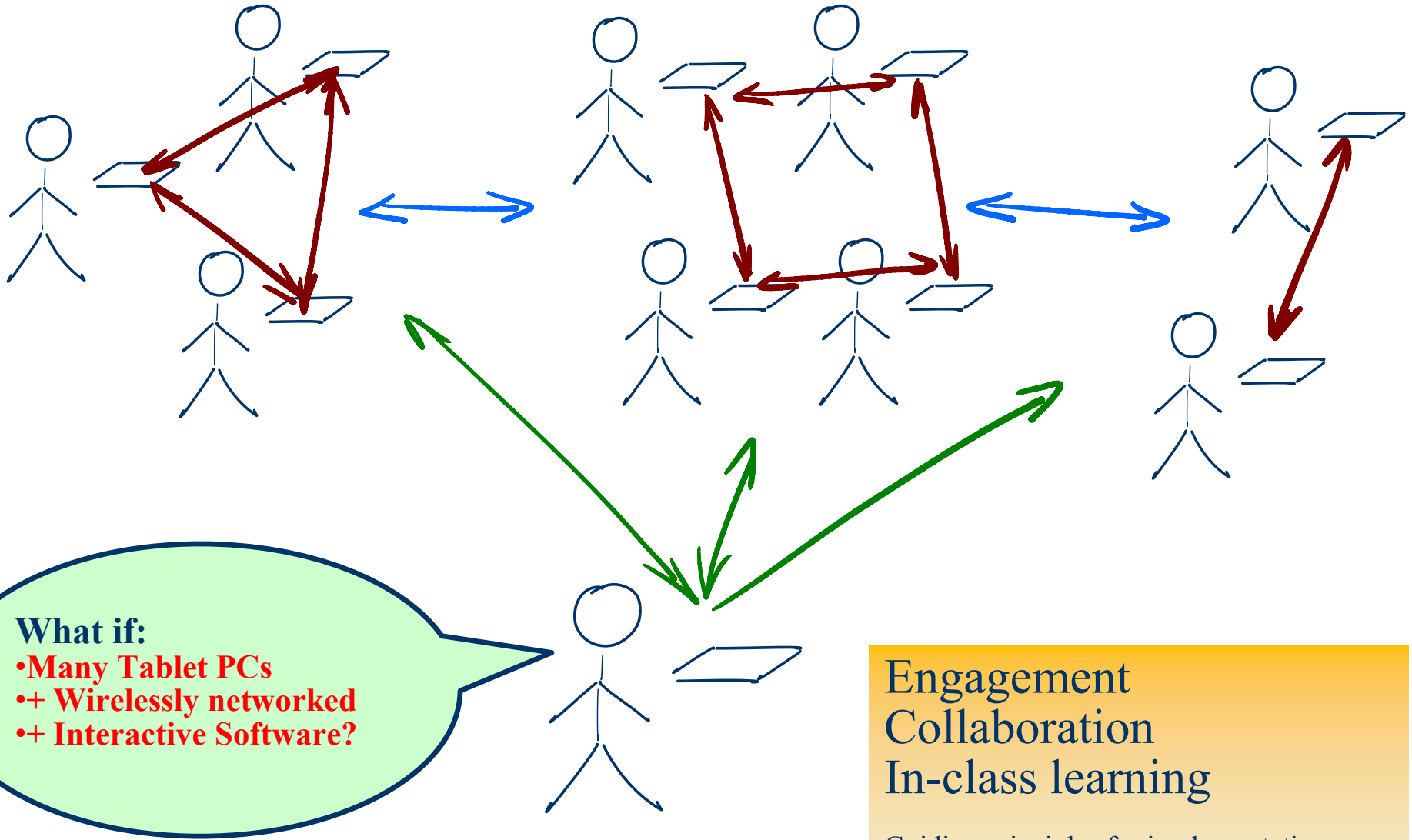

What if:
- **Many Tablet PCs**
- **+ Wirelessly networked**
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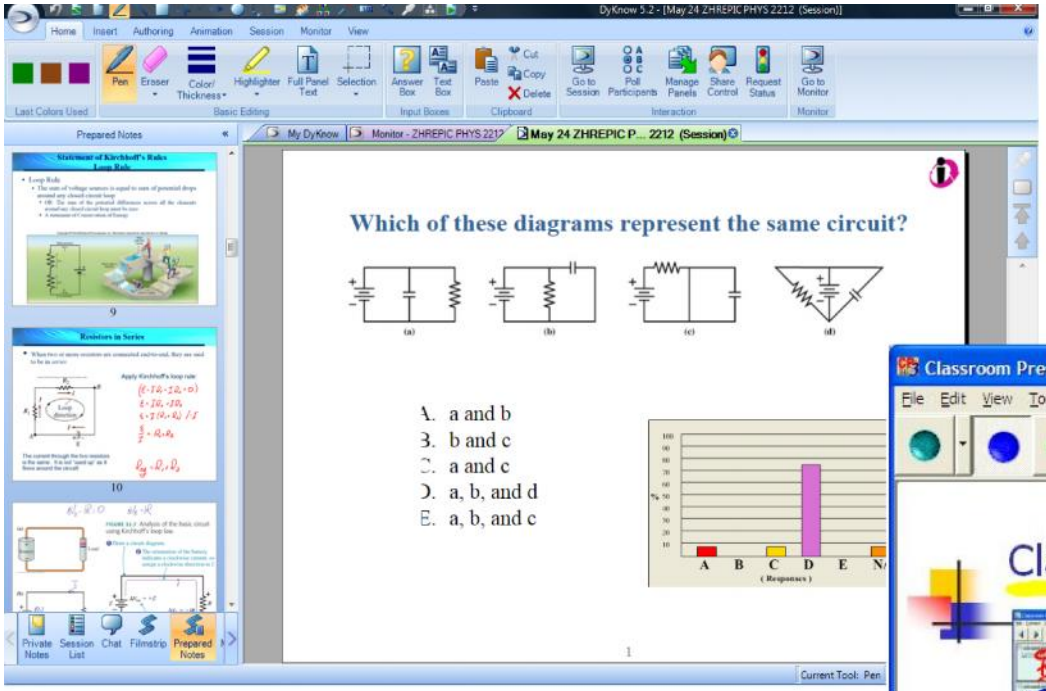
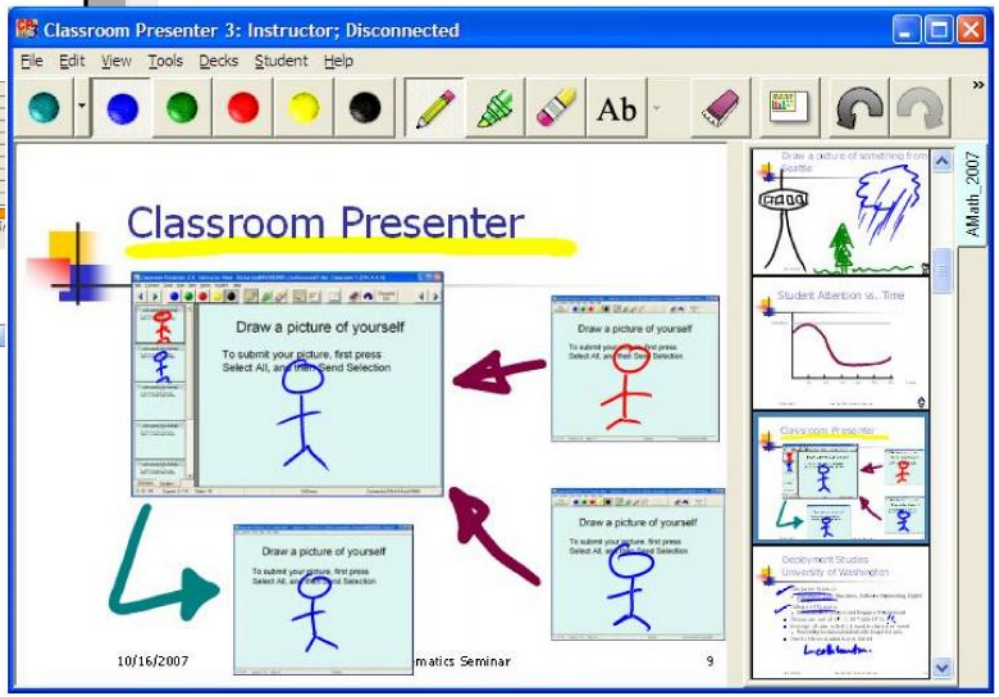
Engagement
Collaboration
In-class learning

Guiding principles for implementation (2005)

Interactive Software Solutions

DyKnow; Classroom Presenter (Ubiquitous presenter)





DyKnow: http://www.dyknow.com/
CP: http://classroompresenter.cs.washington.edu
UP: http://up.ucsd.edu/about/WhatIsUP.html

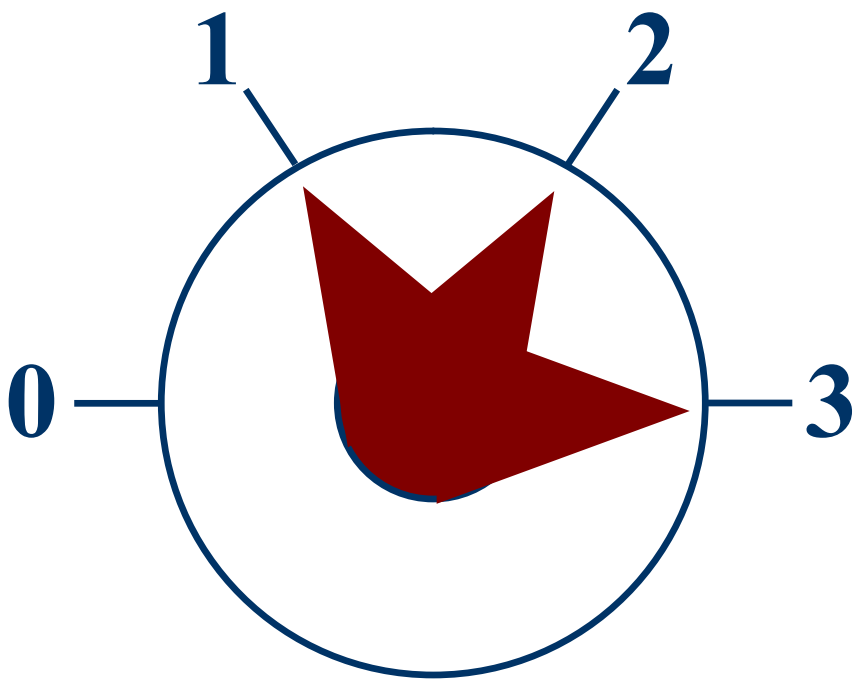
Demo: DyKnow
3 levels above "ordinary Tablet usage"

0 -Tablet usage baseline

1 - Step 1 up: New dynamics of the note taking

2 - Step 2 up: Multiple channels of real-time feedback

3 - Step 3 up: All in control: Students in charge of the teaching/learning game



- **Synergy of 1 & 2 & 3**

DyKnow – The solution found: 3 levels above “ordinary Tablet usage”

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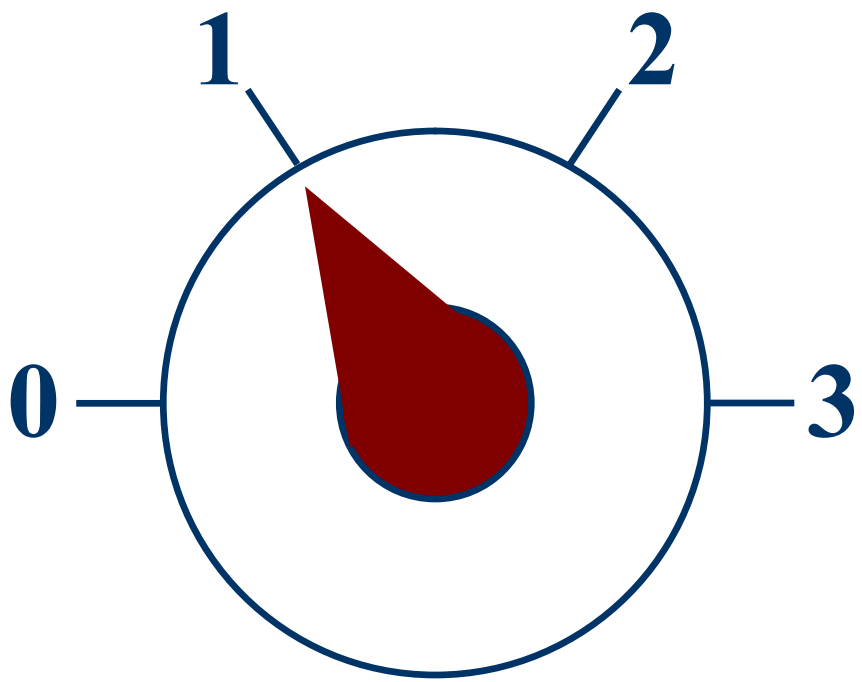

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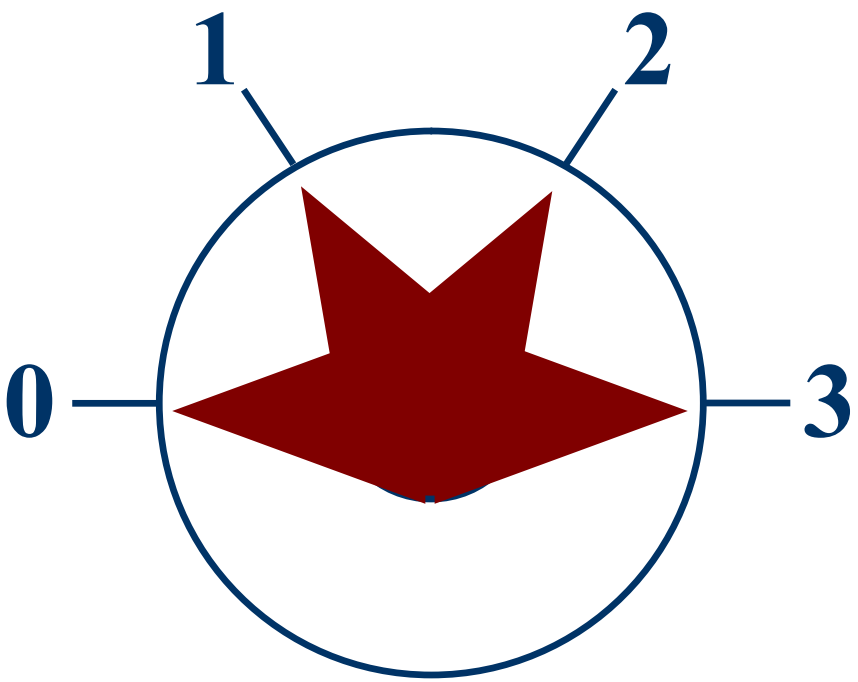


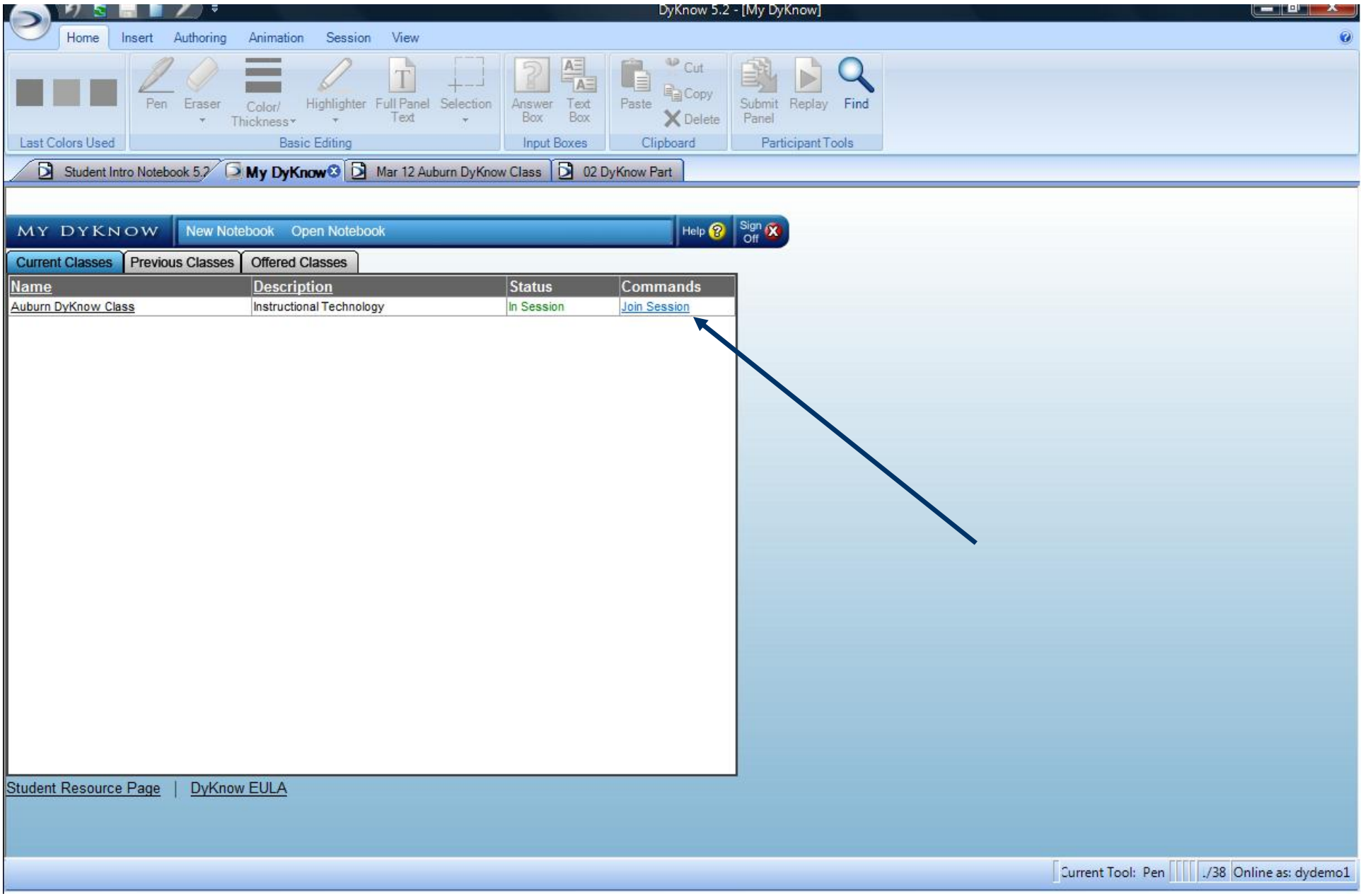
Usernames: demo1 … demo7

Password: ____

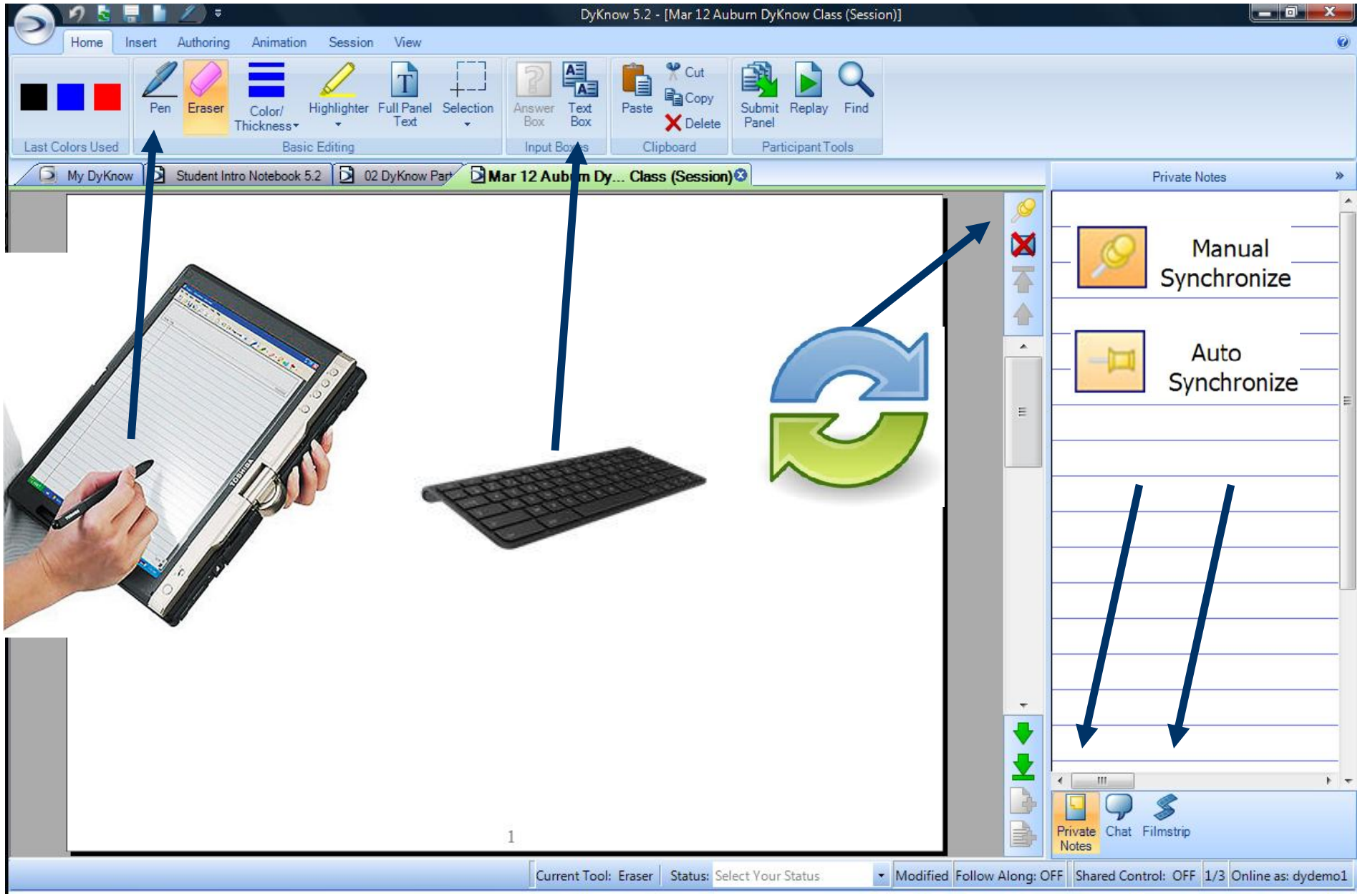
Check Communication setting:

dyknow://wdyn01.columbusstate.edu

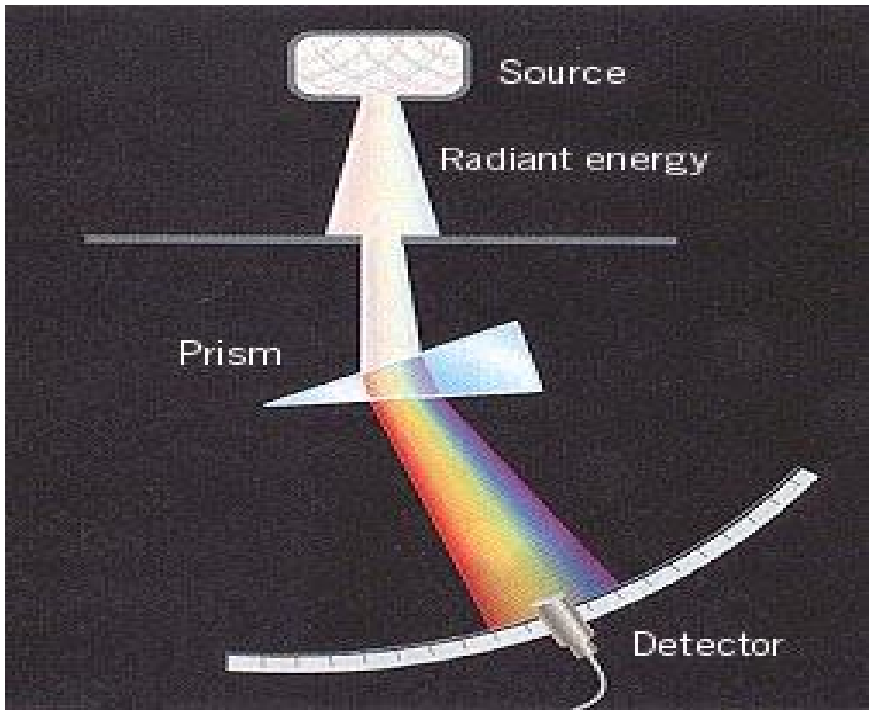
Join session

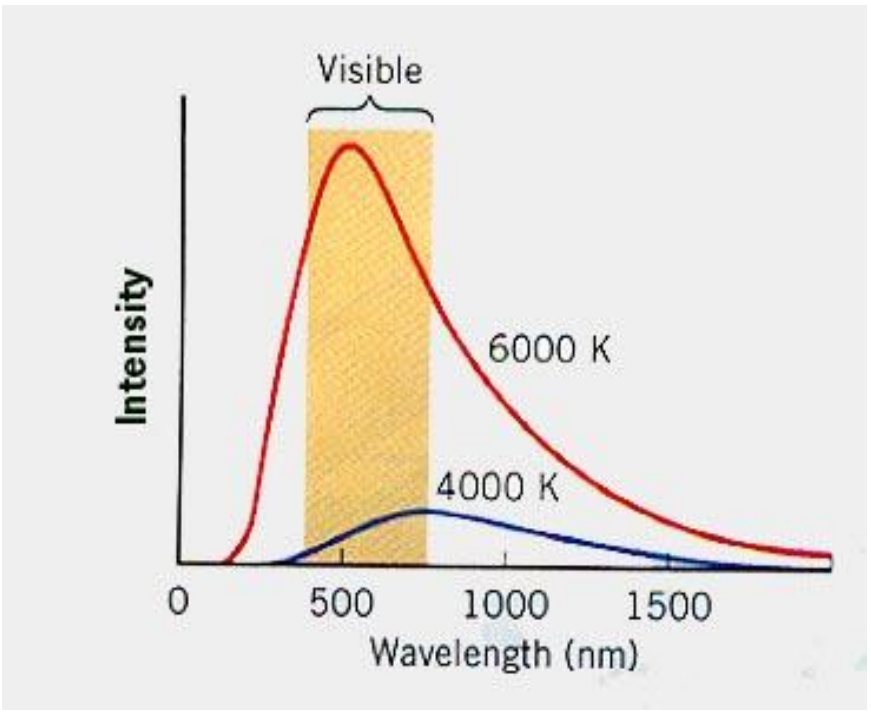


Step 1 above ordinary: Note Taking (Home Tab)



The Radiation Spectrum from Hot Objects





- Prism disperses electromagnetic energy into its component parts.
- Spectrum of wavelengths emitted by bodies at different temperatures

http://sol.sci.uop.edu/~jfalward/particlesandwaves/particlesandwaves.html

Feature set 1: New dynamics of the note taking Content Annotations

A Particle's Momentum

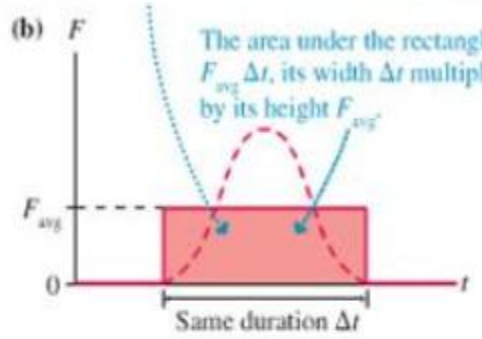


FIGURE 9.4 Looking at the impulse graphically.

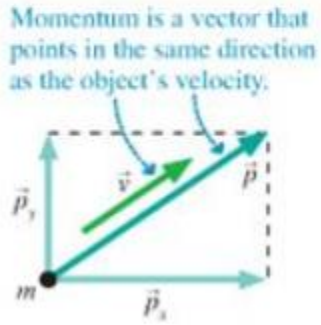


FIGURE 9.7 A particle's momentum vector $\vec{p}$ can be decomposed into x- and y-components.

$$\checkmark\ a_{avg} = \frac{F_{avg}}{m} = \leftarrow$$

$$\checkmark\ a_{avg} = \frac{\Delta V}{\Delta t} = \frac{V_f - V_i}{\Delta t} \leftarrow$$

$$\frac{\vec{F}_{avg}}{m} = \frac{\vec{V}_f - \vec{V}_i}{\Delta t}$$

$$\vec{F}_{avg} \cdot \Delta t = m(\vec{V}_f - \vec{V}_i)$$

$$F_{avg} \cdot \Delta t = m\vec{V}_f - m\vec{V}_i$$

$$\vec{p} = m\vec{v} \left[kg\,\frac{m}{s} \right]$$

Feature set 1: New dynamics of the note taking Problem Solving

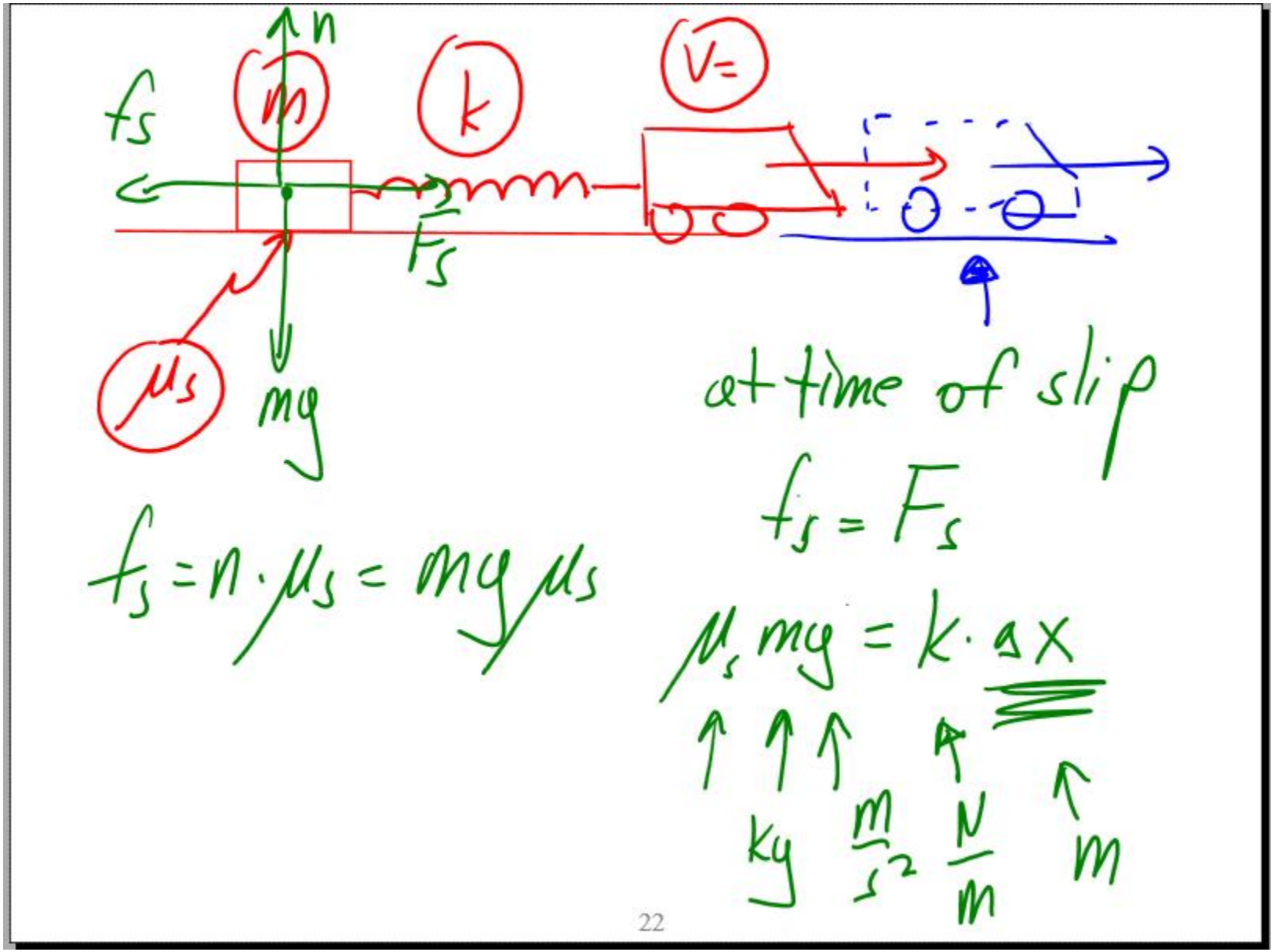
When Does the Block Slip?

EXAMPLE 8.7 When does the block slip?

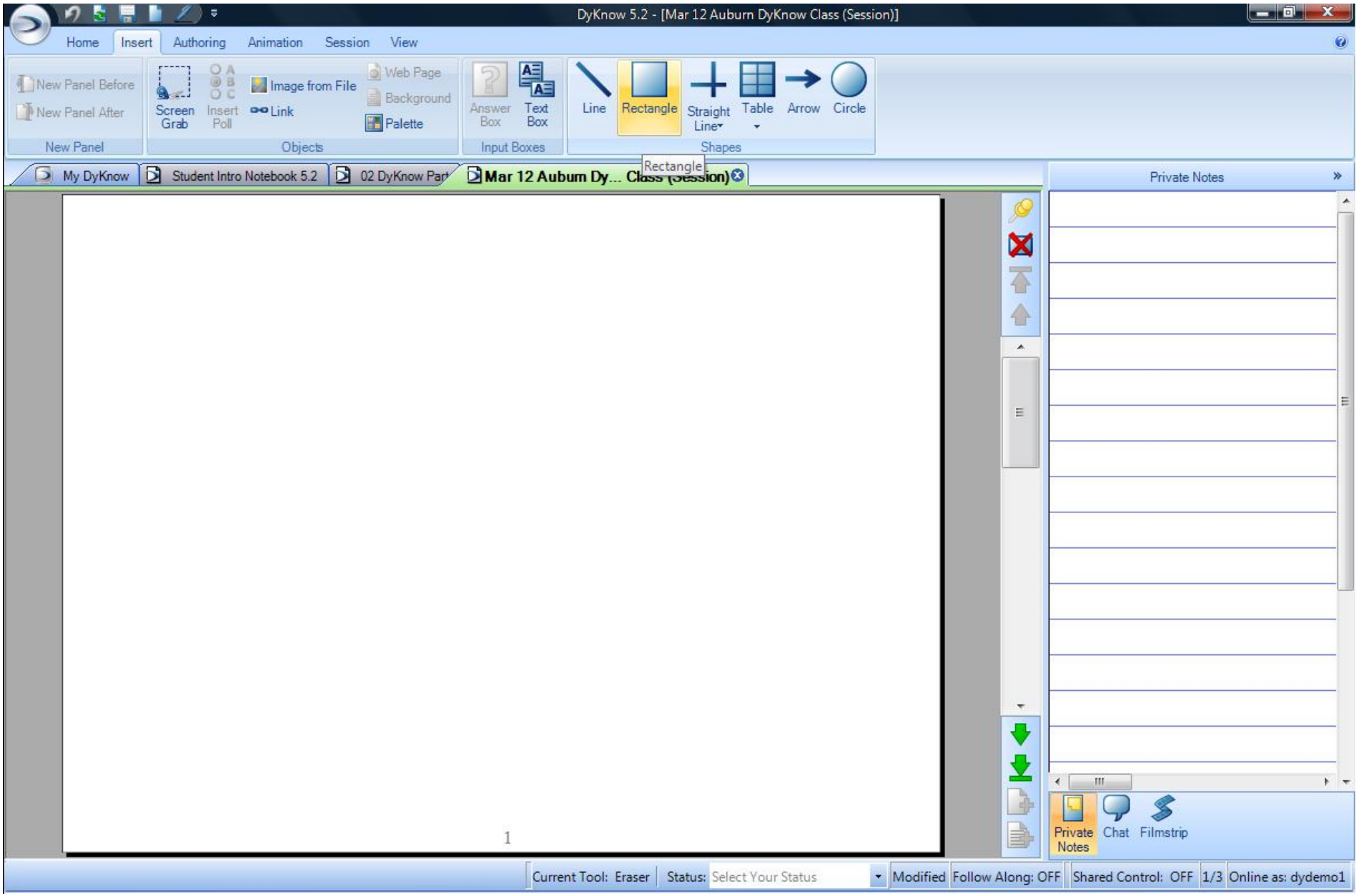
Figure 8.21 shows a spring attached to a 2.0 kg block. The other end of the spring is pulled by a motorized toy train that moves forward at 5.0 cm/s. The spring constant is 50 N/m and the coefficient of static friction between the block and the surface is 0.60. The spring is at its equilibrium length at $t = 0$ s when the train starts to move. When does the block slip?

FIGURE 8.21 A toy train stretches the spring until the block slips.

New dynamics of the note taking
Problem Solving - Record



Feature set 1: Note Taking fancy tools (Insert Tab and other Tabs)



Postulating basic form of free particle de Broglie wave

$\underline{\Psi}(x,t) = A \sin(kx - \omega t)$ ✓ $\quad k = \frac{2\pi}{\lambda}, \quad \omega = 2\pi\nu$

→ representing wave of amplitude A traveling in +x dir

Equivalent to $y(x,t) = A \sin(kx - \omega t)$ - string

$\vec{E}(x,t) = \vec{E}_0 \sin(kx - \omega t)$ - $\vec{E}$ of EMW

$\vec{B}(x,t) = \vec{B}_0 \sin(kx - \omega t)$ → $\vec{B}$ of EMW

Consider time independent, stationary case:

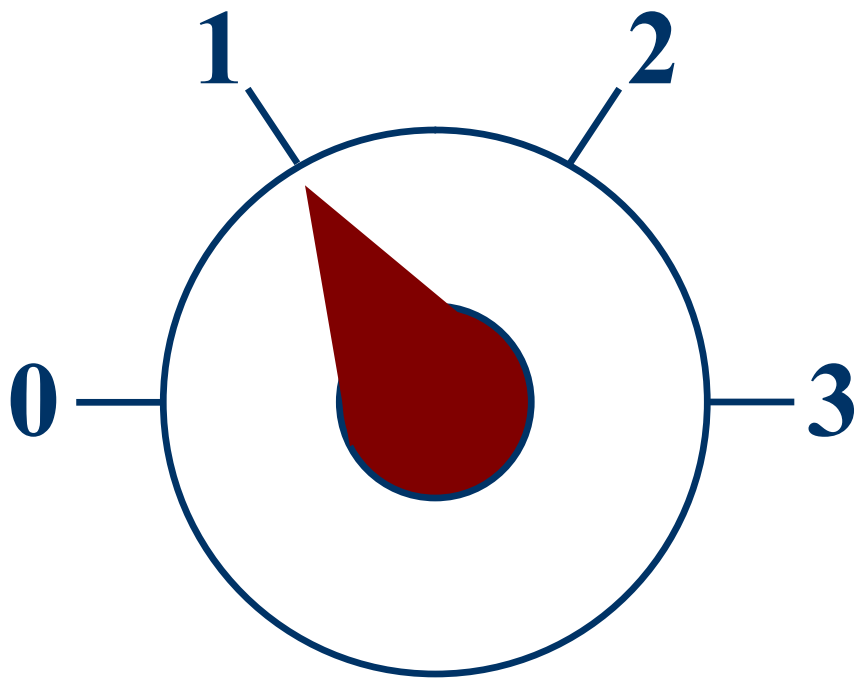
$\psi(x) = \underline{\Psi}(x, t = 0)$

$\psi(x) = A \sin kx$ ✓

Benefits of the new dynamics of the note taking

Old dilemma resolved:
Can have both:
Notes + Understanding

- Time saving
- Accuracy
- Interaction/Discussion
- Monitoring
- Display of Students' slides



Other advantages when compared with Tablets + PowerPoint:

- Students' notes synchronized with instructor's:
  (all on same page & no copying)
- No double posting (before and after class)
- Playback slide – problem solving gem
- Synchronization (On / Off option)

Step 2

Multiple, distinctly different channels of Real-time feedback

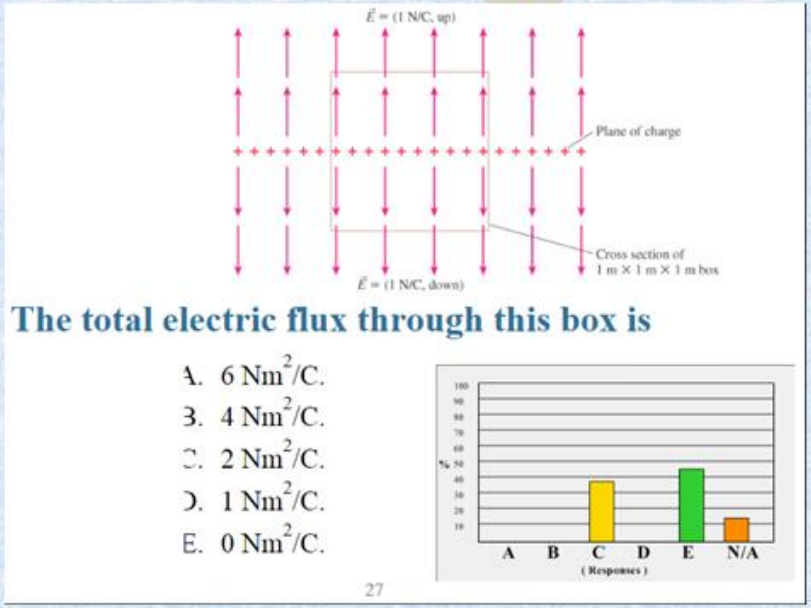
Status: Are you with me?

Status: Select Your Status

Chat: Embarrassed to ask?

Pooling: Embedded Clickers

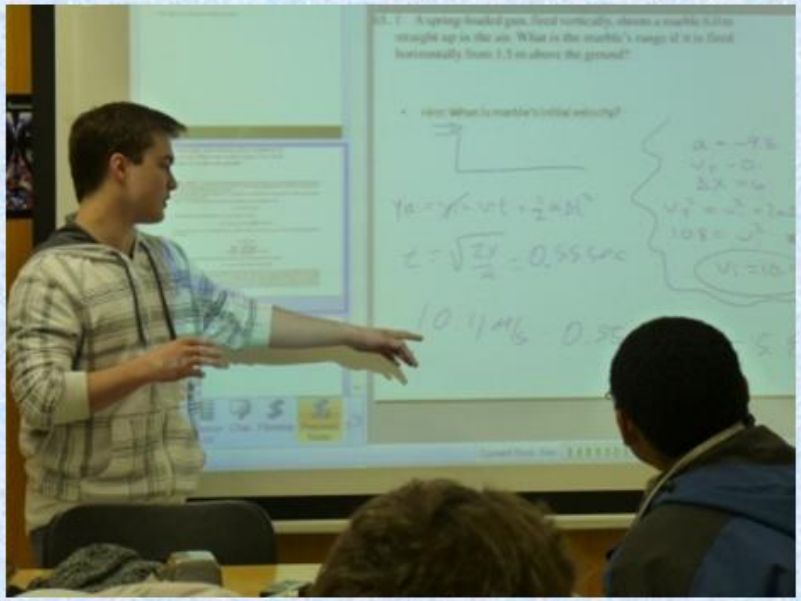
Slide submission: Open-ended questions and numerical problems



The total electric flux through this box is

A. 6 Nm^2/C.
B. 4 Nm^2/C.
C. 2 Nm^2/C.
D. 1 Nm^2/C.
E. 0 Nm^2/C.

27



Example (text problem 21.10)

A hair dryer has a power rating of 1200 W at 120 V rms. Assume the hair dryer is the only resistance in the circuit.

(a) What is the resistance of the heating element?
(b) What is the rms current drawn by the hair dryer?
(c) What is the maximum instantaneous power that the resistance must withstand?

a) $V_{RMS} = 120\,V$, $P = 1200\,W$
$P_{AV} = I_{RMS} \cdot V_{RMS}$
$I_{RMS} = \frac{P}{V_{RMS}} = \frac{1200\,W}{120\,V} = 10\,Amps$
$P_{AV} = I_{RMS}^2 R \Rightarrow R = \frac{P_{AV}}{I_{RMS}^2} = \frac{1200\,W}{10\,A^2} = 12\,\Omega$

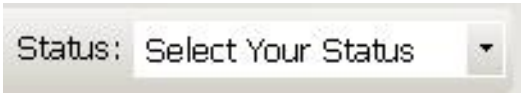
b) $I_{RMS} = \frac{P}{V_{RMS}} = \frac{1200\,W}{120\,V} = 10\,A$

c) $P_{max} = I_m V_m = I_{RMS}\sqrt{2} \cdot V_{RMS}\sqrt{2} = 10A \cdot \sqrt{2} \cdot 120V \cdot \sqrt{2} = 2400\,W$

15

Step 2 up from ordinary: Multiple channels of real-time feedback

- **Status:** Are you with me?



http://www.youtube.com/watch?v=s2e_QL-QHpw

Step 2 up from ordinary: Multiple channels of real-time feedback

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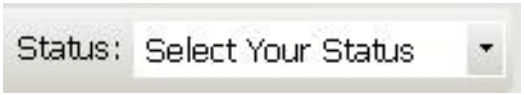

- **Chat:** Embarrassed to ask?

Channels of real-time feedback

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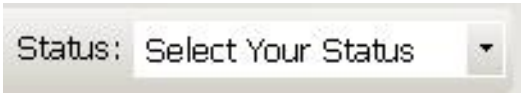

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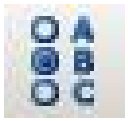
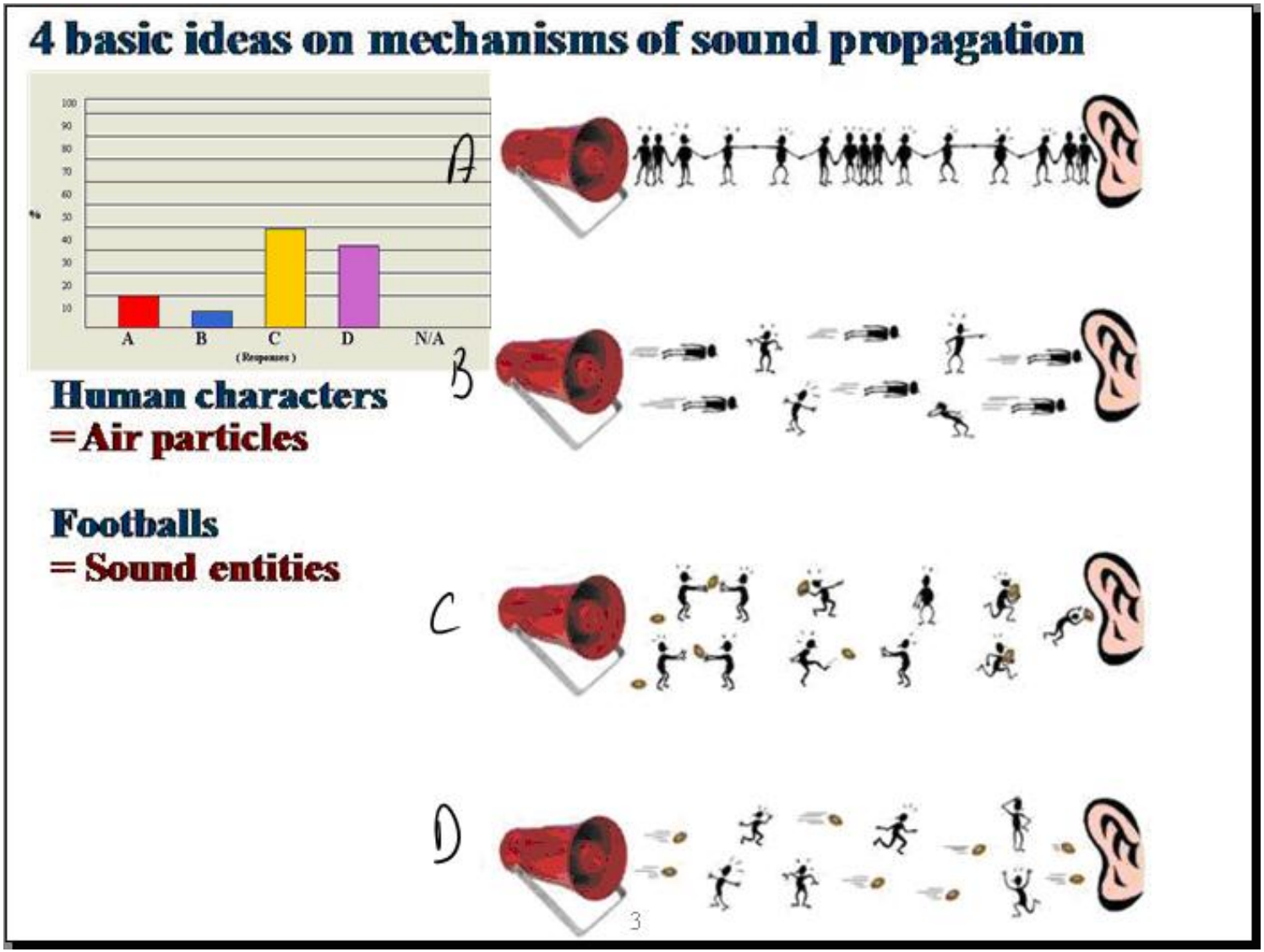


Quiz

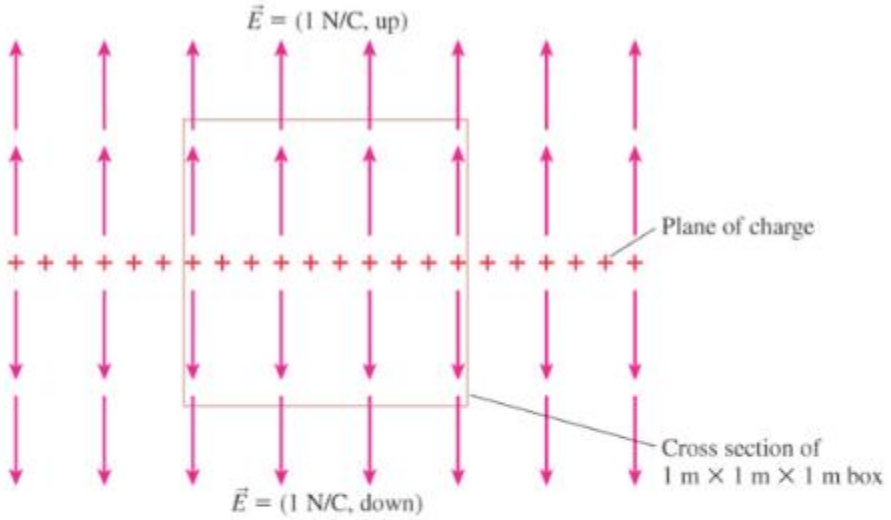
DyKnow is a:

a) Hair dying method
b) Washer/Drier combo
c) Software for interactive learning

A multiple-choice question and obtained distribution of students answers incorporated into the panel



A multiple-choice question and obtained distribution of students answers incorporated into the panel



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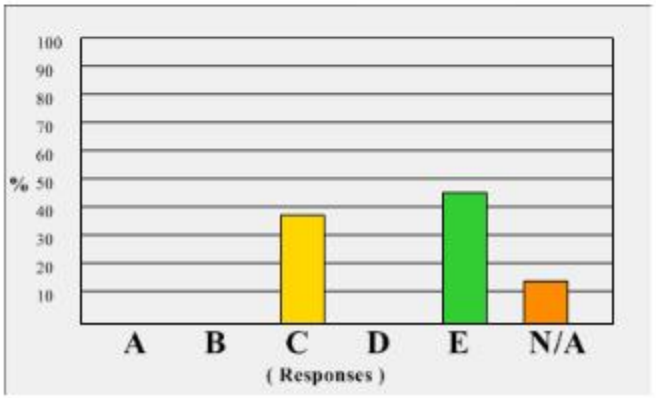


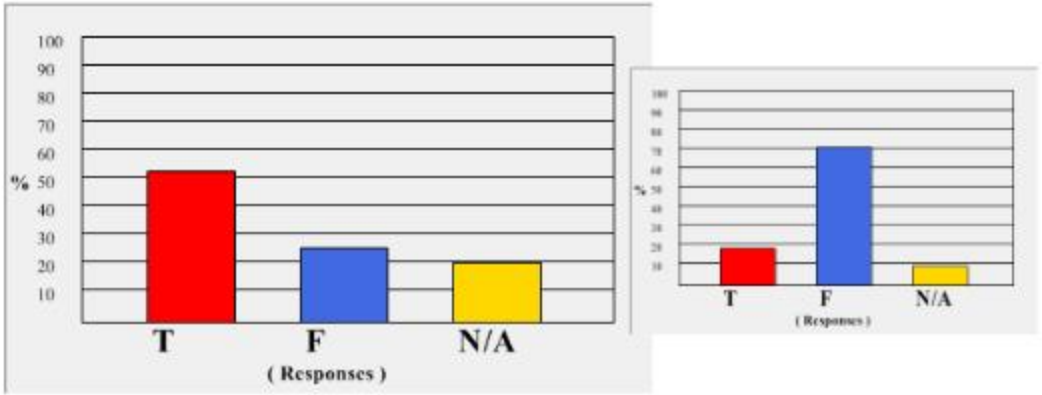
Multiple channels of real-time feedback Pooling

Aristotle on Motion

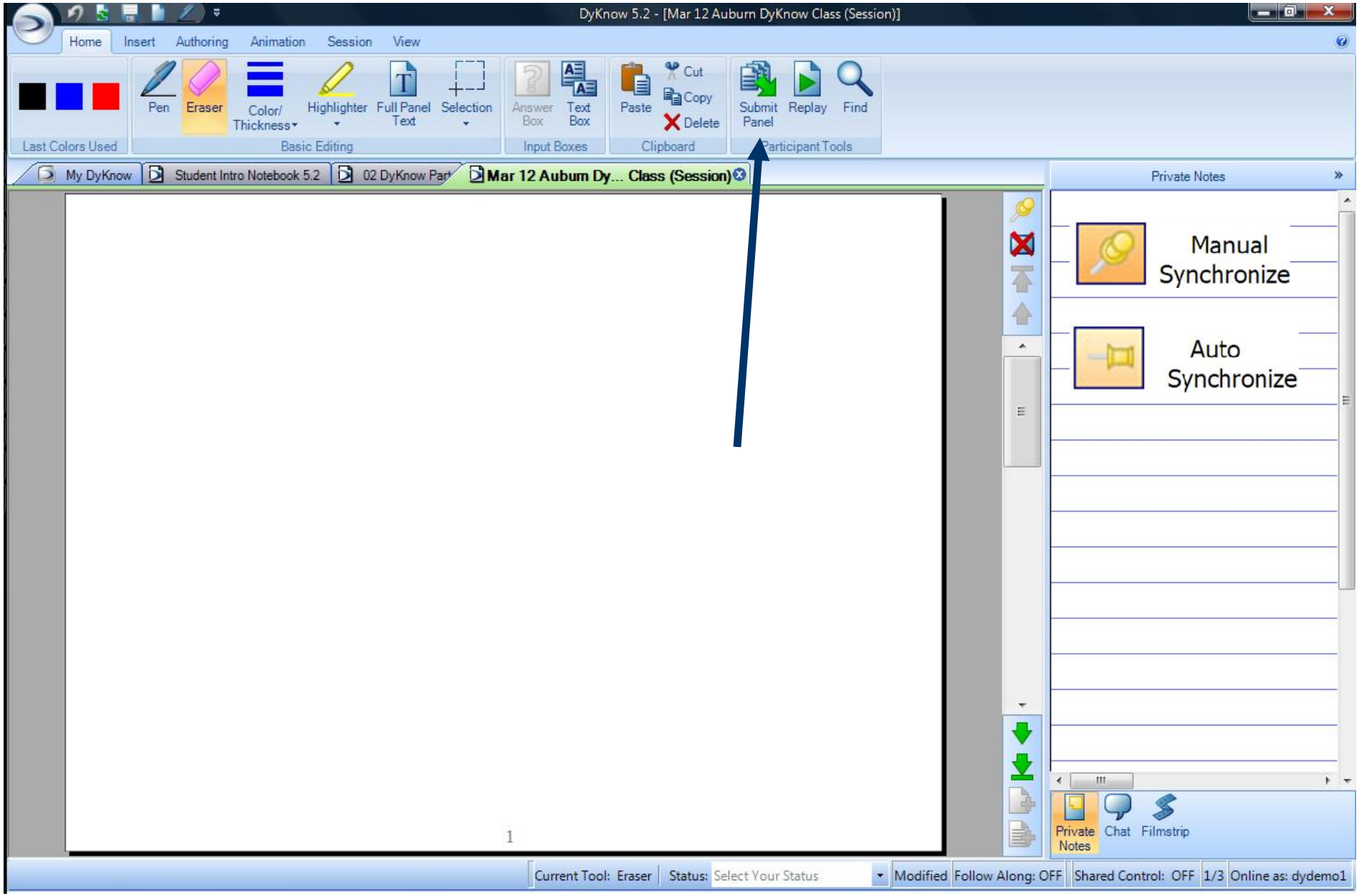
- "Any object in motion on earth requires a force to keep it going."
  - (The only exceptions were objects that were returning to their natural positions, such as a rock that is made of earth, falling out of air to its lower natural position.)

True

False



Step 2 up from ordinary:
Multiple channels of real-time feedback



Step 2 up from ordinary: Multiple channels of real-time feedback

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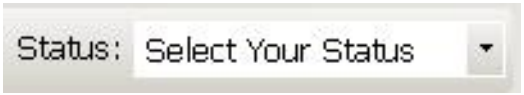

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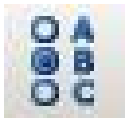
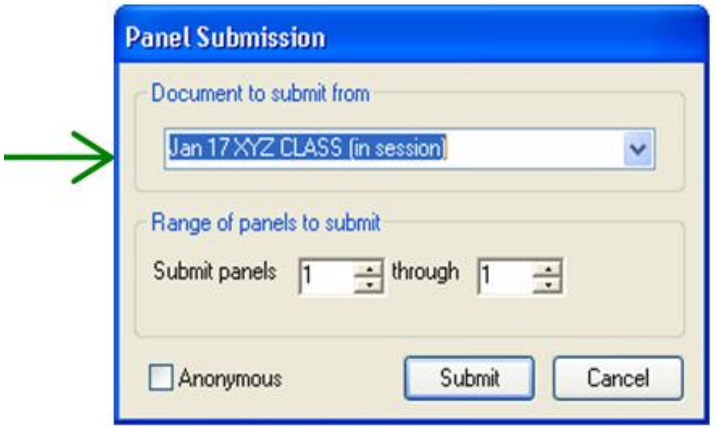


- **Slide submission:** Open-ended questions and numerical problems

Write below the name of the most famous scientist of 20th century and submit the slide with answer:



Students submissions with handwritten input

EXPLAIN: Model Building

- Is **any motion needed** in order for sound to propagate (that does not exist when sound does not propagate)?

  Yes, you need motion

- If so, **motion of what**? What it is that moves for this purpose?

  Sound waves.

- **What kind of motion**? How it (whatever moves) moves?

  every which way.

- Is there **anything** that **obstructs the motion**?

  yes.

- **How is this motion related to sound?**

  because it is moving it is making sound.

Multiple channels of real-time feedback
Student Slide Submissions - Laptop

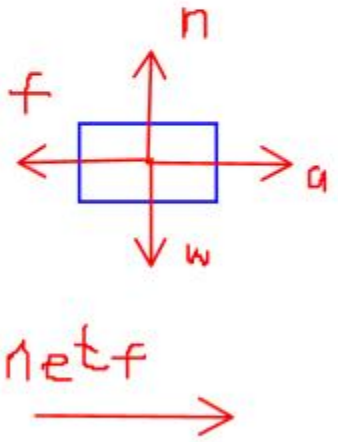
Problems 29 through 35 describe a situation. For each, identify all forces acting on the object and draw a free-body diagram of the object.

29. I Your car is sitting in the parking lot.
30. I Your car is accelerating from a stop.
31. II Your car is slowing to a stop from a high speed.
32. I An ice hockey puck glides across frictionless ice.
33. I An elevator, hanging from a cable, descends at steady speed.
34. I Your physics textbook is sliding across the table.
35. II You hold a picture motionless against a wall by pressing on it, as shown in Figure P4.35.

FIGURE P4.35

29)

30)



Multiple channels of real-time feedback
Student Slide Submissions - Tablet

Example (text problem 21.10)

A hair dryer has a power rating of 1200 W at 120 V rms. Assume the hair dryer is the only resistance in the circuit.

(a) What is the resistance of the heating element?

(b) What is the rms current drawn by the hair dryer?

(c) What is the maximum instantaneous power that the resistance must withstand?

a) $V_{RMS} = 120\,V$ $\quad P = 1200\,W$

$P_{AV} = I_{RMS} \cdot V_{RMS}$

$I_{RMS} = \frac{P}{V_{RMS}} = \frac{1200\,W}{120\,V} = 10\,Amps$

$P_{AV} = I_{RMS}^2 R \Rightarrow R = \frac{P_{AV}}{I_{RMS}^2} = \frac{1200\,W}{10\,A^2} = \boxed{12\,\Omega}$

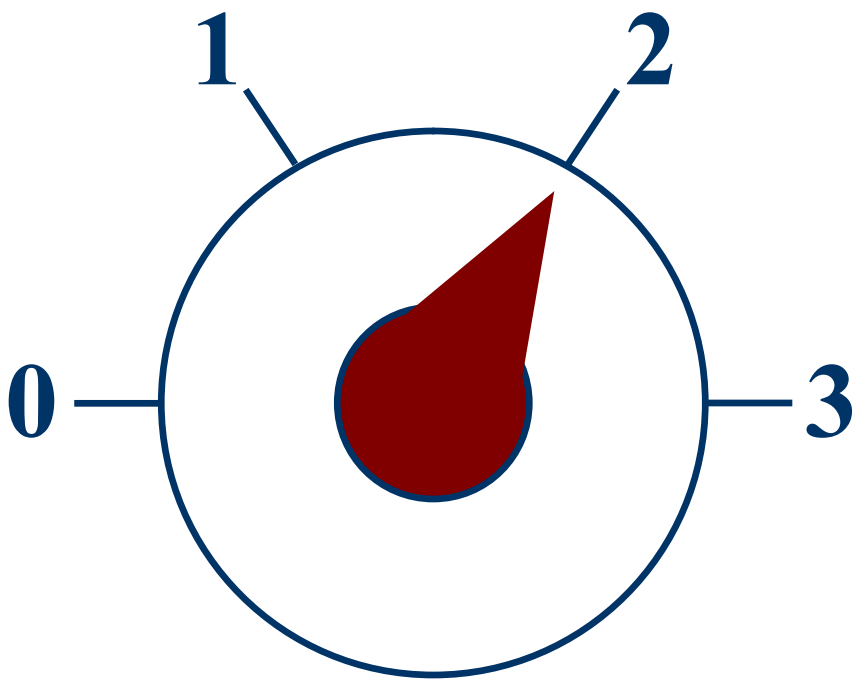
b) $I_{RMS} = \frac{P}{V_{RMS}} = \frac{1200\,W}{120\,V} = 10\,A$

c) $P_{max} = I_m V_m = I_{RMS}\sqrt{2} \cdot V_{RMS}\sqrt{2} = 10\,A \cdot \sqrt{2} \cdot 120\,V \cdot \sqrt{2}$

$= 2400\,W$

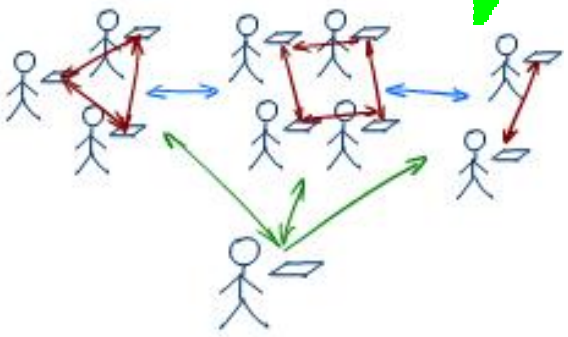
Benefits:
Multiple channels of real-time feedback

- **Heard without voice**
- **All benefits of formative assessment***
  - **Engages** students.
  - Gives **immediate feedback** to the teacher.
  - Enables the teacher to **adjust the teaching before the exam** rather than after it and according to specific needs of his/her students.
  - Facilitates **interactive learning** and **peer instruction** (especially in large enrolment classes).



* Summative vs. Formative assessment: Customer tastes the soup vs. Cook tastes the soup

Step 3 up - All in control
Students in charge of the teaching/learning game



ENGAGE:

	Ideas:	and Questions:
A	The current is being lost between the wire connecting the 2 bulbs.	When battery is connected to one light bulb, bulb lights, when battery is connected to 2 bulbs they don't... why?
B	Series and parallel same circuit	Can you hook up bulbs both in series & parallel in the same circut?
C	Does it matter which bulb you unscrew to keep 2 bulbs lit.	How can you connect 3 bulbs with 2 bulbs lit and one off?
D	make 3 seperate circuits.	How can you create a series circuit where 2 outside bulbs are lit and the inside bulb is not?
E	can you make 1 bulb brighter than the other 2?	How can you hook up 3 bulbs to be as bright as 1 bulb?

ELABORATE: Discovering the Relationship Between Current, Resistance, and Voltage

A

Battery Voltage [Volts]	Measured Voltage [Volts]	Current [Amps]	Ratio V/A
1.5	1.50	.0078	192
3	3.00	.0164	182
4.5	4.49	.0244	184
(6)	5.93	.0322	184

B

Battery Voltage [Volts]	Measured Voltage [Volts]	Current [Amps]	Ratio V/A
1.5	1.43	.0054	260
3	2.83	.0154	183
4.5	4.35	.0234	186
(6)	6.07	.033	184

C

Battery Voltage [Volts]	Measured Voltage [Volts]	Current [Amps]	Ratio V/A
1.5	1.53	.008	191
3	2.96	.015	197
4.5	4.46	.024	186
(6)	5.96	.042	141

D

Battery Voltage [Volts]	Measured Voltage [Volts]	Current [Amps]	Ratio V/A
1.5	1.49	.0084	177
3	2.98	.0164	181
4.5	4.54	.0251	181
(6)	5.8	.0338	171

ENGAGE:

	Ideas:	Questions:
A	The current is being lost between the wire connecting the 2 bulbs.	When battery is connected to one light bulb, bulb lights, when battery is connected to 2 bulbs they don't... why?
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2

ELABORATE: Discovering the Relationship Between Current, Resistance, and Voltage

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Battery Voltage [Volts]	Measured Voltage [Volts]	Current [Amps]	Ratio V/A
1.5	1.50	.0078	192
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(6)	5.8	.0338	171

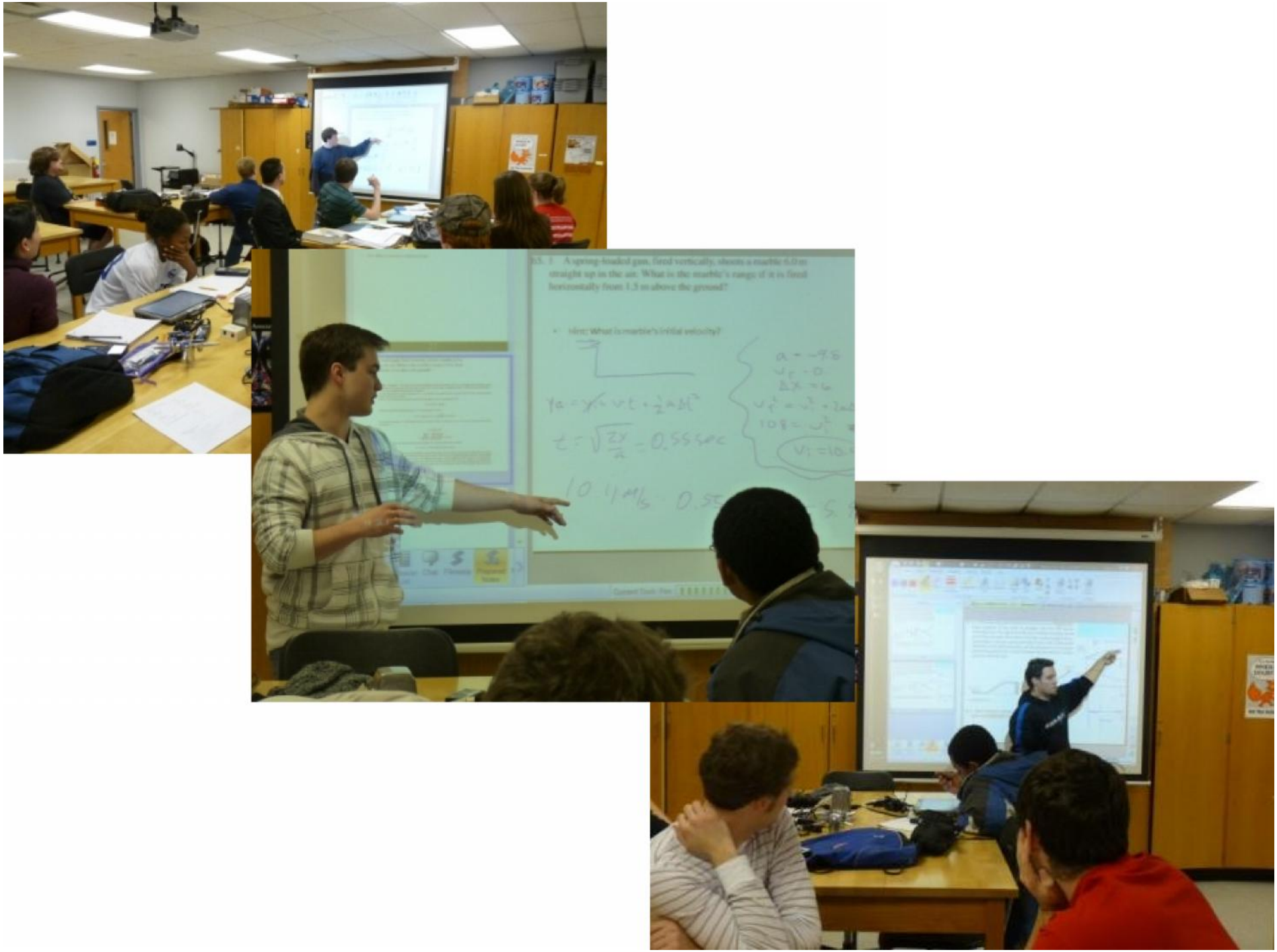
2

Problem: Although an excited atom can radiate at any time from t=0 to t=∞, the average time after excitation at which a group of atoms radiates is called the lifetime, τ of a particular excited state.

(a) If $\tau = 1.0 \times 10^{-8}$s (a typical value), use the uncertainty principle to compute the frequency line width (Δf) of light emitted by the decay of this excited state?

(b) If the wavelength of the spectral line involved in this process is 500 nm, find the fractional broadening $\Delta f / f$?

Multiple Computer Group problem solving
Atomic Physics



Student Slide Submission

58. ||
a. A disk of mass M and radius R has a hole of radius r centered on the axis. Calculate the moment of inertia of the disk.
b. Confirm that your answer agrees with Table 12.2 when $r = 0$ and when $r = R$.
c. A 4.0-cm-diameter disk with a 3.0-cm-diameter hole rolls down a 50-cm-long, 20° ramp. What is its speed at the bottom? What percent is this of the speed of a particle sliding down a frictionless ramp?

$\int_r^R r^2\,dm$

$\int_r^R r^2 \frac{m}{A} 2\pi r\,dr$

$\frac{2\pi m}{A}\int_r^R r^3\,dr$

$\left(\frac{2\pi m}{A}\right)\frac{r^4}{4}\Big|_r^R$

$\left(\frac{2\pi m}{A}\right)\left(\frac{R^4}{4}-\frac{r^4}{4}\right)$

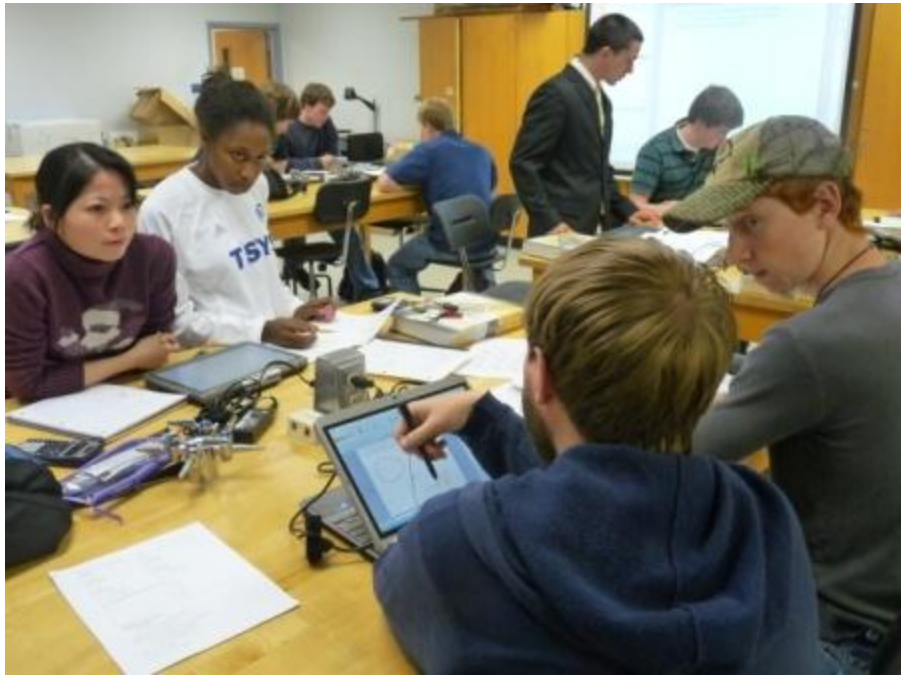
$\left(\frac{2\pi m}{(R^2-r^2)\pi}\right)\left(\frac{R^4}{4}-\frac{r^4}{4}\right)$

$\frac{2m}{R^2-r^2}\left(\frac{R4-r^4}{4}\right)$

$\frac{2m}{R^2-r^2}\left(\frac{R4-r^4}{4}\right)$

$\frac{2m}{4}\left(\frac{(R^2+r^2)(R^2-r^2)}{(R^2-r^2)}\right)$

$\frac{m(R^2+r^2)}{2}$

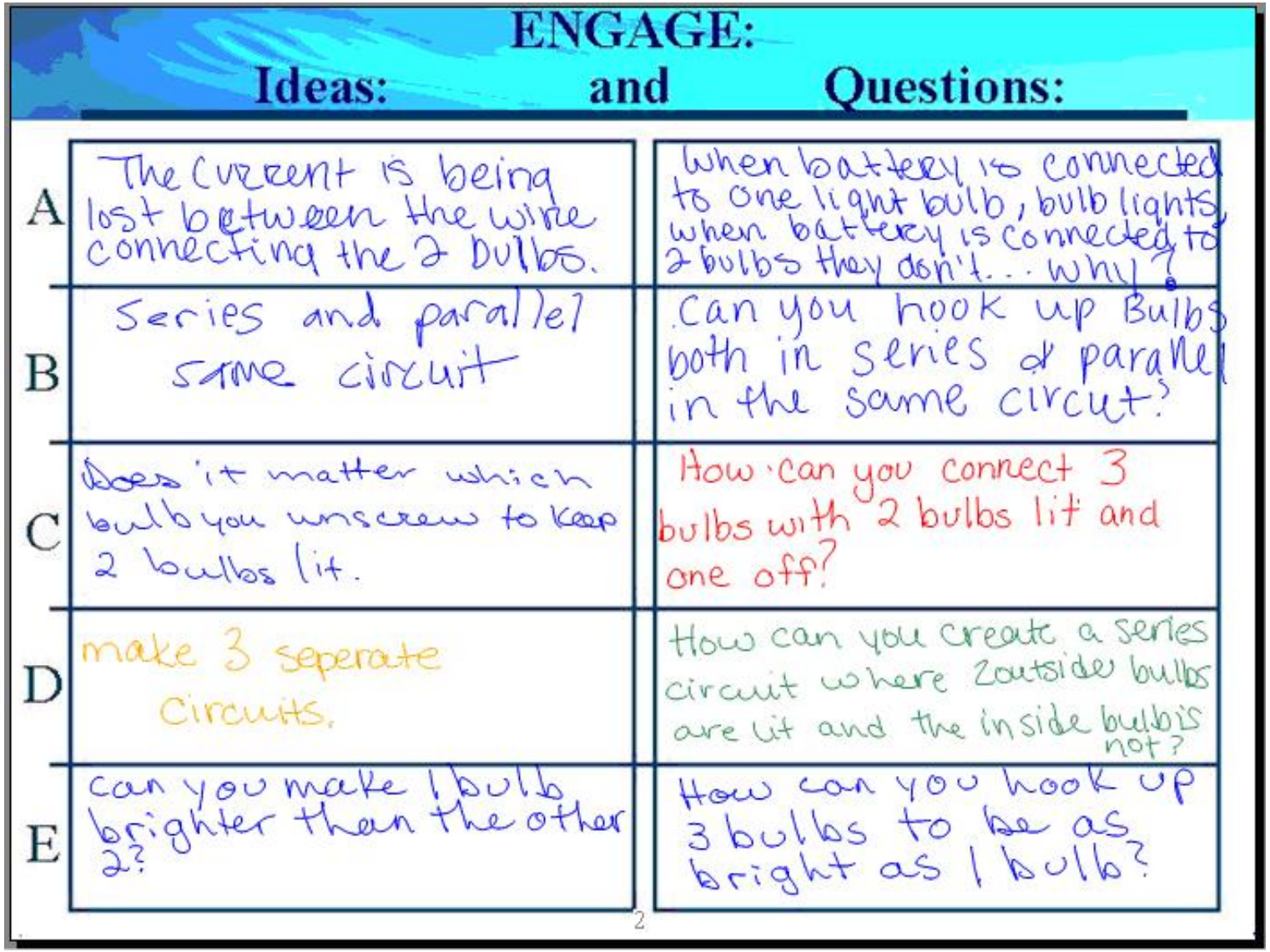



TEXAS


PARAGON
COUGAR
SOCCER

Group Work and Group Annotations
Experimental investigation Physical Science

Slides collaboratively annotated by whole class, with each group writing to their respective spaces



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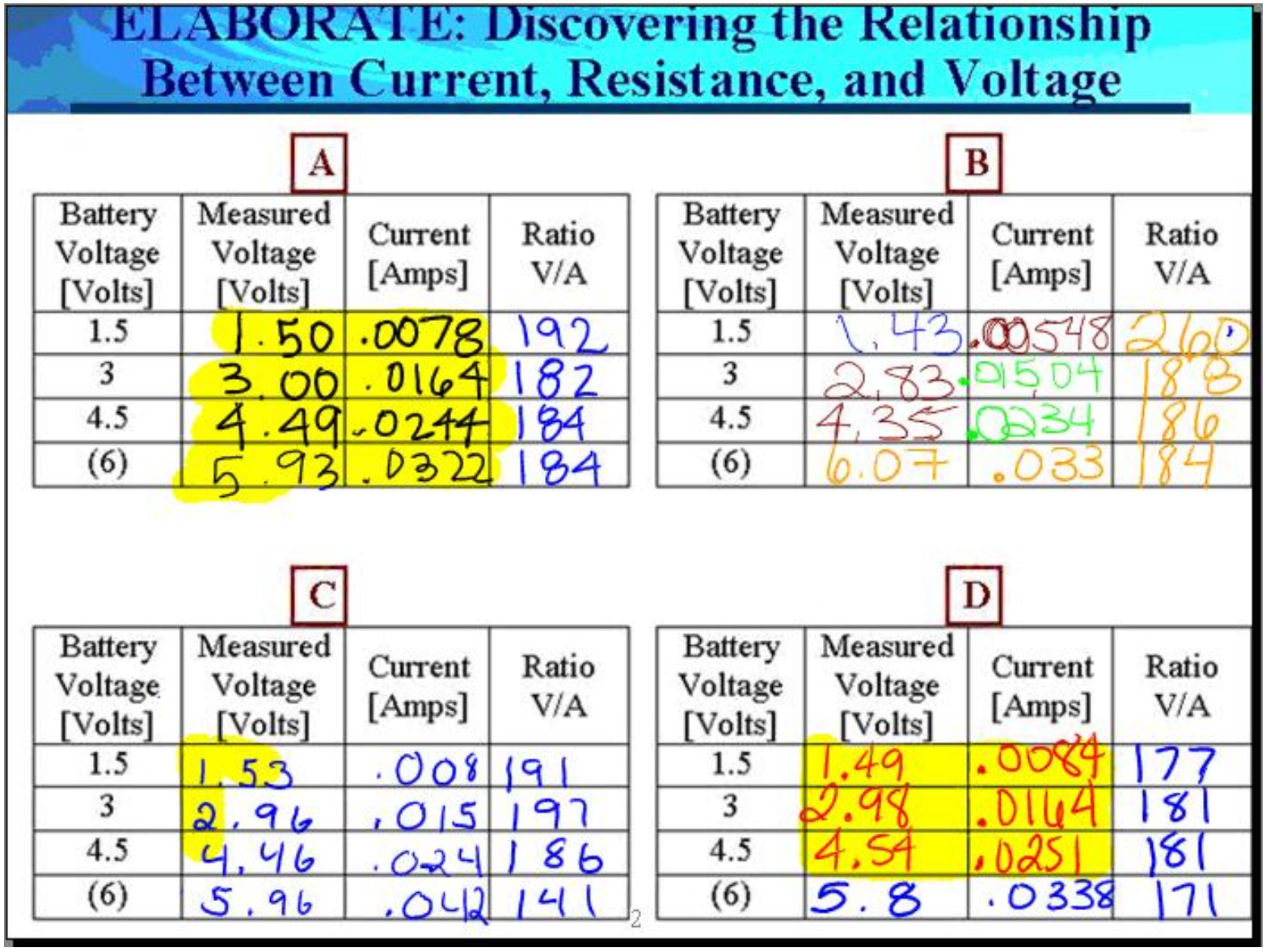
2

Group experimental investigation
Physical Science

Slides collaboratively annotated by whole class, with each group writing to their respective spaces



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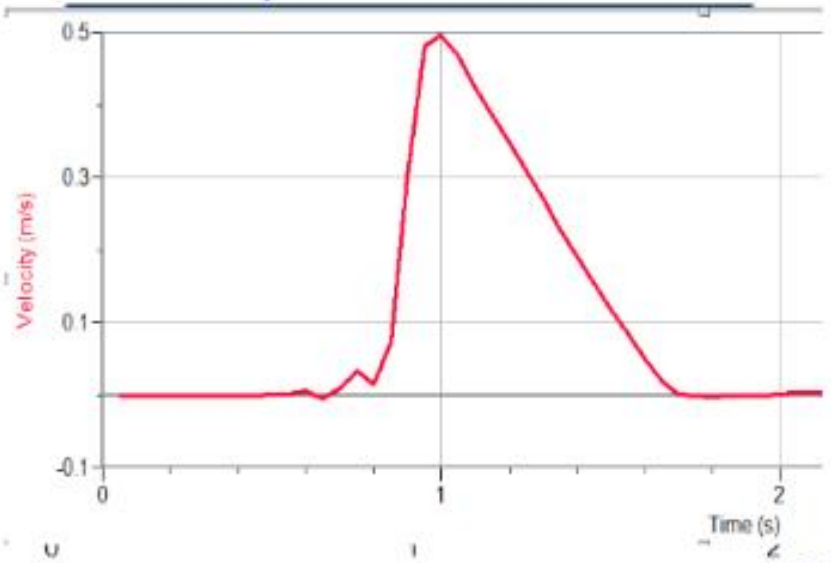
All in control: Students in charge of the teaching/learning game + Technology Combo

Exp #2

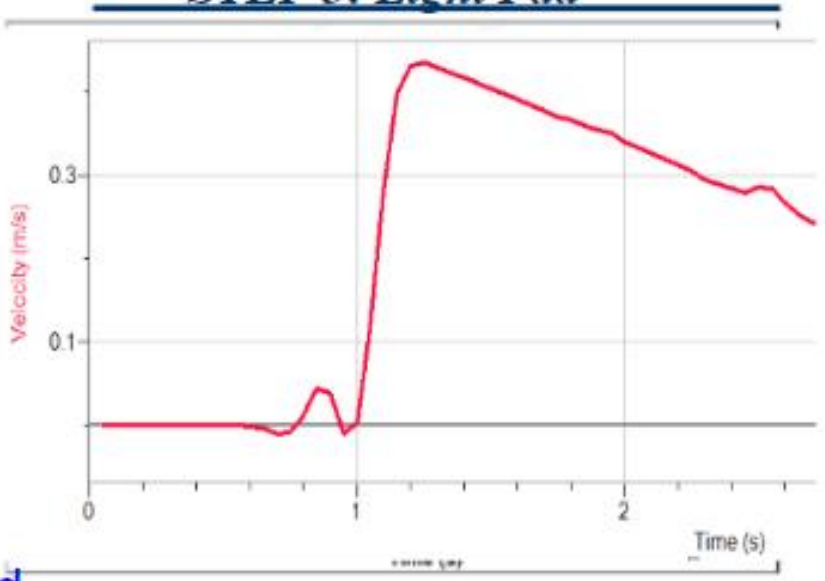
STEP 3 & STEP 4

Group B

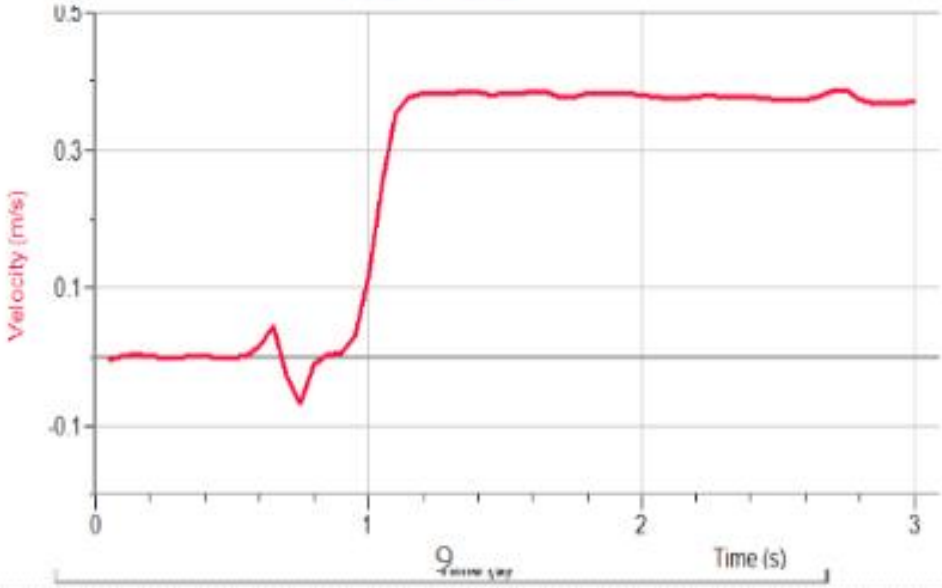
Step 3: Firm Pad



STEP 3: Light Pad



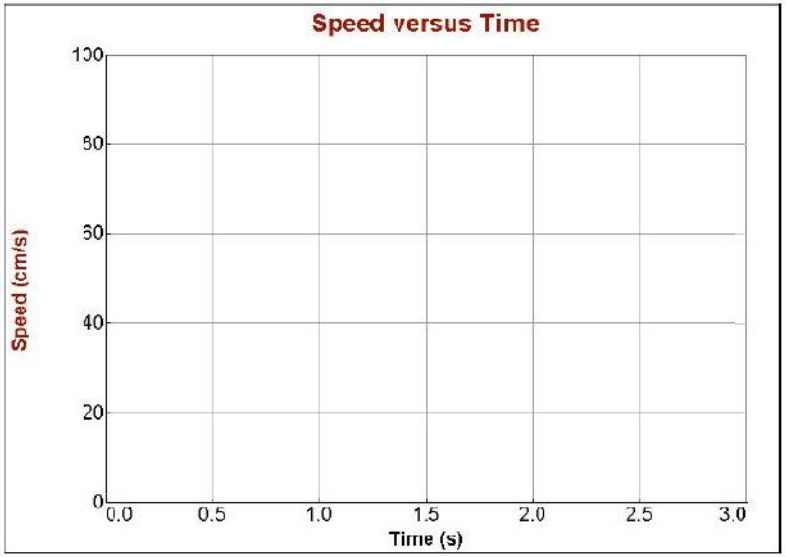
No Pad



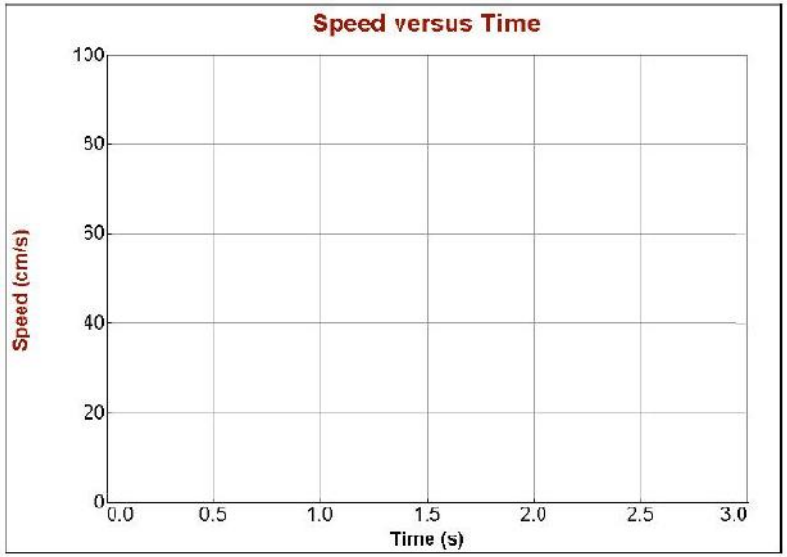
Exp #1

Sketch the speed-time graphs produced by the Motion Sensor from STEPS 1, 3, 4, and 5 below.

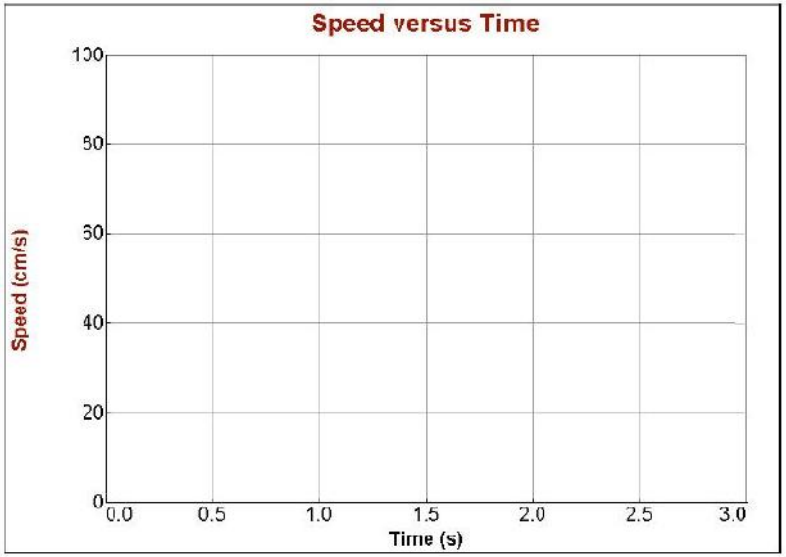
STEP 1: Single quick push



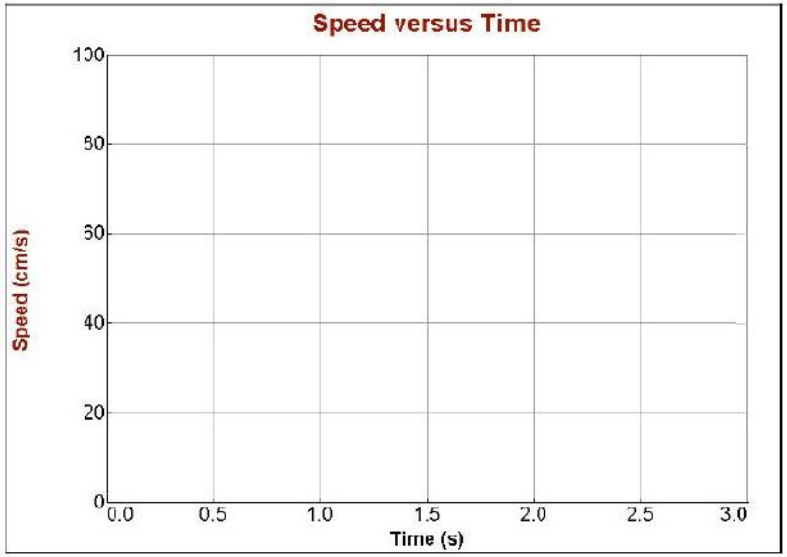
STEP 3: Forward push while moving



STEP 4: Gentle backward tap while moving



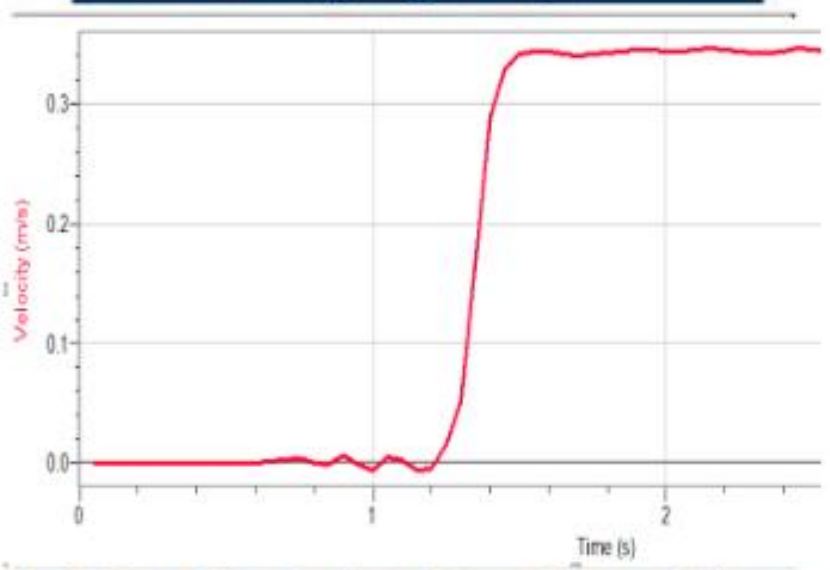
STEP 5: Tap to return to start



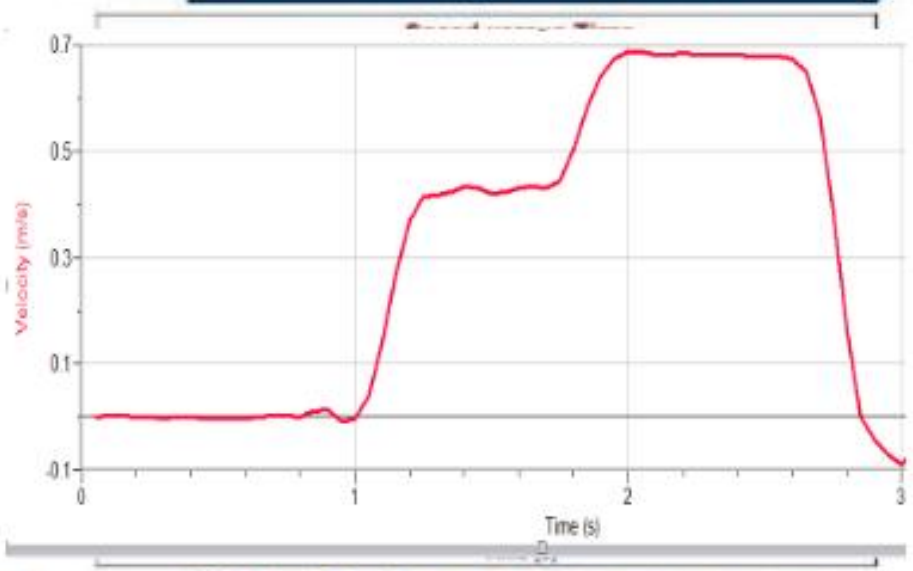
Exp #1

Sketch the speed-time graphs ~~produced by~~ the Motion Sensor from STEPS 1, 3, 4, and 5 below. GROUP B

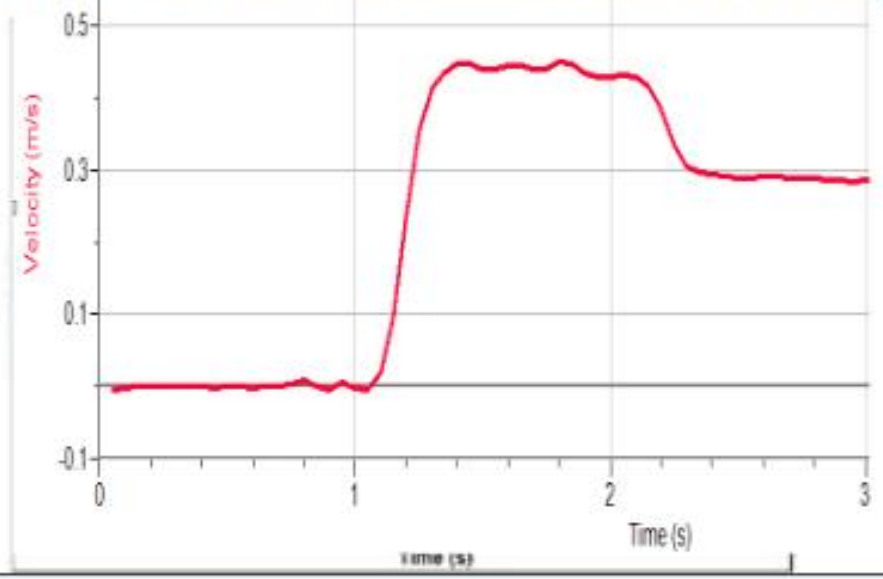
STEP 1: Single quick push



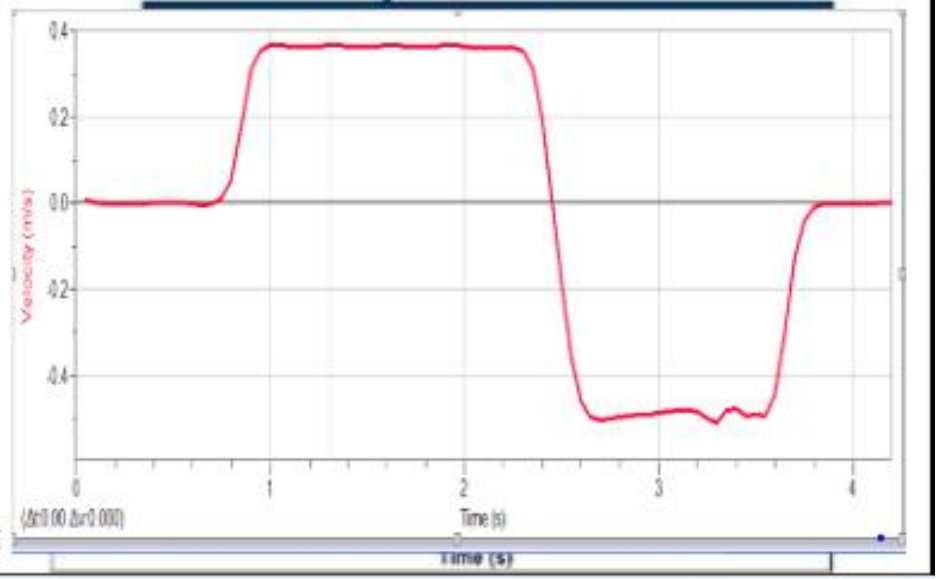
STEP 3: Forward push while moving



STEP 4: Gentle backward tap while moving



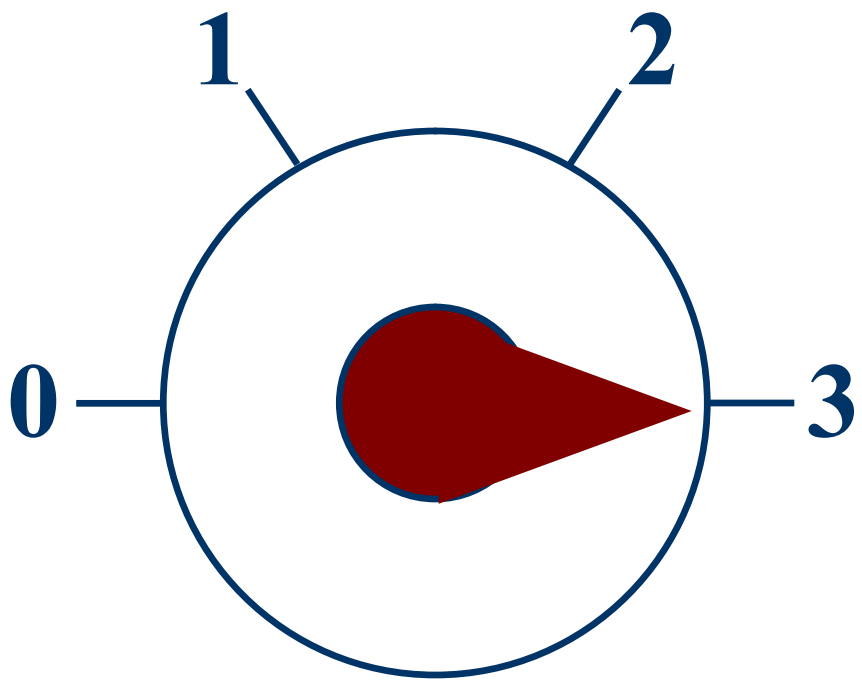
STEP 5: Tap to return to start



Benefits: All in control: Students in charge of the teaching/learning game

Unprecedented interaction opportunities:

- Group problem solving
- Group experimental investigations
- Interaction and discussions within the group and class-wide
- Automatic "file" sharing - results
- Brainstorming
- On-the-fly quizzes
- Monitoring and helping/correcting



Follow up Replay Slide – Sound recording

- Save
- Lecture Recording automatic
- Replay

Prominent Research
Tablet PCs and DyKnow Software

- Sisson (2009; 2010) - allocated one of the three weekly class periods in introductory physics course to problem solving and deployed Tablet PCs combined with interactive software (DyKnow):

Sisson, C. J. (2009). Tablet-based recitations in Physics: Less lecture, more success. In D. A. Berque, L. M. Konkle & R. H. Reed (Eds.), *The impact of Tablet PCs and pen-based technology on education: new horizons* (pp. 133-139). West Lafayette, IN: Purdue University Press.


undergrad
TA

Research
Tablet PCs and DyKnow Software

- Sisson (2009; 2010) - allocated one of the three weekly class periods in introductory physics course to problem solving and deployed Tablet PCs combined with interactive software (DyKnow):

	Conceptual Understanding (FCI)	**Problem Solving (Final Exam)**	**Course Success (% A, B, C)**
Algebra-based Physics I (n = 39, Fall 07)	7% increase ($p = 0.14$)	2% improvement 67% → 69% ($p = 0.64$)	**22% increase 57% → 79% (more than 2σ)**
Calculus-based Physics I (n = 26, Fall 08)	3% increase ($p = .99$)	**11% increase 56% → 67% ($p = 0.05$)**	**10% increase 56% → 67% (more than 1σ)**

Sisson, C. J. (2009). Tablet-based recitations in Physics: Less lecture, more success. In D. A. Berque, L. M. Konkle & R. H. Reed (Eds.), *The impact of Tablet PCs and pen-based technology on education: new horizons* (pp. 133-139). West Lafayette, IN: Purdue University Press.

Studies on Tablet PC and DyKnow Software
www.hrepic.com

Modern Physics (Calculus-based, FHSU) Fall06 (Survey/Test N=9/10)
Physical Science (Concept-based, FHSU) Sum06–Fall08 (Survey/Test N=76/91)
General Physics (Algebra-based, CSU) Spring10 (Survey/Test N=37/53)

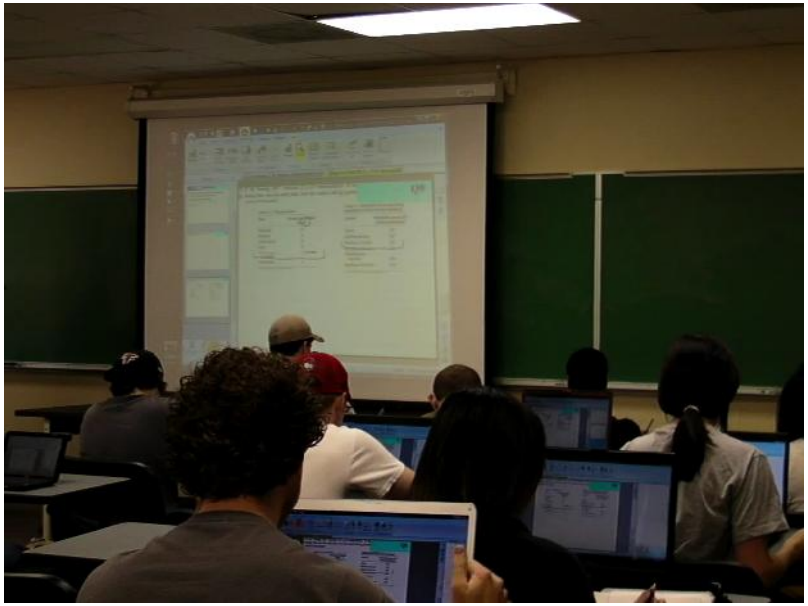
General Physics (CSU) Spring10
Focus Group findings (N=34/53)

Advantages

- **More interaction for the whole class**
- **Easy to go back and review material**
- Helps students organize notes
- **Allows you to focus on content, not note-taking**
- **Can check status button without embarrassment**
- Can telecommute to class

Disadvantages

- If you have **no computer**, you are at a **disadvantage**
- **Technical issues** can eat up class time.
- **Temptation to check email during class**
- **Couldn't take notes by hand if using laptop in class**



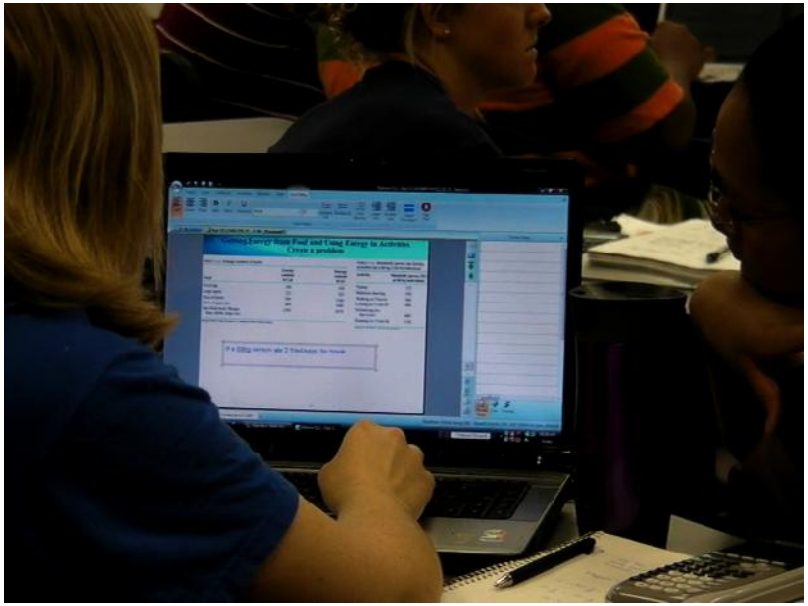


Figure 1: Student scores measured against Cumulative Computer Presence DyKnow Activity

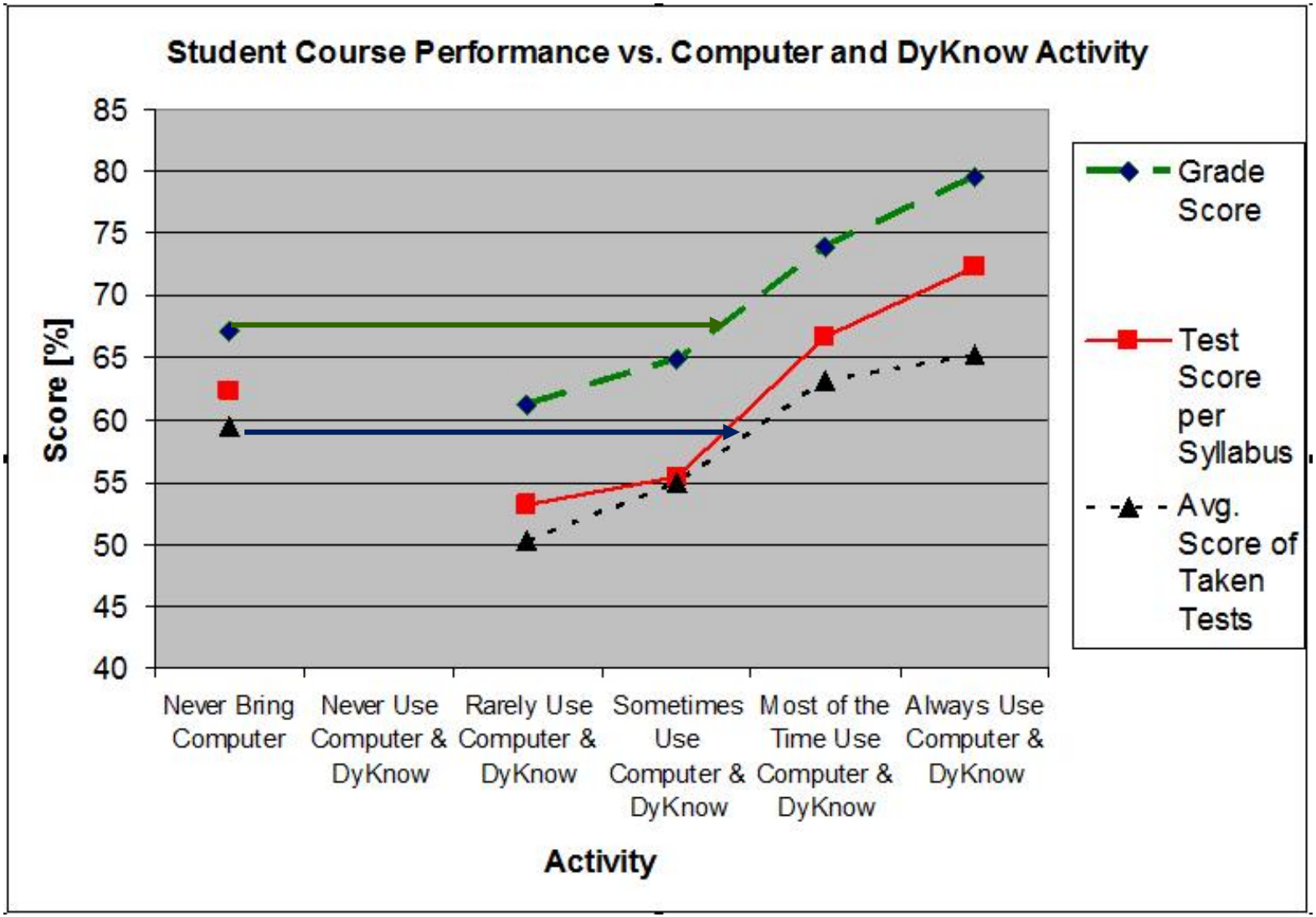


Table 6: Comparison of Students' Computer & DyKnow Activity with Success Level

What about student background?

				Tests Taken	*Tests Syla*	*Grade*	*SAT Math*	*HS GPA*
I bring my computer to physics class: (Table 2 Subcategories)	**3 x week**	**N=12**	**Avg**	**69.6**	**74.9**	**81.3**	**552.5**	**3.27**
			SD	18.1	18.1	16.0	60.3	0.33
	Inconsistent	**N=6**	**Avg**	**43.4**	**43.1**	**54.8**	**475.0**	**3.35**
			SD	30.3	33.57	27.2	88.3	0.55
	Never	**N=5**	**Avg**	**58.4**	**61.0**	**67.7**	**500.0**	**3.22**
			SD	29.2	33.7	32.7	111.8	0.21
I bring computer AND I log on to DyKnow AND I actively participate (Table 3 Subcategories)	**Always**	**N=7**	**Avg**	**67.0**	**73.4**	**81.4**	**520.0**	**3.05**
			SD	15.0	15.4	12.0	21.9	0.26
	Inconsistent	**N=11**	**Avg**	**57**	**58.5**	**66.8**	**530.9**	**3.38**
			SD	30.3	33.0	27.5	97.9	0.43
	Never	**N=5**	**Avg**	**58.4**	**61.0**	**67.7**	**500.0**	**3.22**
			SD	29.2	33.7	32.7	99.7	0.38

Tablet PC advantage? - Comparison of the Tablet PC owners other students: All students included

- In addition to three tablet PC owners who took the survey, one more student in class owned a Tablet PC (and was using it consistently). Comparing those four to the rest of the class:

		Cate-gory	All and Each Category		
The top mobile computer I own		**Code**	**N**	**Avg. %**	**SD**
Avg. Scores Of Taken Tests	All	**2**	53	55.53	25.15
	Tablet	**1**	4	81.96	3.67
	Other	**0**	49	53.38	24.93
	Mann-Whitney (2 groups)			**p=0.016**	
The top mobile computer I own		**Code**	**N**	**Avg. %**	**SD**
Course Grade Result	All	**2**	53	64.44	27.57
	Tablet	**1**	4	90.29	2.36
	Other	**0**	49	62.33	27.62
	Mann-Whitney (2 groups)			**p=0.040**	

Advantages and disadvantages of bringing the computer to classes – Survey Inputs

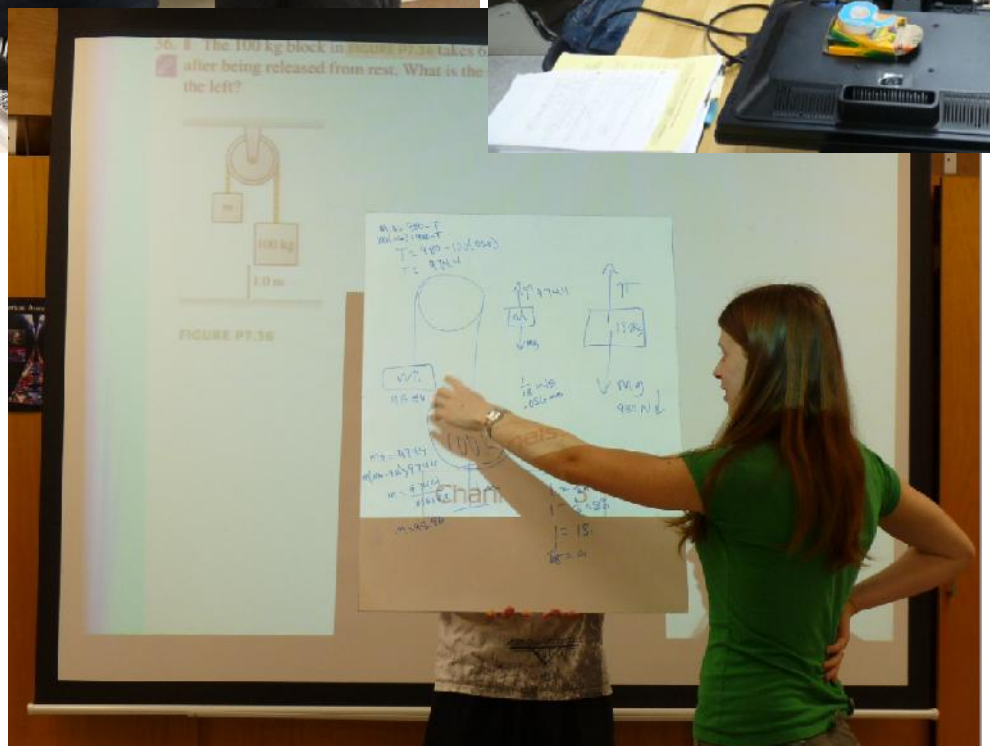
Advantages of bringing the computer to classes

- **the ease of taking/obtaining notes (10), saving/accessing notes (7), personalizing slides (5).**
- **the ease of following the content (9).**
- the ease of seeing the screen on computer (8)
- **being able to actively participate (4)** and to use DyKnow (4).
- A unique benefit - to actively, and interactively, participate in a synchronous classroom experience via DyKnow software (with Skype if two way voice communication is desired).

Disadvantages of bringing computers to class:

- **the inconveniences of physically carrying laptop (8)**
- **internet distractions (7).**
- the inability to hand write notes on laptop (4), the issue with the space that the laptop takes on the desk (1)
- "a false feeling that it is not necessary to take notes" (2).
- issues with battery life (4) and technical problems with laptops or Internet (3).
- Some students specifically stated there are no disadvantages (4).

Current CSU Study
Technology vs. Methodology



Current Project

Methodology and/or Technology: Making Difference in Improving Students' Problem Solving Skills

Table 1: Outline of the Experimental Design

	1st third of semester	2nd third of semester	3rd third of semester
Section 1	Experimental (technology users)	Control (paper users)	By individual choice (either technology or paper user
Section 2	Control (paper users)	Experimental (technology users)	By individual choice either technology or paper user

Methods

- 1. quiz and test scores
- 2. pre-and post tests
- 3. the video timings
- 4. the online surveys mid-semester
- 5. three point observations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- Preliminary data: No difference

Exam Comparisons

- Exam 1 average
  - Thursday section 70.9
  - Friday section 70.5
  - Overall average 70.7
- Exam 2 average
  - Thursday section 69.7
  - Friday section 69.3
  - Overall average 69.5

Student's Perceptions on Productivity of Using DyKnow Software in Teaching (FHSU and CSU Deployments)

Category of DyKnow Evaluation	*General Positive Aspects*		*General Negative Aspects*			*Cognition*			*Communication*		*Motivation*	
Students (%) who Agree and Strongly Agree Statement: Using DyKnow …	…was enjoyable	…made learning more fun	…was very challenging	…was very frustrating	…was a waste of time	…helped me take better set of notes	…facilitated my learning	…enhanced my understanding of the course material	…enhanced my interaction with classmates	…enhanced my interaction with the instructor	I was more attentive when DyKnow was used	I was more motivated when DyKnow was used
Modern Physics (Calculus-based, FHSU) Fall06 (N=9/10)	88.9	77.8	11.1	33.3	0.0	66.7	88.9	62.5	88.9	77.8	44.4	33.3
Physical Science (Concept-based, FHSU) Sum06–Fall08 (N=76/91)	92.1	90.8	10.5	5.3	3.9	61.8	89.3	82.9	77.6	86.7	69.7	70.7
General Physics (Algebra-based, CSU) Spring10 (N=37/53)	81.1	75.7	24.3	24.3	27.0	51.4	64.9	67.6	67.6	70.3	59.5	59.5
Weighted average across courses	**88.5**	**85.3**	**14.7**	**13.1**	**10.6**	**59.0**	**81.9**	**76.8**	**75.4**	**81.1**	**64.7**	**64.5**

Student's Recommendations for Future Usage of DyKnow Software and Tablet PCs in Physics Courses They Took (FHSU and CSU Deployments)

Students (%) enrolled in	*Recommend to keep in the Physics course:*	*Definitely Yes*	*Yes*	*Neutral*	*No*	*Definitely No*
Modern Physics (Calculus-based, FHSU) Fall06 (N=9/10)	**DyKnow**	11.1	44.4	44.4	0.0	0.0
	Tablet PCs	22.2	66.7	11.1	0.0	0.0
Physical Science (Concept-based, FHSU) Sum06–Fall08 (N=76/91)	**DyKnow**	50.0	38.0	12.0	0.0	0.0
	Tablet PCs	50.0	41.7	6.3	2.1	0.0
General Physics (Algebra-based, CSU) Spring10 (N=37/53)	**DyKnow**	24.3	37.8	18.9	8.1	10.8
	Tablet PCs	24.3	27.0	29.7	13.5	5.4
Normalized average (to 100%) across courses	**DyKnow**	**28.5**	**40.1**	**25.1**	**2.7**	**3.6**
	Tablet PCs	**32.2**	**45.1**	**15.7**	**5.2**	**1.8**

Conclusion

- Tablet PC technology accompanied by DyKnow software opened a plethora of new possibilities for greater and more efficient classroom interactions in all directions.
- In our experience a great majority of students like both, this hardware and the software (Hrepic, 2008-2011).
- However, still much an uncharted territory – challenges as numerous as opportunities.
- Results may very substantially with student population even within the same institution and same class (major and seniority)
- Further rigorous research necessary to determine all the relevant factors associated with its effective usage and optimal ways of using it.

References

Adams, P.E., Taggart, G. L., & Kallam, L. (1999). Fort Hays State University, NASA Project NOVA: Final Report. Hays, KS: Fort Hays State University

Hake, R. R. (1997). Interactive-engagement vs traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *Am. J. Phys, 66*, 64-74.

Hrepic, Z. (2007). Utilizing DyKnow software and pen-based, wireless computing in teaching introductory modern physics. In M. Čičin-Šain, I. Turčić & I. Sluganović (Eds.), *Proceedings of 30th jubilee international convention MIPRO, conference on computers in education (2007)*. Opatija, Croatia.

Hrepic, Z. (2008). Exploring the role of pen-based computing in advancing knowledge society. In J. Langer, N. Alfirević & J. Pavičić (Eds.), *Proceedings from the international symposium "Alpe-Adria: Knowledge region" (2007)*. Frankfurt am Main, Germany: Peter Lang.

Hrepic, Z., Adams, P., Zeller, J., Talbott, N., Taggart, G., & Young, L. (2005). Developing an inquiry-based physical science course for preservice elementary teachers. In P. Heron, L. McCollough & J. Marx (Eds.), *Proceedings of 2005 physics education research conference* (Vol. 818, pp. 121-124). Salt Lake City, Utah: AIP Conf. Proceedings.

Louisiana State University. (2005). Operation primary physical science homepage. Retrieved June, 2005, from http://www.phys.lsu.edu/dept/opps/opps_personnel.htm

Redish, E. F. (2003). *Teaching physics with the physics suite*. Hoboken, NJ: John Wiley & Sons, Inc.

Questions

More Information

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Thank You!