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

Zdeslav Hrepic  
Columbus State University

Katherine Lodder  
Columbus State University

Kimberly Shaw  
Columbus State University

Follow this and additional works at: https://digitalcommons.georgiasouthern.edu/stem

Part of the Curriculum and Instruction Commons, Educational Methods Commons, Higher Education Commons, Instructional Media Design Commons, and the Science and Mathematics Education Commons

Recommended Citation

Hrepic, Zdeslav; Lodder, Katherine; and Shaw, Kimberly, "Methodology and/or Technology: Making Difference in Improving Students' Problem Solving Skills" (2012). Interdisciplinary STEM Teaching & Learning Conference. 61.  
https://digitalcommons.georgiasouthern.edu/stem/2012/2012/61

This event is brought to you for free and open access by the Conferences & Events at Digital Commons@Georgia Southern. It has been accepted for inclusion in Interdisciplinary STEM Teaching & Learning Conference by an authorized administrator of Digital Commons@Georgia Southern. For more information, please contact digitalcommons@georgiasouthern.edu.
Methodology and/or Technology: Making Difference in Improving Students’ Problem Solving Skills

Zdeslav Hrepic, Katherine Lodder, Kimberly Shaw
Columbus State University

Georgia Scholarship of STEM Teaching and Learning
March 2012

Georgia Southern University
Motivation

Eh, what’s down Doc?
1. DEMO
  • to demonstrate the instructor-student classroom interaction dynamics enabled or facilitated by DyKnow software and pen-input computers.

2. SELECTED RESEARCH
  • to present selected research findings associated with student learning with this technology.
Pen-Input Computing

- Tablet PC

Laptop w/ Wacom Bamboo


+ Slate Devices / iPad
Simultaneity and clock Synchronization

0: Clock 1 at $x_1=0$ begins at $t_1 = \frac{L}{2c}$
Clock 2 at $x_2=L$ begins at $t_2 = \frac{L}{2c}$

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

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

\[
\Delta t' = t_1' - t_2' = \gamma \frac{u L}{c^2}
\]
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?

\[ d = 0.500 \text{mm} \]
\[ D = 3.30 \text{m} \]
\[ y_{\text{bright}} = 3.4 \text{ mm (m=1)} \]
\[ \lambda = ? \]
\[ y_{\text{bright}} = \frac{\lambda D}{d} m \]
\[ m = 0, \pm 1, \pm 2 \]

Better:

For max: \[ dsinQ = n\lambda \]

\[ \lambda = \frac{dsinQ}{n} = \frac{0.500 \times 10^{-3} \text{ m} \cdot \sin Q}{1} \]

\[ Q \text{ from} \]

\[ \tan Q = \frac{y}{D} = \frac{3.4 \times 10^{-3} \text{ m}}{3.30 \text{ m}} \]

\[ \lambda = \frac{y_m d}{m D} = 515 \text{ nm} \]
Above “Ordinary” Usage

What if:
• Many Tablet PCs
• + Wirelessly networked
• + Interactive Software?
What if:
• Many Tablet PCs
• + Wirelessly networked
• + Interactive Software?
What if:
• Many Tablet PCs
• + Wirelessly networked
• + Interactive Software?
Integrating Engagement, Collaboration and IN class learning

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

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
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”

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”

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
Usernames: demo1 ... demo7

Password: _____

Check Communication setting:
ydknow://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

\[
\begin{align*}
\Delta q_{\text{avg}} &= \frac{F_{\text{avg}}}{m} \\
\Delta q_{\text{avg}} &= \frac{\Delta V}{\Delta t} = \frac{v_f - v_i}{\Delta t} \\
F_{\text{avg}} &= \frac{v_f - v_i}{\Delta t} \\
F_{\text{avg}} \cdot \Delta t &= m (v_f - v_i) \\
F_{\text{avg}} \cdot \Delta t &= m \vec{v}_f - m \vec{v}_i \\
\vec{p} &= m \vec{v} \left[ \text{kg} \frac{\text{m}}{\text{s}} \right]
\end{align*}
\]
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?
New dynamics of the note taking
Problem Solving - Record

At time of slip
\[ f_s = F_s \]
\[ \mu_s mg = k \cdot a \times \]
\[ k \gamma \frac{m}{s^2} \frac{N}{m} \rightarrow m \]
Feature set 1: Note Taking fancy tools
(Insert Tab and other Tabs)
Postulating basic form of free particle de Broglie wave

\[ \Psi(x,t) = A \sin(kx - \omega t) \quad \text{for} \quad k = \frac{2\pi}{\lambda}, \quad \omega = 2\pi v \]

representing wave of amplitude \( A \) traveling in +x dir.

Equivalent to

\[ y(x,t) = A \sin(kx - \omega t) \quad \text{- strong} \]
\[ \vec{E}(x,t) = \vec{E}_0 \sin(kx - \omega t) \quad \text{- \( \vec{E} \) of EMW} \]
\[ \vec{B}(x,t) = \vec{B}_0 \sin(kx - \omega t) \quad \text{- \( \vec{B} \) of EMW} \]

Consider time independent, stationary case:

\[ \Psi(x) = \Psi(x,t=0) \]
\[ \Psi(x) = A \sin kx \quad \text{for} \]

\[ \Psi(x) = A \sin kx \quad \text{for} \]
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

Status: Are you with me?
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 Nm²/C.
B. 4 Nm²/C.
C. 2 Nm²/C.
D. 1 Nm²/C.
E. 0 Nm²/C.

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?

\[ P_{av} = \frac{P}{V_{rms}} \]
\[ R = \frac{V^2}{P_{rms}} \]
\[ P_{max} = I_{max} V_{max} = I_{rms} \sqrt{2} \cdot V_{rms} \sqrt{2} = 10A \cdot 120V \cdot 2 = 2400W \]
Step 2 up from ordinary: Multiple channels of real-time feedback

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

http://www.youtube.com/watch?v=s2e_QL-OHpw
Step 2 up from ordinary: Multiple channels of real-time feedback

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

- **Chat:** Embarrassed to ask?
Channels of real-time feedback

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

- **Chat:** Embarrassed to ask?

- **Pooling:** Embedded Clickers

---

**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.

**4 basic ideas on mechanisms of sound propagation**

- **Human characters = Air particles**
- **Footballs = Sound entities**

![Graph showing distribution of answers: A: 10%, B: 20%, C: 30%, D: 40%, N/A: 20%]
A multiple-choice question and obtained distribution of students' answers incorporated into the panel.

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.
“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
Status: Are you with me?

Chat: Embarrassed to ask?

Pooling: Embedded Clickers

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

29

30

FIGURE P4.35

\[ \text{Net force} \]

\[ \text{Normal force} \]
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?

\[ V_{\text{RMS}} = 120 \text{ V} \quad p = 1200 \text{ W} \]
\[ I_{\text{RMS}} = \frac{P}{V_{\text{RMS}}} = \frac{1200 \text{ W}}{120 \text{ V}} = 10 \text{ Amps} \]

\[ P_{\text{AV}} = I_{\text{RMS}}^2 R \quad \Rightarrow \quad R = \frac{P_{\text{AV}}}{I_{\text{RMS}}^2} = \frac{1200 \text{ W}}{10^2 \text{ A}^2} = 12 \Omega \]

\[ I_{\text{RMS}} = \frac{P}{V_{\text{RMS}}} = \frac{1200 \text{ W}}{120 \text{ V}} = 10 \text{ A} \]

\[ P_{\text{max}} = I_{\text{m}} V_{\text{m}} = I_{\text{RMS}} \sqrt{2} \cdot V_{\text{RMS}} \sqrt{2} = 10 \text{ A} \cdot \sqrt{2} \cdot 120 \text{ V} \cdot \sqrt{2} = 2400 \text{ W} \]
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:**

<table>
<thead>
<tr>
<th>Ideas:</th>
<th>Questions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The current is being lost between the wire connecting the 2 bulbs.</td>
<td>When battery is connected to one light bulb, bulb lights. When battery is connected to 2 bulbs they don't...Why?</td>
</tr>
<tr>
<td>Series and parallel same circuit.</td>
<td>Can you hook up bulbs both in series or parallel in the same circuit?</td>
</tr>
<tr>
<td>Doesn't matter which bulb you unscrew to keep 2 bulbs lit.</td>
<td>How can you connect 3 bulbs with 2 bulbs lit and one off?</td>
</tr>
<tr>
<td>make 3 separate circuits.</td>
<td>How can you create a series circuit where outside bulbs are lit and inside bulbs not?</td>
</tr>
<tr>
<td>can you make 1 bulb brighter than the other.</td>
<td>How can you hook up 3 bulbs to be as bright as 1 bulb?</td>
</tr>
</tbody>
</table>

---

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

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
<td><strong>C</strong></td>
<td><strong>D</strong></td>
</tr>
</tbody>
</table>

**Table A:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.50</td>
<td>0.0078</td>
<td>192</td>
</tr>
<tr>
<td>3</td>
<td>3.00</td>
<td>0.0169</td>
<td>182</td>
</tr>
<tr>
<td>4.5</td>
<td>4.49</td>
<td>0.0244</td>
<td>184</td>
</tr>
<tr>
<td>(6)</td>
<td>5.93</td>
<td>0.0327</td>
<td>184</td>
</tr>
</tbody>
</table>

**Table B:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.42</td>
<td>0.0058</td>
<td>216</td>
</tr>
<tr>
<td>3</td>
<td>3.77</td>
<td>0.0090</td>
<td>183</td>
</tr>
<tr>
<td>4.5</td>
<td>4.32</td>
<td>0.0084</td>
<td>184</td>
</tr>
<tr>
<td>(6)</td>
<td>5.93</td>
<td>0.0083</td>
<td>184</td>
</tr>
</tbody>
</table>

**Table C:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.33</td>
<td>0.0081</td>
<td>191</td>
</tr>
<tr>
<td>3</td>
<td>2.94</td>
<td>0.0151</td>
<td>191</td>
</tr>
<tr>
<td>4.5</td>
<td>4.49</td>
<td>0.0244</td>
<td>186</td>
</tr>
<tr>
<td>(6)</td>
<td>5.96</td>
<td>0.0404</td>
<td>141</td>
</tr>
</tbody>
</table>

**Table D:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.49</td>
<td>0.0084</td>
<td>177</td>
</tr>
<tr>
<td>3</td>
<td>3.99</td>
<td>0.0144</td>
<td>181</td>
</tr>
<tr>
<td>4.5</td>
<td>4.54</td>
<td>0.0251</td>
<td>181</td>
</tr>
<tr>
<td>(6)</td>
<td>5.8</td>
<td>0.0358</td>
<td>171</td>
</tr>
</tbody>
</table>
### ENGAGE: Ideas: and Questions:

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

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.50</td>
<td>0.078</td>
<td>19.2</td>
</tr>
<tr>
<td>3</td>
<td>3.00</td>
<td>0.164</td>
<td>18.2</td>
</tr>
<tr>
<td>4.5</td>
<td>4.49</td>
<td>0.213</td>
<td>18.4</td>
</tr>
<tr>
<td>(6)</td>
<td>5.93</td>
<td>0.322</td>
<td>18.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.49</td>
<td>0.054</td>
<td>26.9</td>
</tr>
<tr>
<td>3</td>
<td>2.83</td>
<td>0.180</td>
<td>15.8</td>
</tr>
<tr>
<td>4.5</td>
<td>4.35</td>
<td>0.234</td>
<td>18.6</td>
</tr>
<tr>
<td>(6)</td>
<td>5.8</td>
<td>0.338</td>
<td>17.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>1.53</td>
<td>0.081</td>
<td>19.1</td>
</tr>
<tr>
<td>3</td>
<td>2.96</td>
<td>0.195</td>
<td>15.7</td>
</tr>
<tr>
<td>4.5</td>
<td>4.46</td>
<td>0.224</td>
<td>18.6</td>
</tr>
<tr>
<td>(6)</td>
<td>5.96</td>
<td>0.322</td>
<td>18.4</td>
</tr>
</tbody>
</table>
**Problem:** Although an excited atom can radiate at any time from $t=0$ to $t=\infty$, the average time after excitation at which a group of atoms radiates is called the lifetime, $\tau$ 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 ($\Delta f$) 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
A marble is shot horizontally from a height of 1.3 m above the ground. What is the marble’s range?
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?

\[
\begin{align*}
\int_0^R r^2 \, dm & = \frac{2\pi m}{A} \left( \frac{R^4}{4} - \frac{r^4}{4} \right) \\
\int_0^R r^2 \, r \, dr &= \frac{2\pi m}{(R^2+r^2)^{\frac{3}{2}}} \left( \frac{R^4}{4} - \frac{r^4}{4} \right) \\
\frac{2m}{A} \int_0^R r^3 \, dr & = \left( \frac{2\pi m}{\sqrt{R^2-r^2}} \right) \left( \frac{R^4}{4} - \frac{r^4}{4} \right) \\
\int_0^R r^4 \, dm &= \frac{2m}{R^2-r^2} \left( \frac{R^4-r^4}{4} \right)
\end{align*}
\]
Group Work and Group Annotations
Experimental investigation Physical Science
<table>
<thead>
<tr>
<th>ENGAGE: Ideas:</th>
<th>and</th>
<th>Questions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A The current is being lost between the wire connecting the 2 bulbs.</td>
<td></td>
<td>When battery is connected to one light bulb, bulb lights when battery is connected to 2 bulbs they don’t... Why?</td>
</tr>
<tr>
<td>B Series and parallel same circuit</td>
<td></td>
<td>Can you hook up bulbs both in series or parallel in the same circuit?</td>
</tr>
<tr>
<td>C Does it matter which bulb you unscrew to keep 2 bulbs lit.</td>
<td></td>
<td>How can you connect 3 bulbs with 2 bulbs lit and one off?</td>
</tr>
<tr>
<td>D make 3 separate circuits.</td>
<td></td>
<td>How can you create a series circuit where 2 outside bulbs are lit and the inside bulb is not?</td>
</tr>
<tr>
<td>E can you make 1 bulb brighter than the other 2?</td>
<td></td>
<td>How can you hook up 3 bulbs to be as bright as 1 bulb?</td>
</tr>
</tbody>
</table>
Group experimental investigation
Physical Science
Slides collaboratively annotated by whole class, with each group writing to their respective spaces

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>1.50</td>
<td>0.0078</td>
<td>192</td>
</tr>
<tr>
<td>3</td>
<td>3.00</td>
<td>0.0164</td>
<td>182</td>
</tr>
<tr>
<td>4.5</td>
<td>4.49</td>
<td>0.0244</td>
<td>184</td>
</tr>
<tr>
<td>(6)</td>
<td>5.93</td>
<td>0.0322</td>
<td>184</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>1.43</td>
<td>0.0548</td>
<td>269</td>
</tr>
<tr>
<td>3</td>
<td>2.83</td>
<td>0.0150</td>
<td>188</td>
</tr>
<tr>
<td>4.5</td>
<td>4.35</td>
<td>0.0234</td>
<td>186</td>
</tr>
<tr>
<td>(6)</td>
<td>5.80</td>
<td>0.0333</td>
<td>184</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>1.53</td>
<td>0.008</td>
<td>191</td>
</tr>
<tr>
<td>3</td>
<td>2.96</td>
<td>0.015</td>
<td>197</td>
</tr>
<tr>
<td>4.5</td>
<td>4.46</td>
<td>0.024</td>
<td>186</td>
</tr>
<tr>
<td>(6)</td>
<td>5.96</td>
<td>0.042</td>
<td>141</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>1.49</td>
<td>0.008</td>
<td>177</td>
</tr>
<tr>
<td>3</td>
<td>2.99</td>
<td>0.014</td>
<td>181</td>
</tr>
<tr>
<td>4.5</td>
<td>4.54</td>
<td>0.0251</td>
<td>181</td>
</tr>
<tr>
<td>(6)</td>
<td>5.8</td>
<td>0.0338</td>
<td>171</td>
</tr>
</tbody>
</table>
All in control: Students in charge of the teaching/learning game + Technology Combo
STEP 3 & STEP 4

Step 3: Firm Pad

STEP 3: Light Pad

No Pad
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**
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**
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
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):

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):

<table>
<thead>
<tr>
<th></th>
<th>Conceptual Understanding (FCI)</th>
<th>Problem Solving (Final Exam)</th>
<th>Course Success (% A, B, C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra-based Physics I (n = 39, Fall 07)</td>
<td>7% increase ($p = 0.14$)</td>
<td>2% improvement</td>
<td>22% increase</td>
</tr>
<tr>
<td>Calculus-based Physics I (n = 26, Fall 08)</td>
<td>3% increase ($p = .99$)</td>
<td>11% increase</td>
<td>10% increase</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject</th>
<th>(Curriculum/Institution, Location)</th>
<th>Start/End Dates</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modern Physics</td>
<td>(Calculus-based, FHSU)</td>
<td>Fall06</td>
<td>(Survey/Test N=9/10)</td>
</tr>
<tr>
<td>Physical Science</td>
<td>(Concept-based, FHSU)</td>
<td>Sum06–Fall08</td>
<td>(Survey/Test N=76/91)</td>
</tr>
<tr>
<td>General Physics</td>
<td>(Algebra-based, CSU)</td>
<td>Spring10</td>
<td>(Survey/Test N=37/53)</td>
</tr>
</tbody>
</table>
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?

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

<table>
<thead>
<tr>
<th>The top mobile computer I own</th>
<th>Code</th>
<th>N</th>
<th>Avg. %</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Scores Of Taken Tests</td>
<td>All</td>
<td>53</td>
<td>55.53</td>
<td>25.15</td>
</tr>
<tr>
<td>Tablet</td>
<td>1</td>
<td>4</td>
<td>81.96</td>
<td>3.67</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>49</td>
<td>53.38</td>
<td>24.93</td>
</tr>
<tr>
<td>Mann-Whitney (2 groups)</td>
<td></td>
<td></td>
<td>p=0.016</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The top mobile computer I own</th>
<th>Code</th>
<th>N</th>
<th>Avg. %</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Grade Result</td>
<td>All</td>
<td>53</td>
<td>64.44</td>
<td>27.57</td>
</tr>
<tr>
<td>Tablet</td>
<td>1</td>
<td>4</td>
<td>90.29</td>
<td>2.36</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>49</td>
<td>62.33</td>
<td>27.62</td>
</tr>
<tr>
<td>Mann-Whitney (2 groups)</td>
<td></td>
<td></td>
<td>p=0.040</td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Section</th>
<th>1st third of semester</th>
<th>2nd third of semester</th>
<th>3rd third of semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
<td>Experimental (technology users)</td>
<td>Control (paper users)</td>
<td>By individual choice (either technology or paper user)</td>
</tr>
<tr>
<td>Section 2</td>
<td>Control (paper users)</td>
<td>Experimental (technology users)</td>
<td>By individual choice either technology or paper user</td>
</tr>
</tbody>
</table>
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
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

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)

<table>
<thead>
<tr>
<th>Category of DyKnow Evaluation</th>
<th>General Positive Aspects</th>
<th>General Negative Aspects</th>
<th>Cognition</th>
<th>Communication</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students (%) who Agree and Strongly Agree</strong></td>
<td>...was enjoyable</td>
<td>...was very challenging</td>
<td>...helped me take better set of notes</td>
<td>...facilitated my learning</td>
<td>...was more attentive when DyKnow was used</td>
</tr>
<tr>
<td>Statement: Using DyKnow ...</td>
<td>...made learning more fun</td>
<td>...very frustrating</td>
<td>...was a waste of time</td>
<td>...enhanced my understanding of the course material</td>
<td>...enhanced my interaction with classmates</td>
</tr>
<tr>
<td><strong>Modern Physics</strong></td>
<td>88.9</td>
<td>77.8</td>
<td>11.1</td>
<td>35.3</td>
<td>0.0</td>
</tr>
<tr>
<td>(Calculus-based, FHSU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall06 (N=9/10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical Science</strong></td>
<td>92.1</td>
<td>90.8</td>
<td>10.5</td>
<td>5.3</td>
<td>3.9</td>
</tr>
<tr>
<td>(Concept-based, FHSU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum06–Fall08 (N=76/91)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General Physics</strong></td>
<td>81.1</td>
<td>75.7</td>
<td>24.3</td>
<td>24.3</td>
<td>27.0</td>
</tr>
<tr>
<td>(Algebra-based, CSU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring10 (N=37/53)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weighted average across courses</strong></td>
<td>88.5</td>
<td>85.3</td>
<td>14.7</td>
<td>13.1</td>
<td>10.6</td>
</tr>
</tbody>
</table>
## Student’s Recommendations for Future Usage of DyKnow Software and Tablet PCs in Physics Courses They Took (FHSU and CSU Deployments)

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

Studies on Tablet PC and DyKnow Software

www.hrepic.com
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


More Information

Zdeslav Hrepic
Katherine Lodder
Kimberly Shaw

drz@columbusstate.edu
hrepic.com

Thank You!