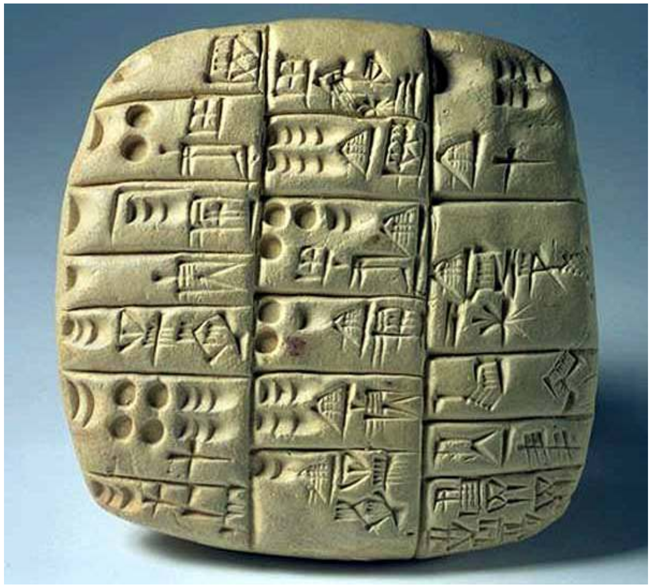
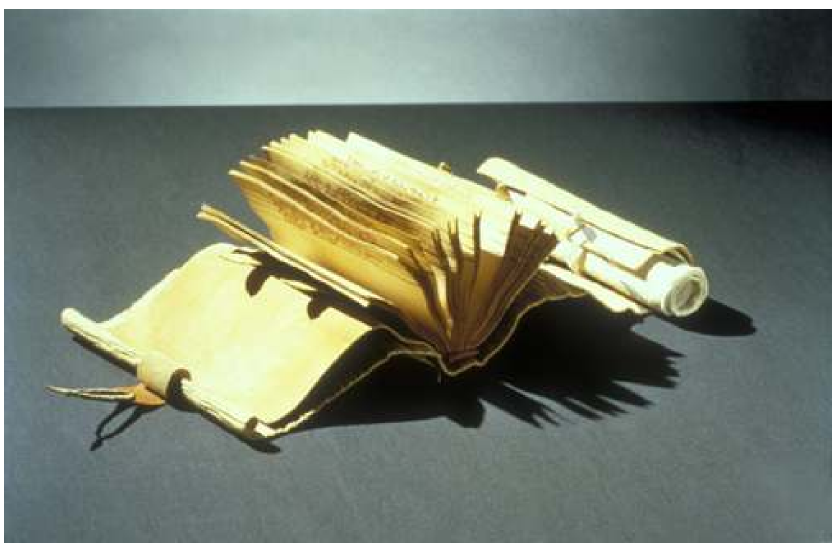


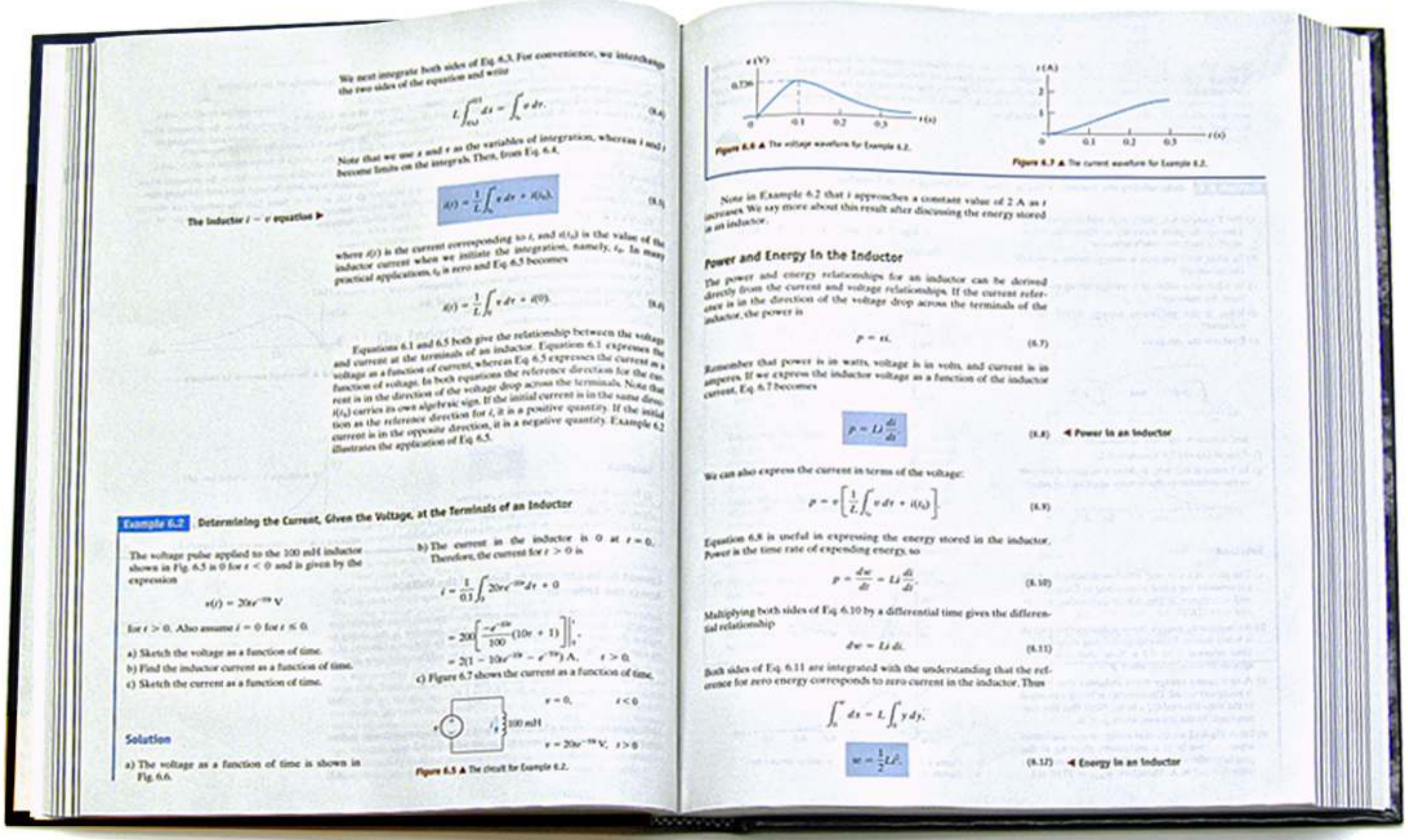
3100 B.C.

120 B.C.



100 A.D.

1452



We next integrate both sides of Eq. 6.3. For convenience, we interchange the two sides of the equation and write

$$L\int_{i(t_0)}^{i(t)} dx = \int_{t_0}^{t} v\,d\tau. \quad (6.4)$$

Note that we use x and τ as the variables of integration, whereas i and t become limits on the integrals. Then, from Eq. 6.4,

The inductor $i - v$ equation ▶

$$i(t) = \frac{1}{L}\int_{t_0}^{t} v\,d\tau + i(t_0), \quad (6.5)$$

where $i(t)$ is the current corresponding to t, and $i(t_0)$ is the value of the inductor current when we initiate the integration, namely, t_0. In many practical applications, t_0 is zero and Eq. 6.5 becomes

$$i(t) = \frac{1}{L}\int_{0}^{t} v\,d\tau + i(0). \quad (6.6)$$

Equations 6.1 and 6.5 both give the relationship between the voltage and current at the terminals of an inductor. Equation 6.1 expresses the voltage as a function of current, whereas Eq. 6.5 expresses the current as a function of voltage. In both equations the reference direction for the current is in the direction of the voltage drop across the terminals. Note that $i(t_0)$ carries its own algebraic sign. If the initial current is in the same direction as the reference direction for i, it is a positive quantity. If the initial current is in the opposite direction, it is a negative quantity. Example 6.2 illustrates the application of Eq. 6.5.

Example 6.2 Determining the Current, Given the Voltage, at the Terminals of an Inductor

The voltage pulse applied to the 100 mH inductor shown in Fig. 6.5 is 0 for $t < 0$ and is given by the expression

$$v(t) = 20te^{-10t}\ \text{V}$$

for $t > 0$. Also assume $i = 0$ for $t \le 0$.

a) Sketch the voltage as a function of time.
b) Find the inductor current as a function of time.
c) Sketch the current as a function of time.

Solution

a) The voltage as a function of time is shown in Fig. 6.6.

b) The current in the inductor is 0 at $t = 0$. Therefore, the current for $t > 0$ is

$$i = \frac{1}{0.1}\int_0^t 20\tau e^{-10\tau}\,d\tau + 0$$

$$= 200\left[\frac{-e^{-10\tau}}{100}(10\tau + 1)\right]\Bigg|_0^t,$$

$$= 2(1 - 10te^{-10t} - e^{-10t})\ \text{A}, \quad t > 0.$$

c) Figure 6.7 shows the current as a function of time.

$v = 0, \quad t < 0$

100 mH

$v = 20te^{-10t}\ \text{V}, \quad t > 0$

Figure 6.5 ▲ The circuit for Example 6.2.

Figure 6.6 ▲ The voltage waveform for Example 6.2.

Figure 6.7 ▲ The current waveform for Example 6.2.

Note in Example 6.2 that i approaches a constant value of 2 A as t increases. We say more about this result after discussing the energy stored in an inductor.

Power and Energy in the Inductor

The power and energy relationships for an inductor can be derived directly from the current and voltage relationships. If the current reference is in the direction of the voltage drop across the terminals of the inductor, the power is

$$p = vi. \quad (6.7)$$

Remember that power is in watts, voltage is in volts, and current is in amperes. If we express the inductor voltage as a function of the inductor current, Eq. 6.7 becomes

$$p = Li\frac{di}{dt}. \quad (6.8)$$ ◀ Power in an inductor

We can also express the current in terms of the voltage:

$$p = v\left[\frac{1}{L}\int_{t_0}^{t} v\,d\tau + i(t_0)\right]. \quad (6.9)$$

Equation 6.8 is useful in expressing the energy stored in the inductor. Power is the time rate of expending energy, so

$$p = \frac{dw}{dt} = Li\frac{di}{dt}. \quad (6.10)$$

Multiplying both sides of Eq. 6.10 by a differential time gives the differential relationship

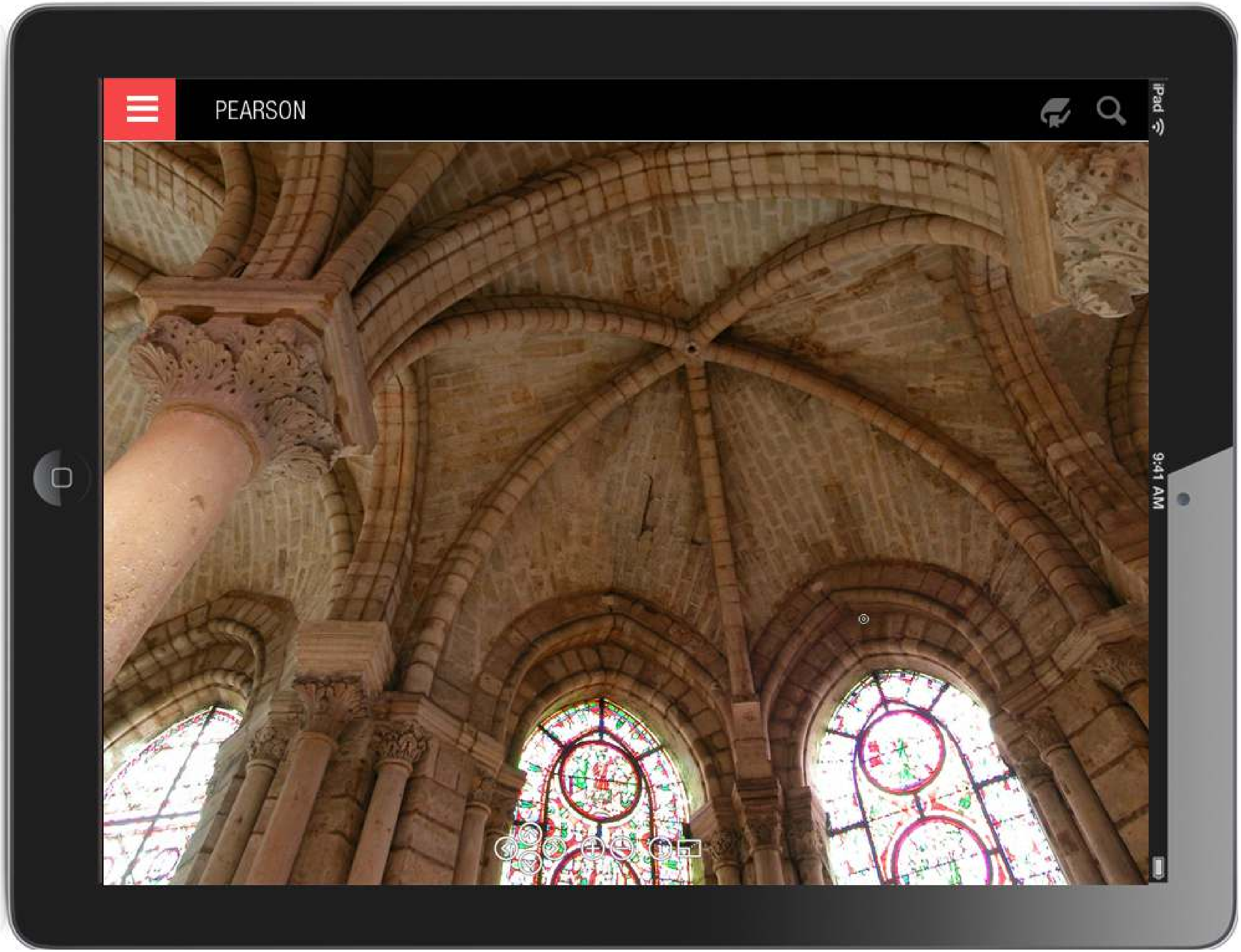
$$dw = Li\,di. \quad (6.11)$$

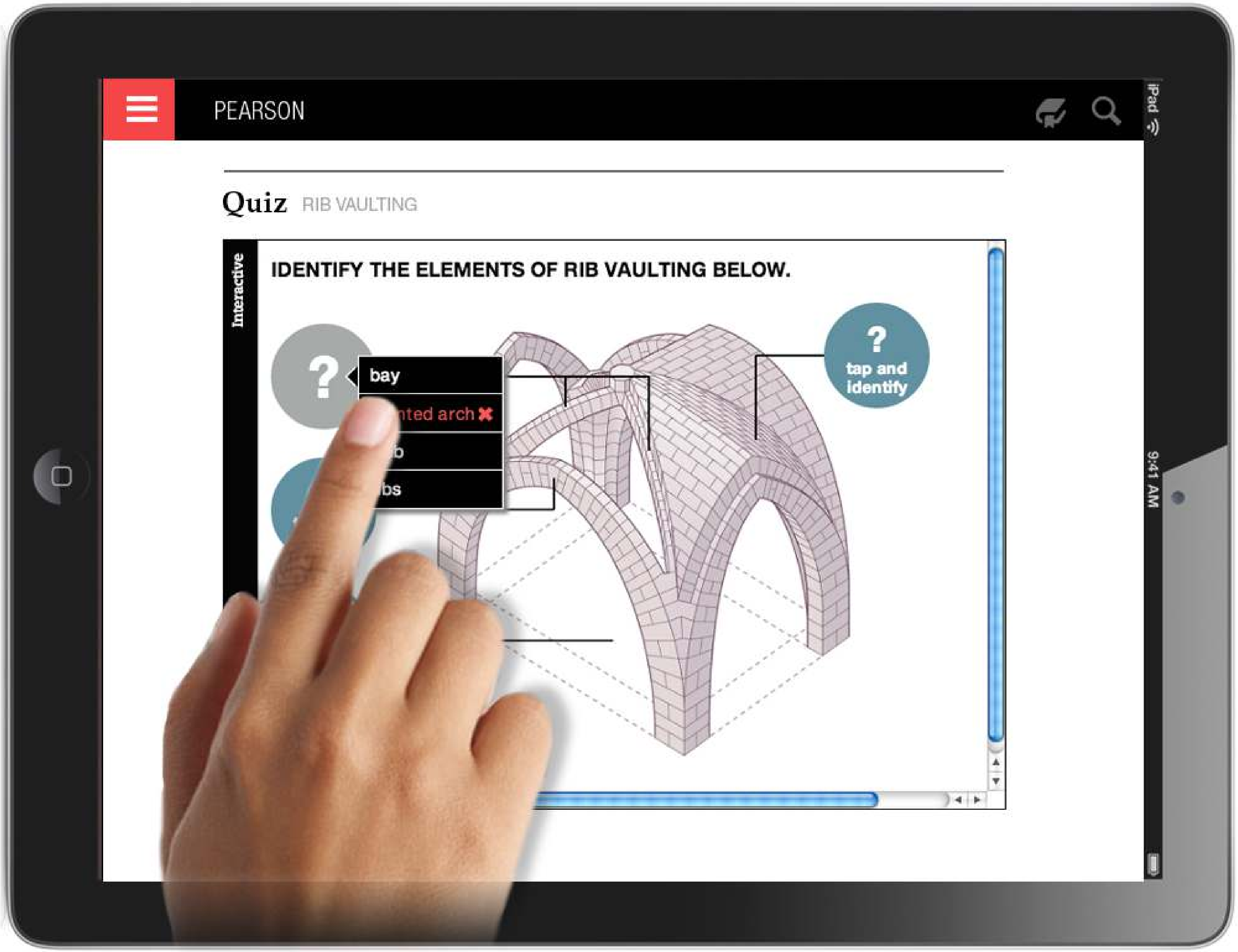
Both sides of Eq. 6.11 are integrated with the understanding that the reference for zero energy corresponds to zero current in the inductor. Thus

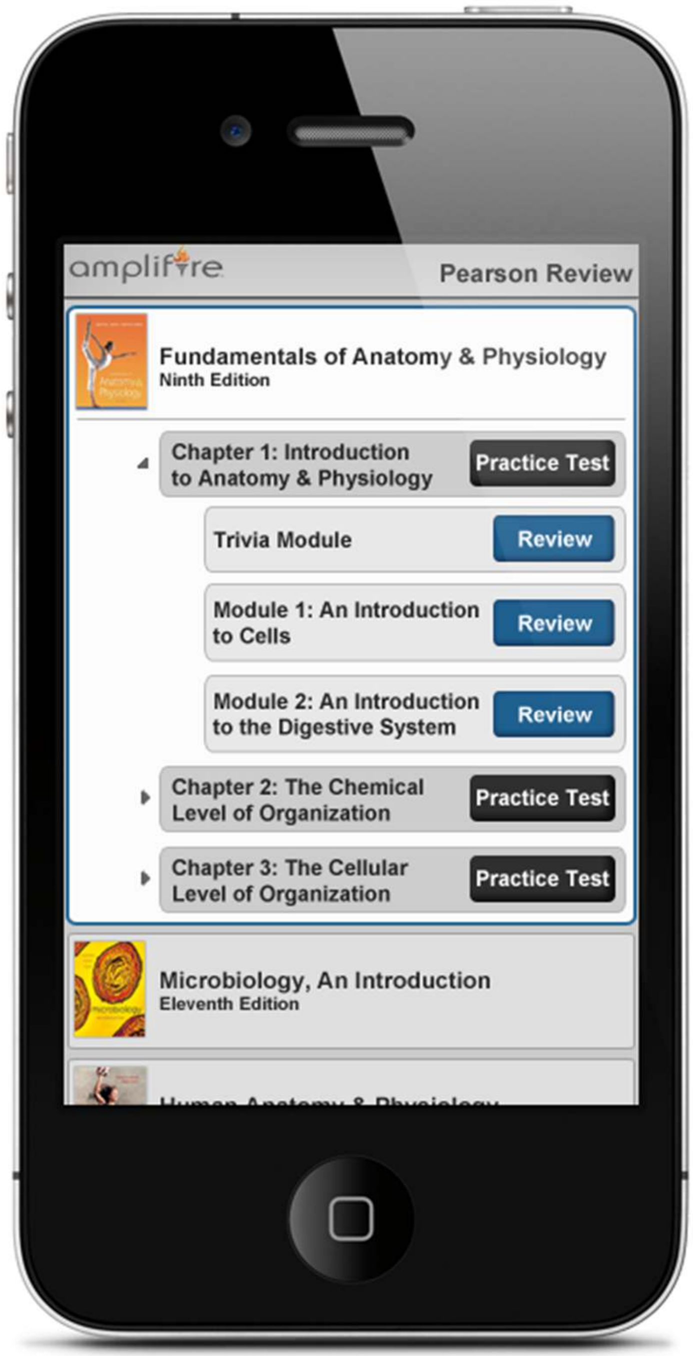
$$\int_0^w dx = L\int_0^i y\,dy,$$

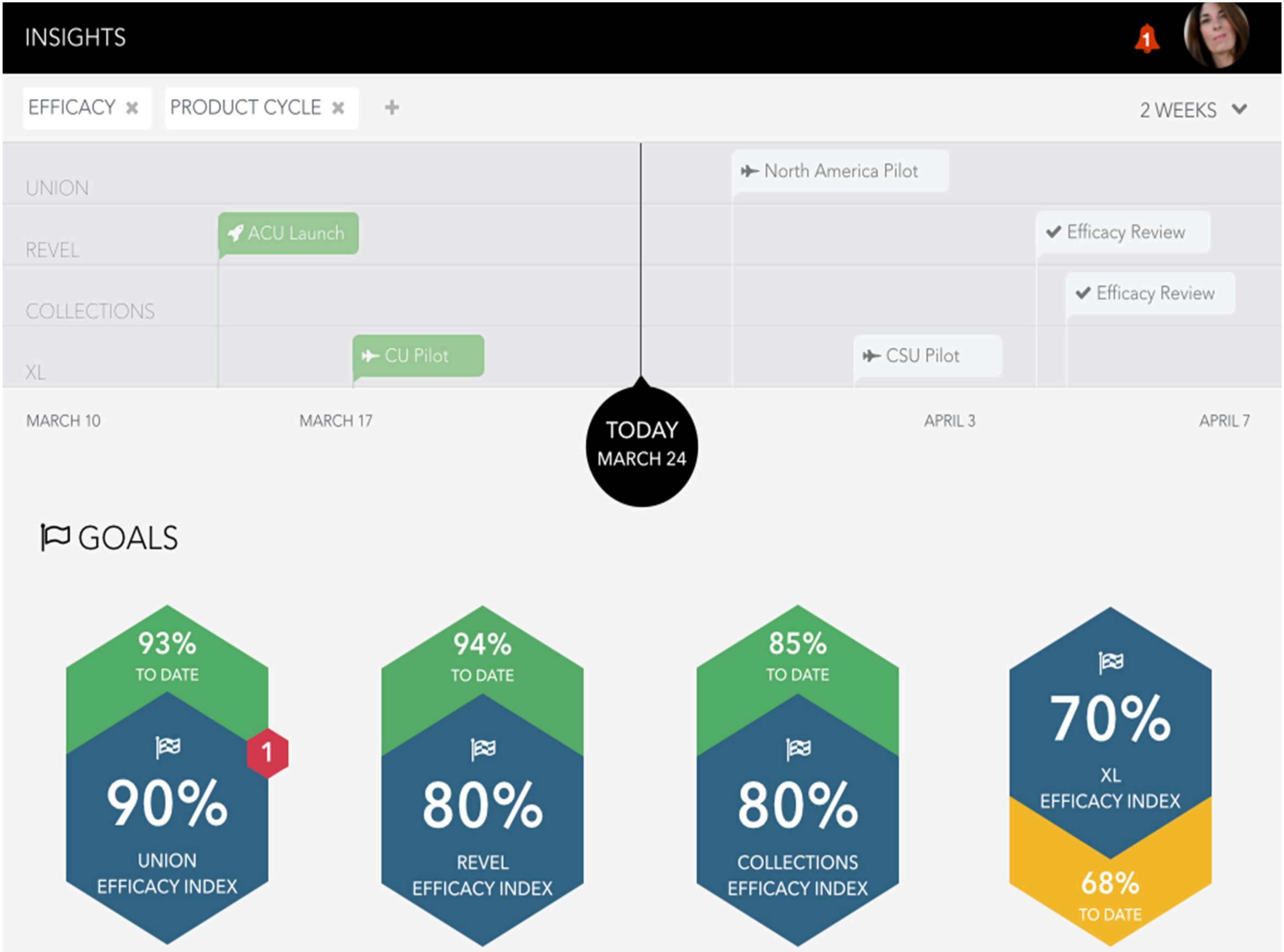
$$w = \frac{1}{2}Li^2. \quad (6.12)$$ ◀ Energy in an inductor

Progress?

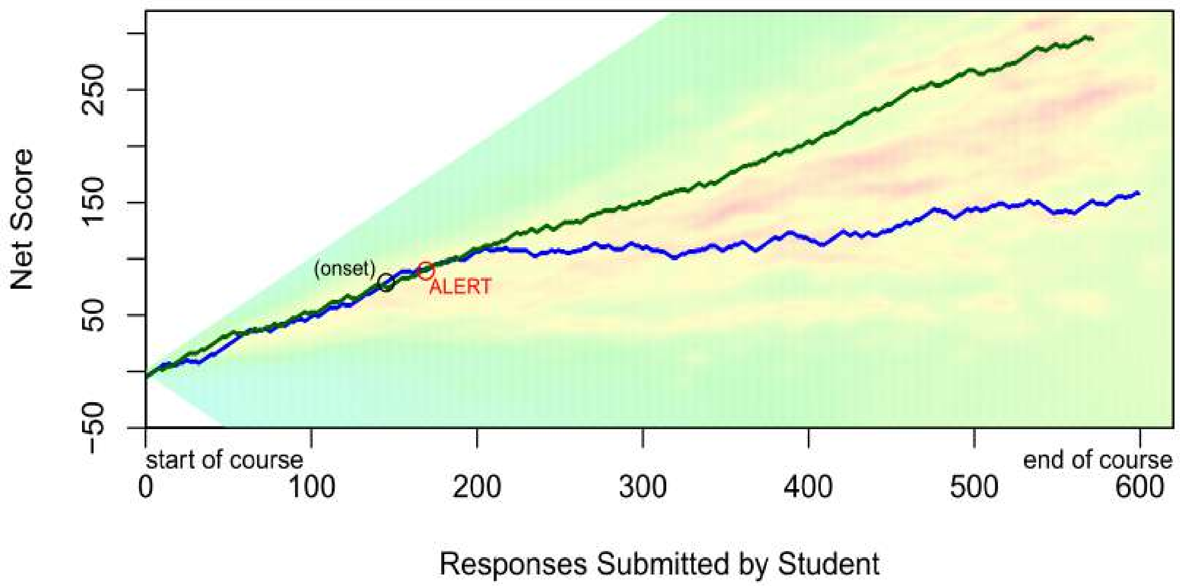

PEARSON
iPad
9:41 AM


PEARSON
Quiz
RIB VAULTING
Interactive
IDENTIFY THE ELEMENTS OF RIB VAULTING BELOW.
bay
?
tap and identify
iPad
9:41 AM


amplifire
Pearson Review
Fundamentals of Anatomy & Physiology
Ninth Edition
Chapter 1: Introduction to Anatomy & Physiology
Practice Test
Trivia Module
Review
Module 1: An Introduction to Cells
Review
Module 2: An Introduction to the Digestive System
Review
Chapter 2: The Chemical Level of Organization
Practice Test
Chapter 3: The Cellular Level of Organization
Practice Test
Microbiology, An Introduction
Eleventh Edition


INSIGHTS
1
EFFICACY
PRODUCT CYCLE
2 WEEKS
UNION
REVEL
COLLECTIONS
XL
North America Pilot
ACU Launch
Efficacy Review
Efficacy Review
CU Pilot
CSU Pilot
MARCH 10
MARCH 17
TODAY
MARCH 24
APRIL 3
APRIL 7
GOALS
93%
TO DATE
1
90%
UNION
EFFICACY INDEX
94%
TO DATE
80%
REVEL
EFFICACY INDEX
85%
TO DATE
80%
COLLECTIONS
EFFICACY INDEX
70%
XL
EFFICACY INDEX
68%
TO DATE

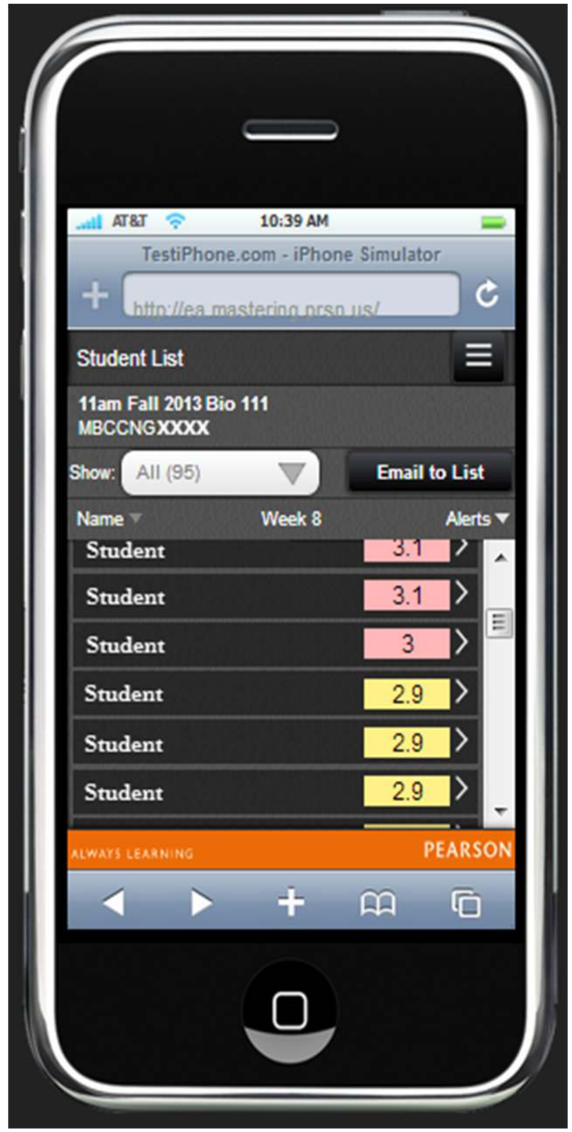
FRACTAL ALERTS



Predictive alerts can identify struggling students before it is evident from their grades

Actionable Student Data

- Students rank ordered by alert severity
- Easily email alert groups
- Track individual students



Closing the **achievement gap** at an R1 state school