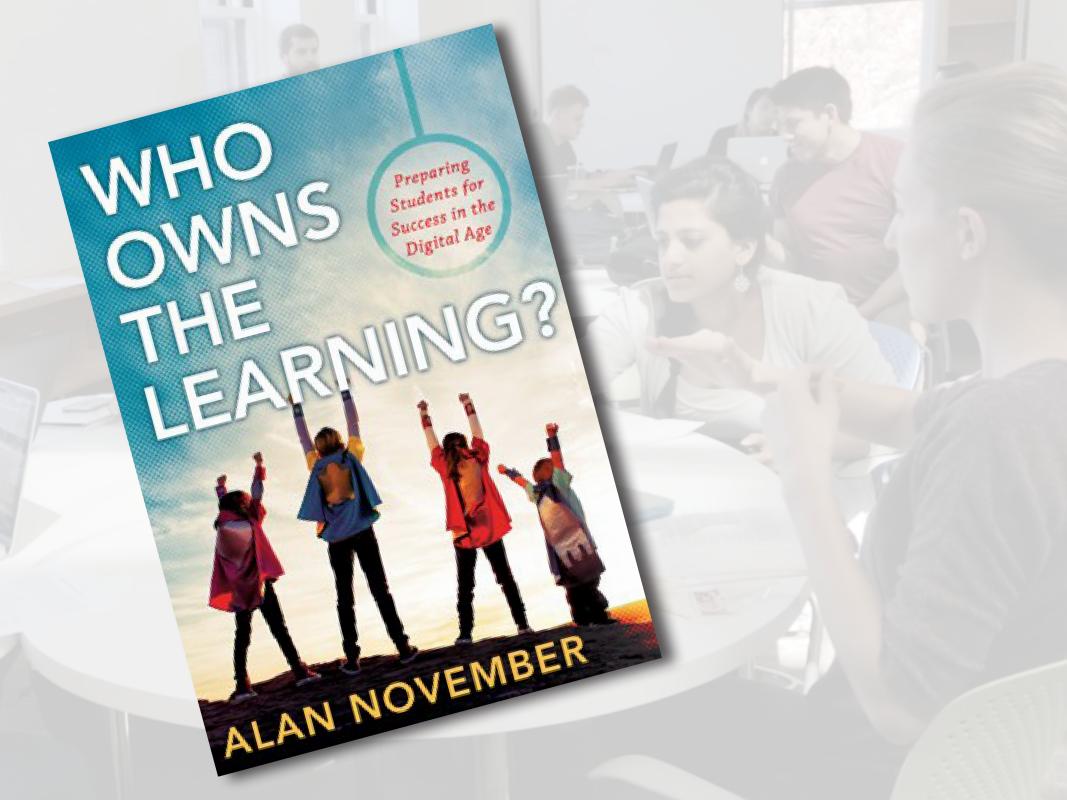
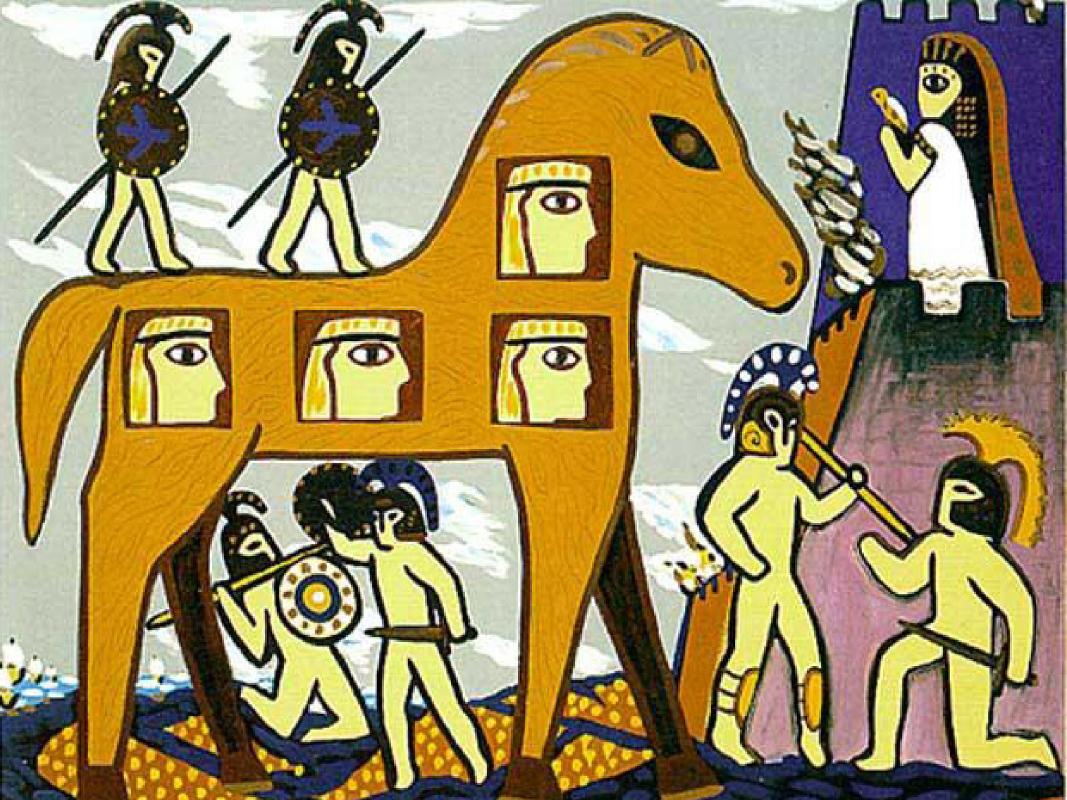
AP50: A team-based, project-based approach to teaching introductory physics



Harvard University Cambridge, MA, 9 September 2013



Ownership of learning physics?



team & project-based approach

D

9



















Need to:

- align goals to students' needs and expectations
- change the approach
- redesign the learning space



Setting learning goals

Grant Wiggins and Jay McTighe, Understanding by Design (Prentice Hall, 2001)



MERRILL EDUCATION/ASCD COLLEGE TEXTBOOK SERIES

UNDERSTANDING by DESIGN

GRANT WIGGINS AND JAY MCTIGHE

Backward design

desired outcomes

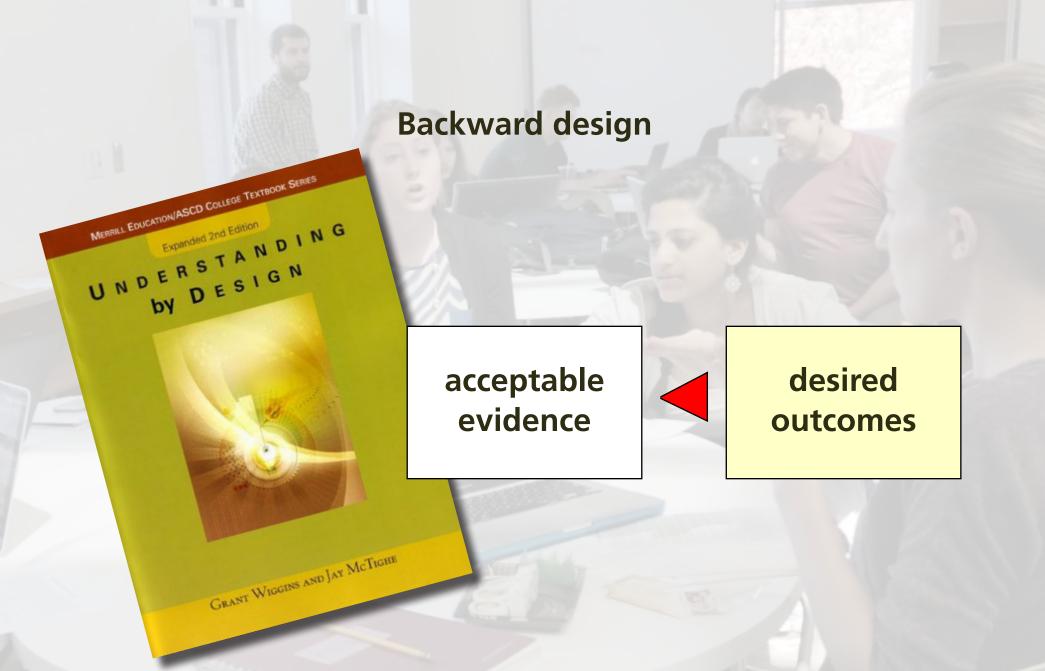
Grant Wiggins and Jay McTighe, Understanding by Design (Prentice Hall, 2001)



MERRILL EDUCATION/ASCD COLLEGE TEXTBOOK SERIES

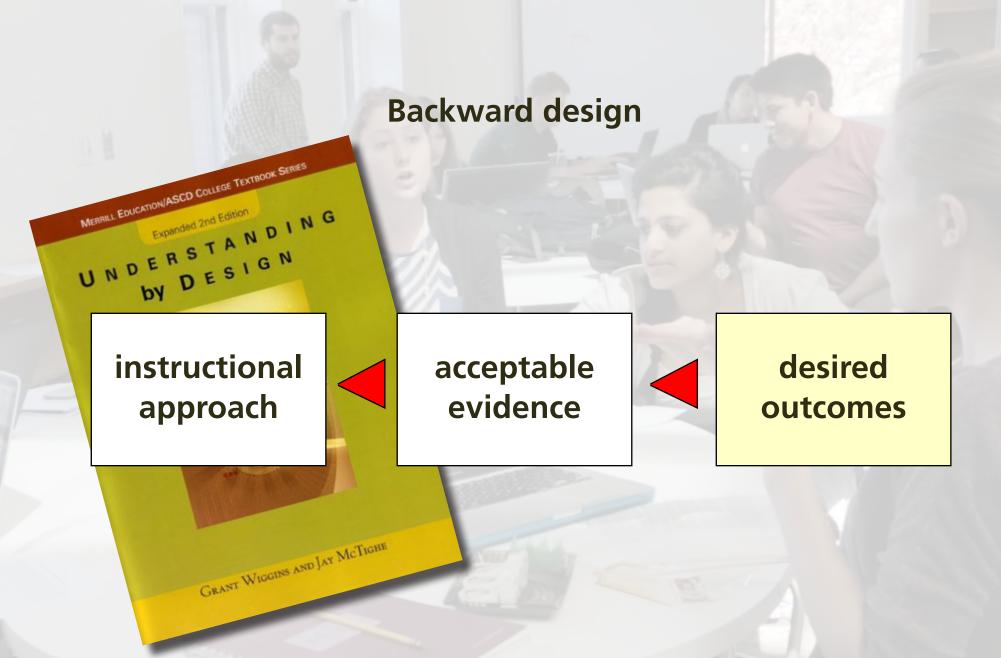
UNDERSTANDING by DESIGN

GRANT WIGGINS AND JAY MCTIGHE



Grant Wiggins and Jay McTighe, Understanding by Design (Prentice Hall, 2001)

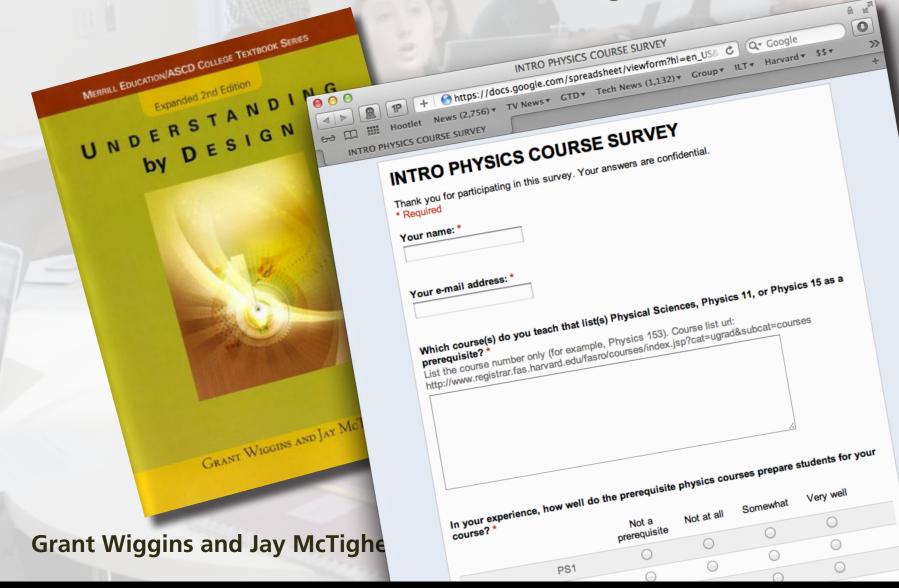




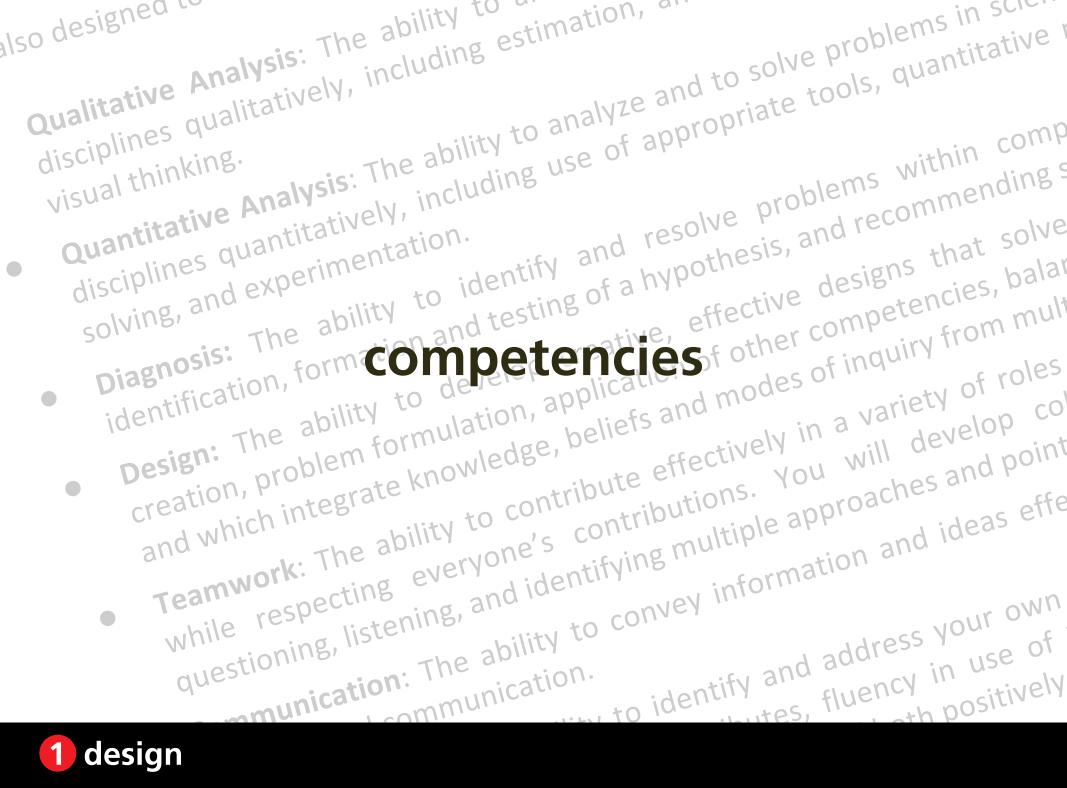
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Backward design



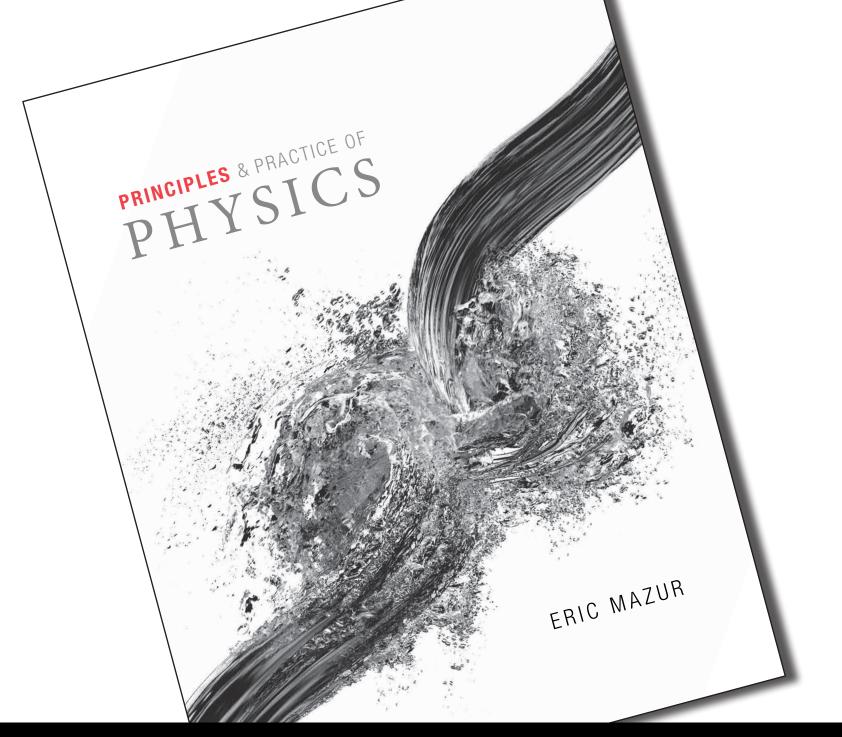




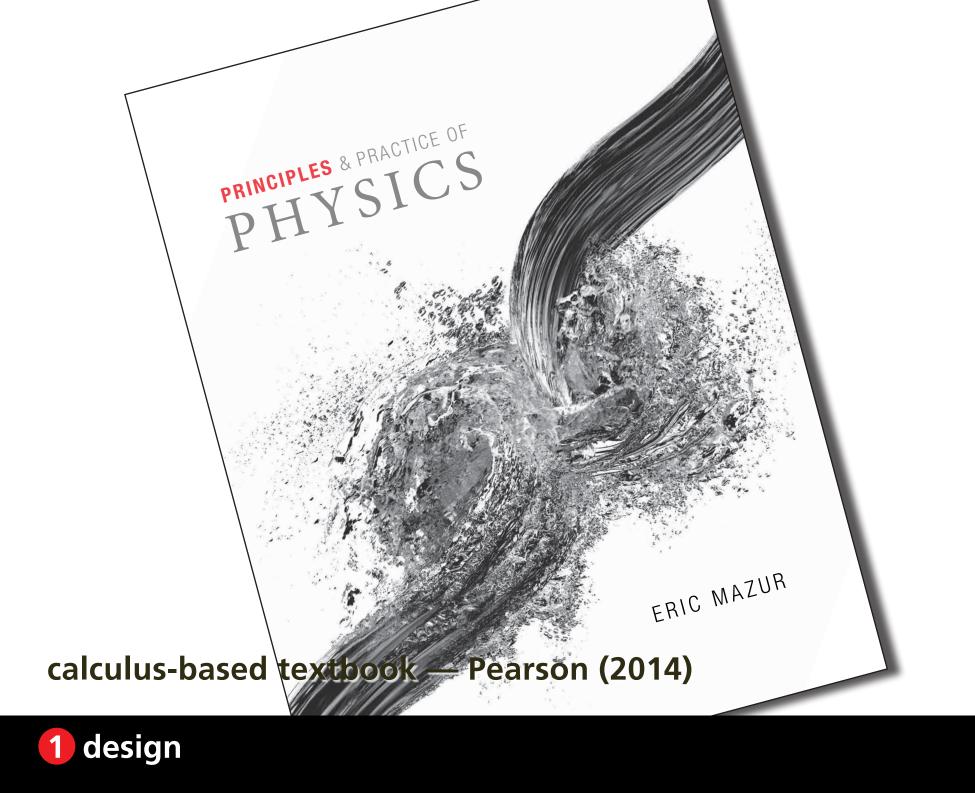




Describe the observations supporting the quantization and conservation of Describe how the charge carriers behave in insulators and conductors. Explain polarization and how it gives rise to an electric force on a neutral obje Explain polarization and how it gives rise to an electric force on a neutral objective Describe what happens and explain the process of the polarization of the polarization of the process of the polarization of the polarizat Explain what a field is and give examples of scalar and vector fields. Explain the conditions in which Coulomb's law is valid. distribution, exerts on a charged particle. wector field diagrams for a simple distribution of charged particle







Content

1 Foundations 2 Motion in one dimension **3** Acceleration 4 Momentum 5 Energy **6** Principle of relativity 7 Interactions **8** Force 9 Work 10 Motion in a plane 11 Motion in a circle

12 Torque 13 Gravity 14 Special relativity 15 Periodic Motion 16 Waves in one dimension 17 Waves in 2&3 dimensions **18 Fluids 19 Entropy 20 Energy transferred thermally 21 Degradation of energy** ERIC MAZUR



Content

- 22 Electric interactions
- 23 The electric field
- 24 Gauss's law
- 25 Work and energy in electrostatics
- 26 Charge separation and storage
- **27 Magnetic interactions**
- 28 Magnetic fields of particles in motion

29 Changing magnetic fields
30 Changing electric fields
31 Electric circuits
32 Electronics
33 Ray optics
34 Wave and particle optics

ERIC MAZUR













CLASS

ROOM

1st exposure

deeper understanding

ROOM

CLASS

1st exposure

deeper understanding



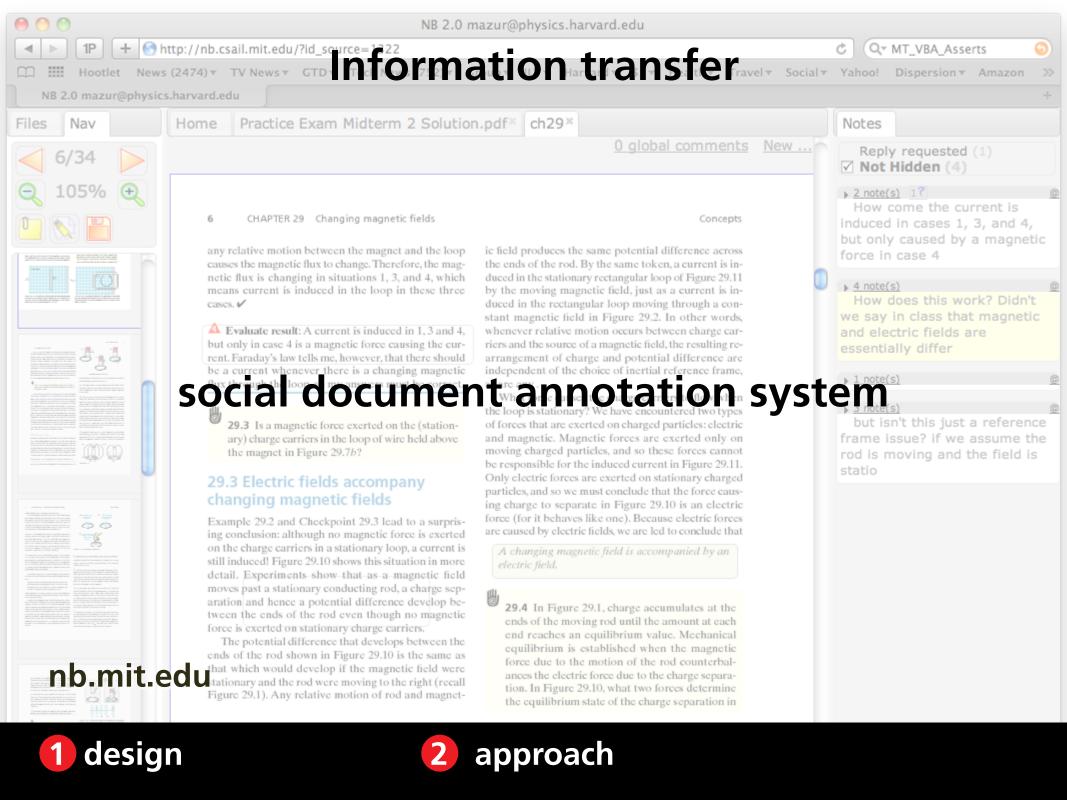


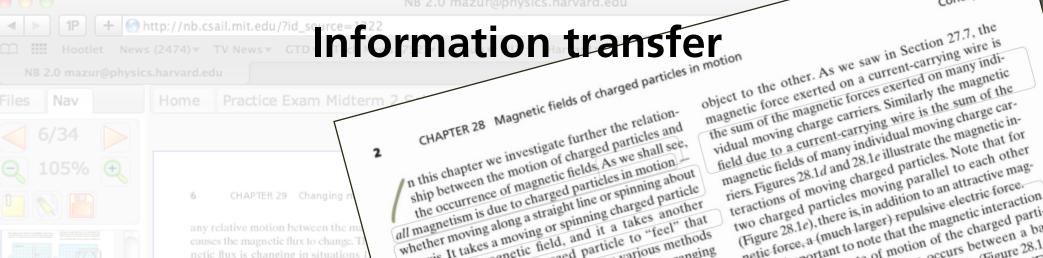
Three major components:

- information transfer (out of class)
- in-class activities
- projects









ments.

cases. V

Evaluate result: A current is induced

nb.mit.edu

design

In this chapter we investigate further the relationship between the motion of charged particles and the occurrence of magnetic fields. As we shall see, all magnetism is due to charged particles in motion whether moving along a straight line or spinning about an axis. It takes a moving or spinning charged particle to create a magnetic field, and it a takes another moving or spinning charged particle to "feel" that moving or spinning energed particle to rect mat magnetic field. We shall also discuss various methods for creating magnetic fields, which have wide-ranging applications in electromechanical machines and instru-

magnet and a stationary charged particle (Figure 28.1f or between two stationary charged particles (Figure 20.1) 28.1 Source of the magnetic field As we saw in Chapter 27, magnetic interactions take place between magnets, current-carrying wires, and moving charged particles. Figure 28.1 summarizes the interactions we have encountered so far. Figure 201 28.1*a*-*c* show the interactions between magnets and between a magnet and a surger to and a surgere between a magnet and a current-carrying wire(Figure 28.1b) is unlike any other interaction we have encourtered. The forces between the wire and the magnet are not central – they do not point directly from one

N F21 F12 S

approach

(a)

(b)

netic force, a (much larger) repulsive electric force.

It is important to note that the magnetic interaction

depends on the state of motion of the charged parti-

cles. No magnetic interaction occurs between a bar

ure 28.1g). These observations suggest that the motiof charged particles might be the origin of all magn ism. There are two problems with this assumption, h ever. First, the magnetic field of a wire carryi constant current looks very different from that of magnet (Compare Figures 27.13 and 27.19). Se there is no obvious motion of charged particl

Figure 28.2*a* shows the magnetic field line piece of magnetic material.

Concepts

As we saw in Section 27.7, the ted on a current-carrying wire is netic forces exerted on many indige carriers Similarly the magnetic rent-carrying wire is the sum of the many individual moving charge car-

1d and 28.1e illustrate the magnetic inoving charged particles. Note that for

articles moving parallel to each other there is, in addition to an attractive mag-

(much larger) repulsive electric force.

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Figure 28.2a shows the magnetic field line

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might be the origin of all magn blems with this assumption, b

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res 27.13 and 27.19). Se

1P + http://nb.csail.mit.edu/?id_source=122 Hootlet News (2474) TV News TT Information transfer

Student 1 – 25 Feb, 04:55PM

Yeah, this is where I'm confused. From the first paragraph: "It takes a moving or spinning charged particle to create a magnetic field..." however there is no obvious motion of charged particles in a piece of magnetic material (bar magnet for example?). How does this reconcile?

Student 2 – 26 Feb, 08:29PM

Maybe they are trying to say that there is no OBVIOUS motion, but they are moving via a current. Therefore, it meets their definition that it takes moving ticles to create a magnetic field

Student 3 – 2 Mar, 09:00AM

I agree that the motion is not "obvious" in that it is not visible to the naked eye. The cause must be atomic.

Student 2 – 2 Mar, 11:37AM

Oh the answers to this question kind of address my question above - I guess there isn't a force if the particle is stationary, but since even when an object is stationary (thus no obvious motion), there is a magnetic force. It's when everything, including the particles, are stationary that there is no obvious motion.

Student 4 – 4 Mar, 01:05PM

Is there ever a situation in reality where everything, even the particles are not ...





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1P + Matter http://nb.csail.mit.edu/?id_ **Information**

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Student 4 – 4 M. 0. 0.

Is there ever a situation reality where everything, even the particles are not ...









2 weekly 3-hour class periods





blend of best practices





estimation

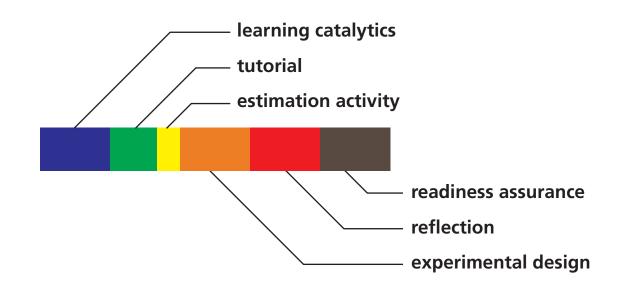
blend of best practices

reflection

tutorials

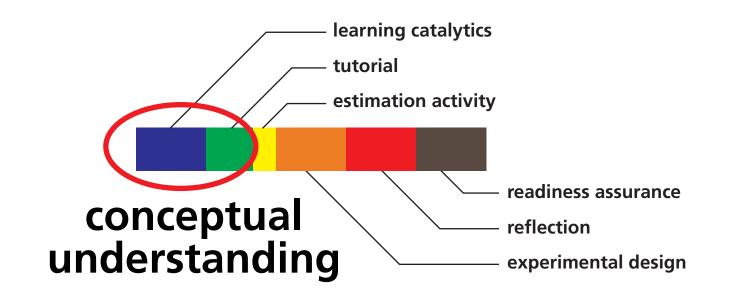






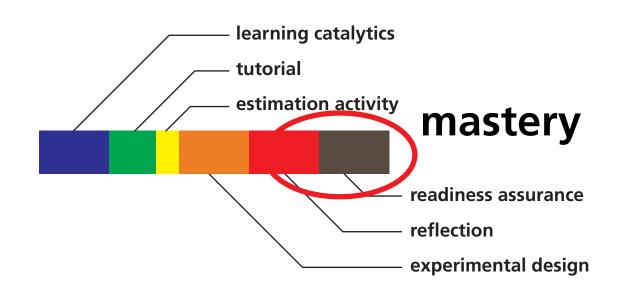








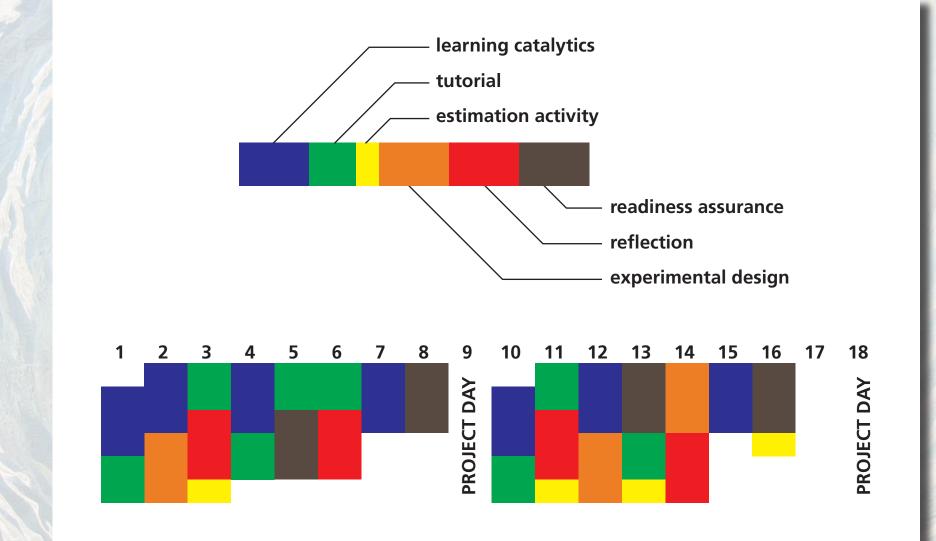








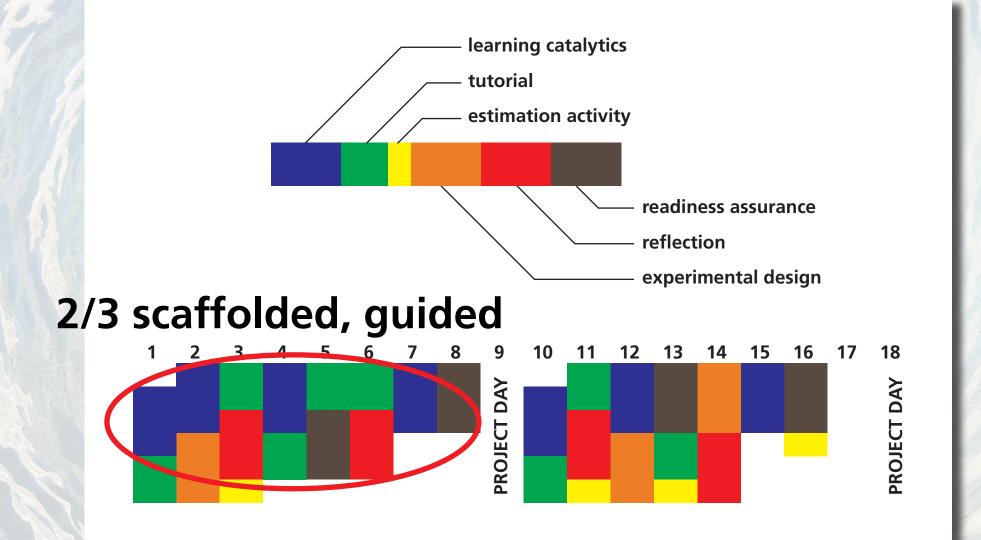
In-class activities



1 design



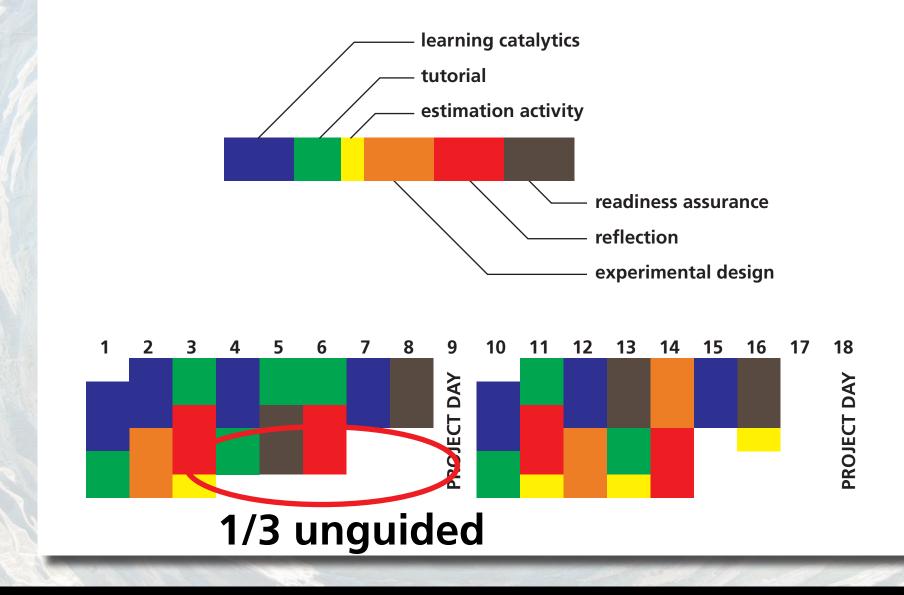
In-class activities







In-class activities



1 design



Projects



AMP



Projects

- 3 projects/semester
- each project roughly one month long
- different team formation for each project
- projects not prescriptive, but open-ended
- 3 types of project "fairs"





Projects

Fall	Spring
Rube Goldberg	Environment
Mission to Mars	Safe cracking
Musical Instrument	Energy



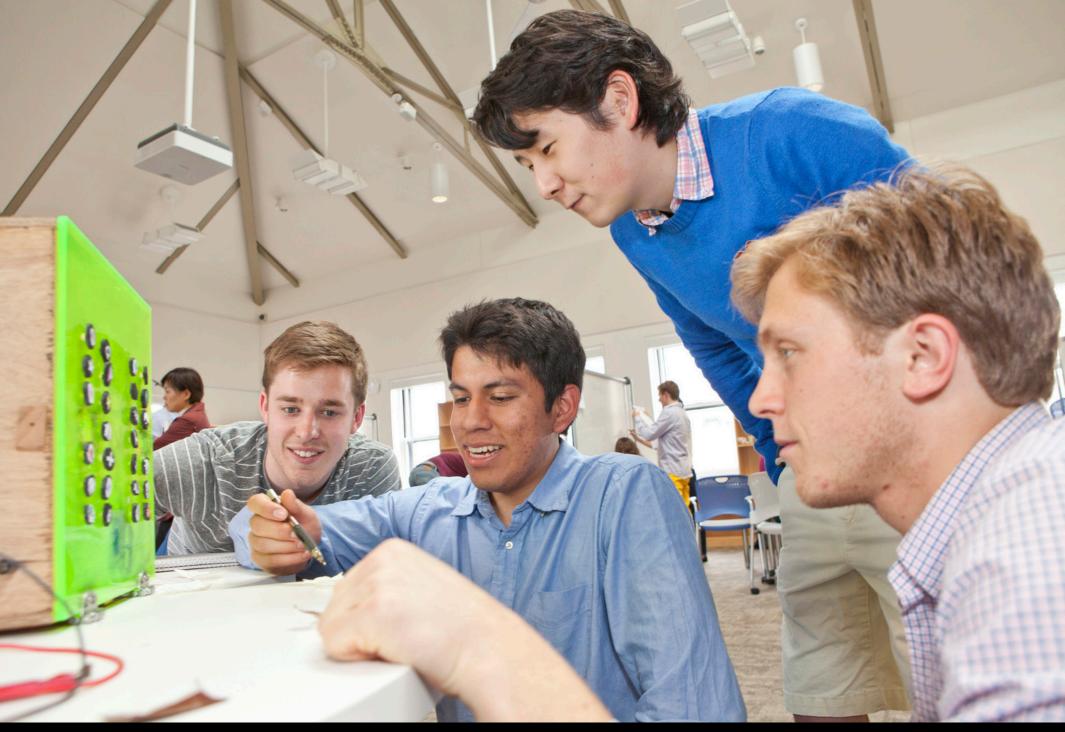


Wed Apr 10 • 2–5 pm • Pierce 301

CRACK-A-THON

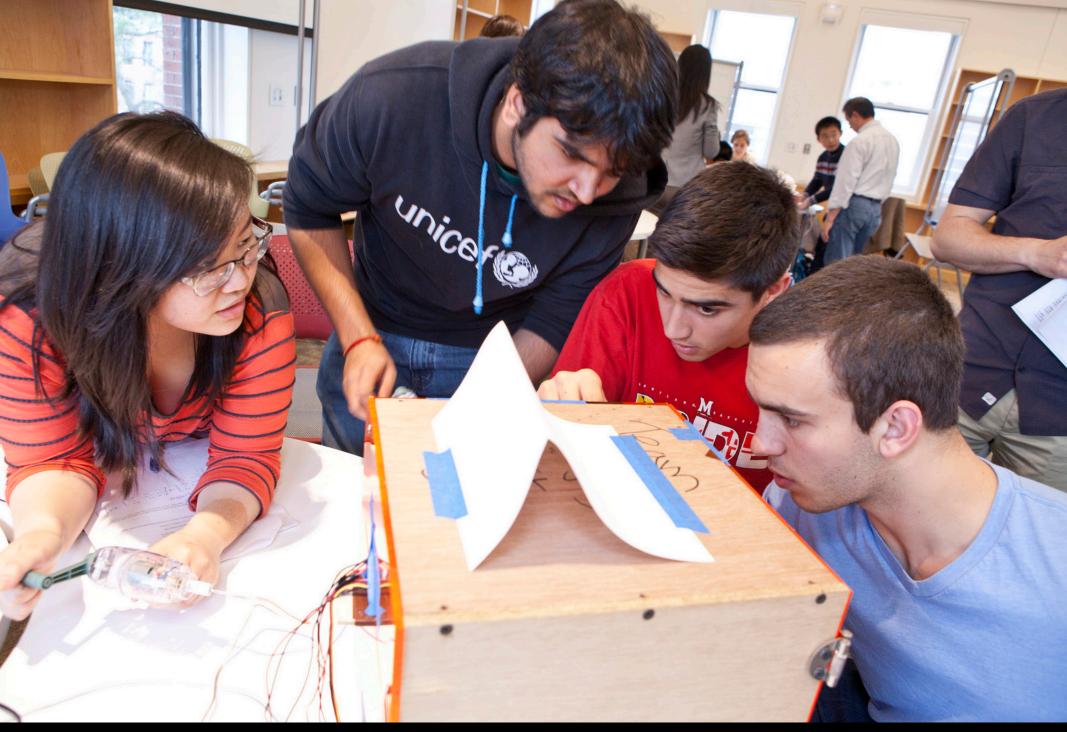






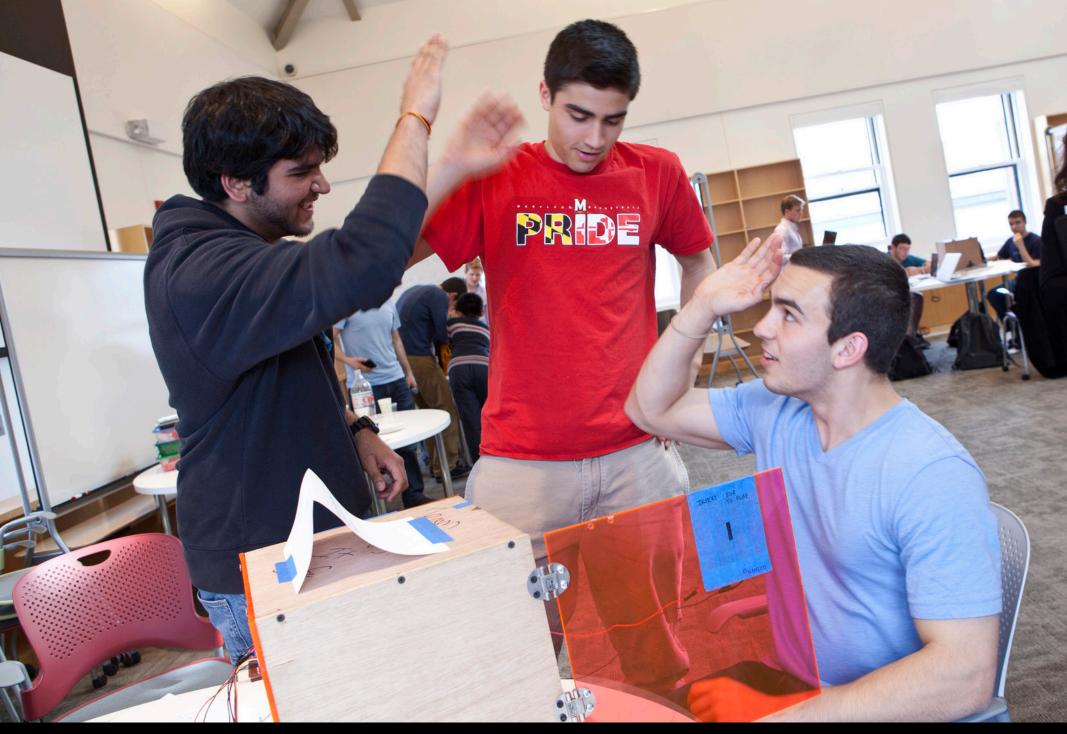
















Assessment

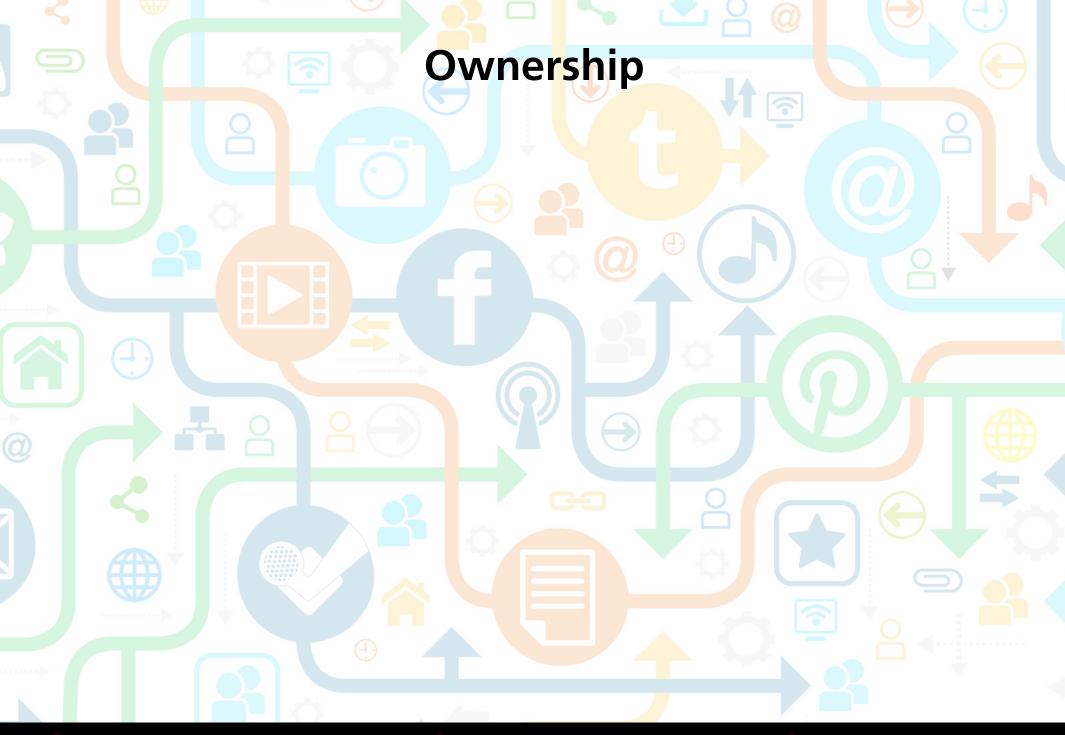
PRA

- reading quality of NB contribution
- problem solving effort & self-assessment
- readiness assurance indiv. & team scores
- projects meeting project criteria















Ownership Course evaluation: 4.2/5







"The structure of the class made what was my least-favorite subject into one of my favorites.







"The structure of the class made what was my least-favorite subject into one of my favorites. I was worried that people, including myself, would just slack off and do the bare minimum, but you really need to be on top of your readings and concepts in order to contribute to your team. GREAT CLASS!!!!!!!"







"Dear Harvard students, this class will be unlike any class you've taken at Harvard, and it will, hopefully, shift the entire foundation upon which you've based your education. I truly believe everyone should take this course; prepare to take full ownership of your learning."







Attendance: 94% (AP50a), 97% (AP50b)







Attendance: 94% (AP50a), 97% (AP50b)

3 hours and they don't leave!







<u></u>







-

NB data shows:

student spend on average 2.3 hrs/chapter

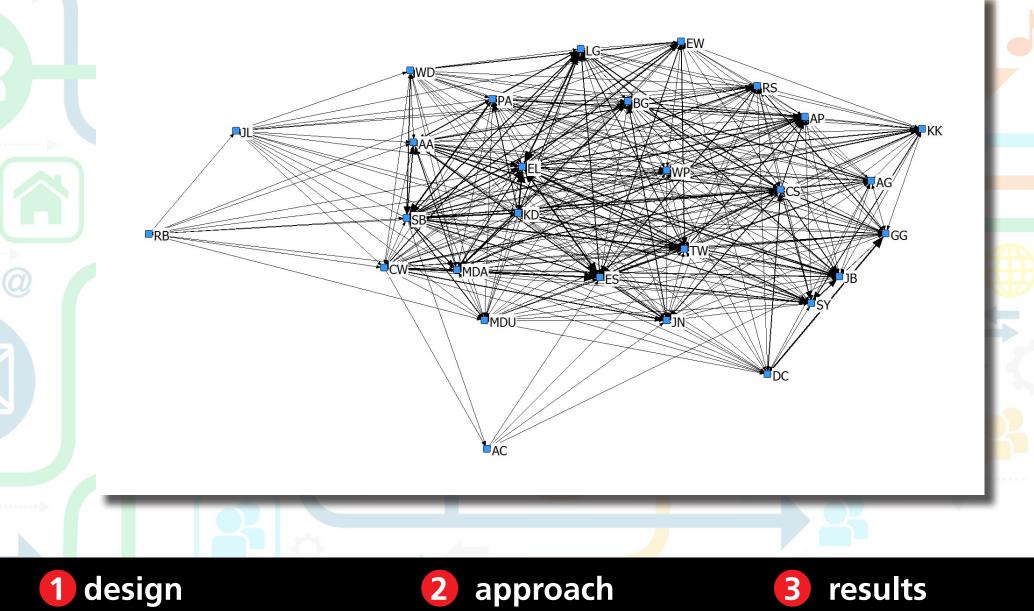
160–230 annotations/chapter (5–7/stu)







-



"I think I am having a little too much fun annotating in the text... ③ It is a great way to communicate throughout the class!"







Content mastery

- FCI normalized gain 0.56
- Problem solving ability on par or better















Can create ownership of learning physics!







"you come out with so much know-

ledge and experience and fun"





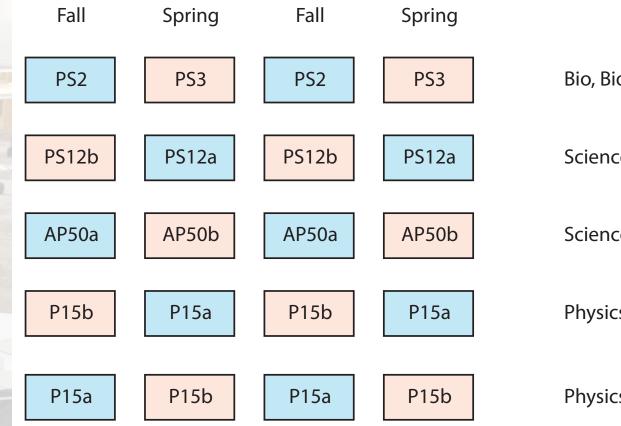


where does AP50 fit?









Bio, BioChem (premed) concentrators

Science and engineering (pre)concentrators

Science and engineering (pre) concentrtors

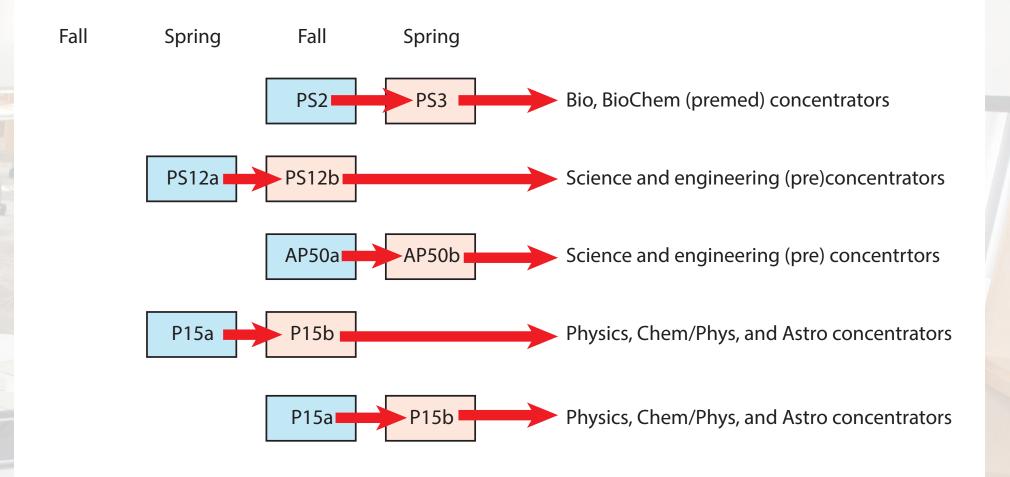
Physics, Chem/Phys, and Astro concentrators

Physics, Chem/Phys, and Astro concentrators





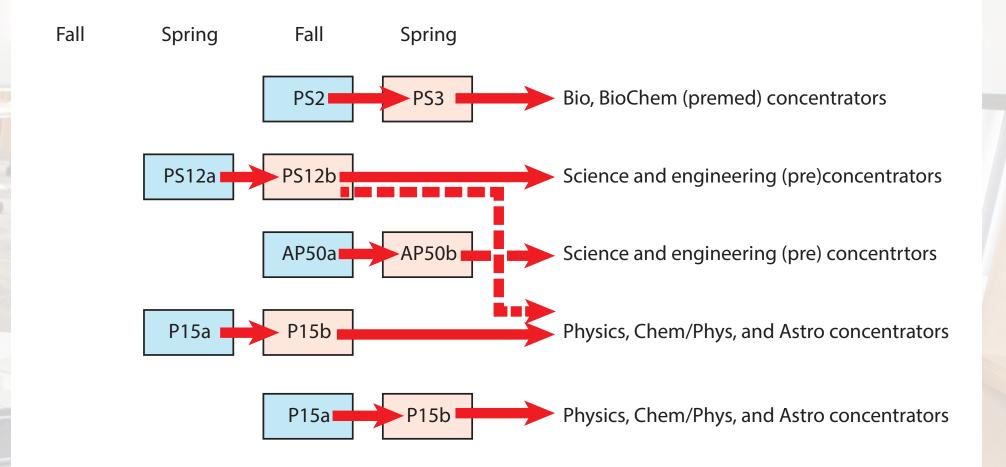








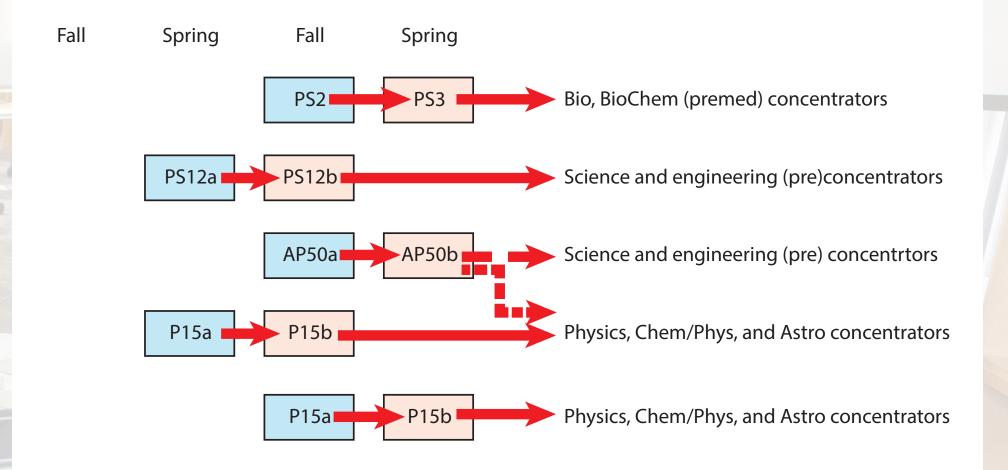


















some food for thought

- should AP50 be listed on physics page?
- do we offer too many tracks?
- is AP50 okay for physics concentrators?







Some points in closing

- UMich implementation
- SEAS documentary
- Come visit!







for a copy of this presentation:

mazur.harvard.edu







