Flat space, deep learning

NES APS Spring Meeting
Boston University
Boston, MA, 24 April 2015

Flat space, deep learning

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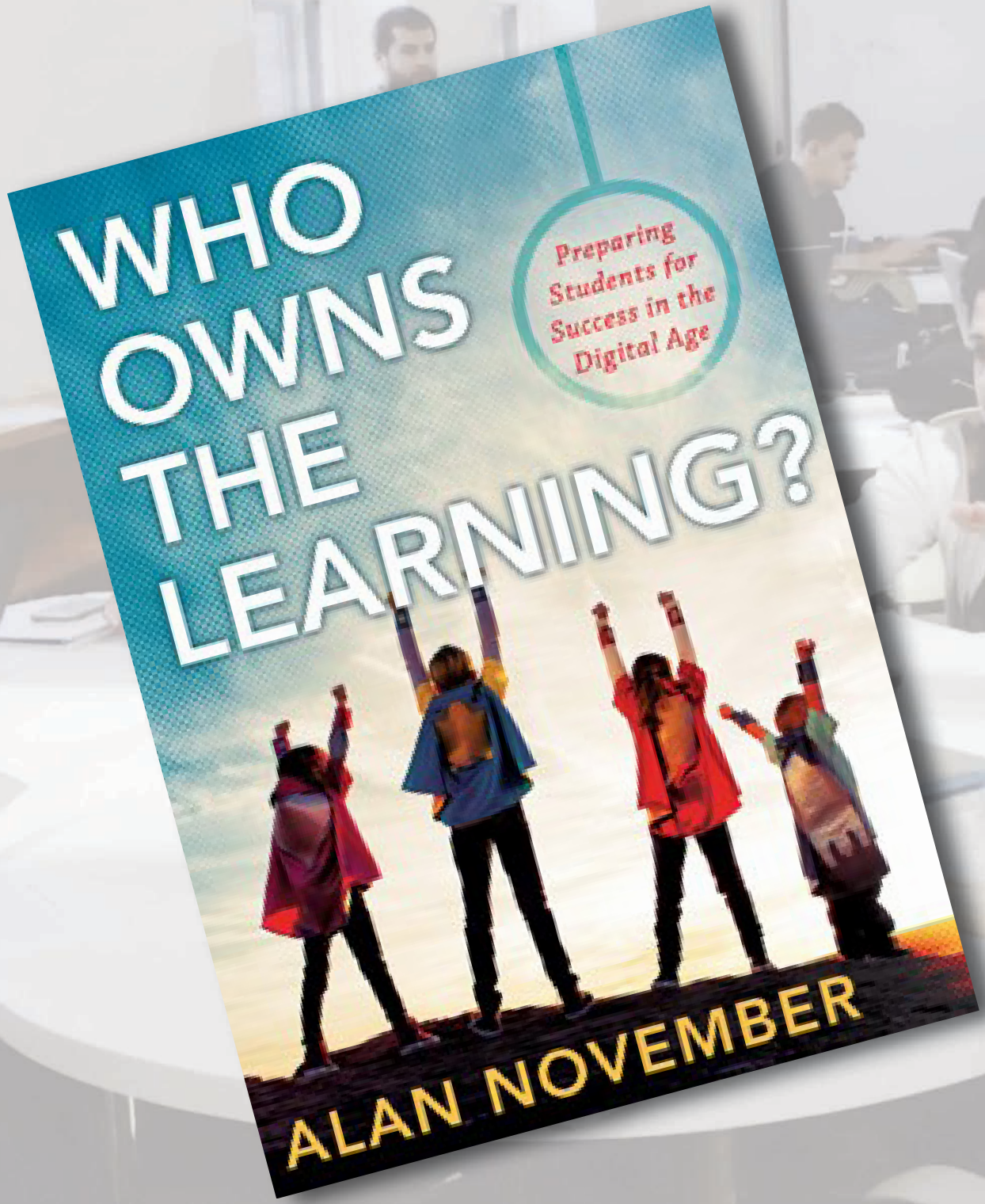
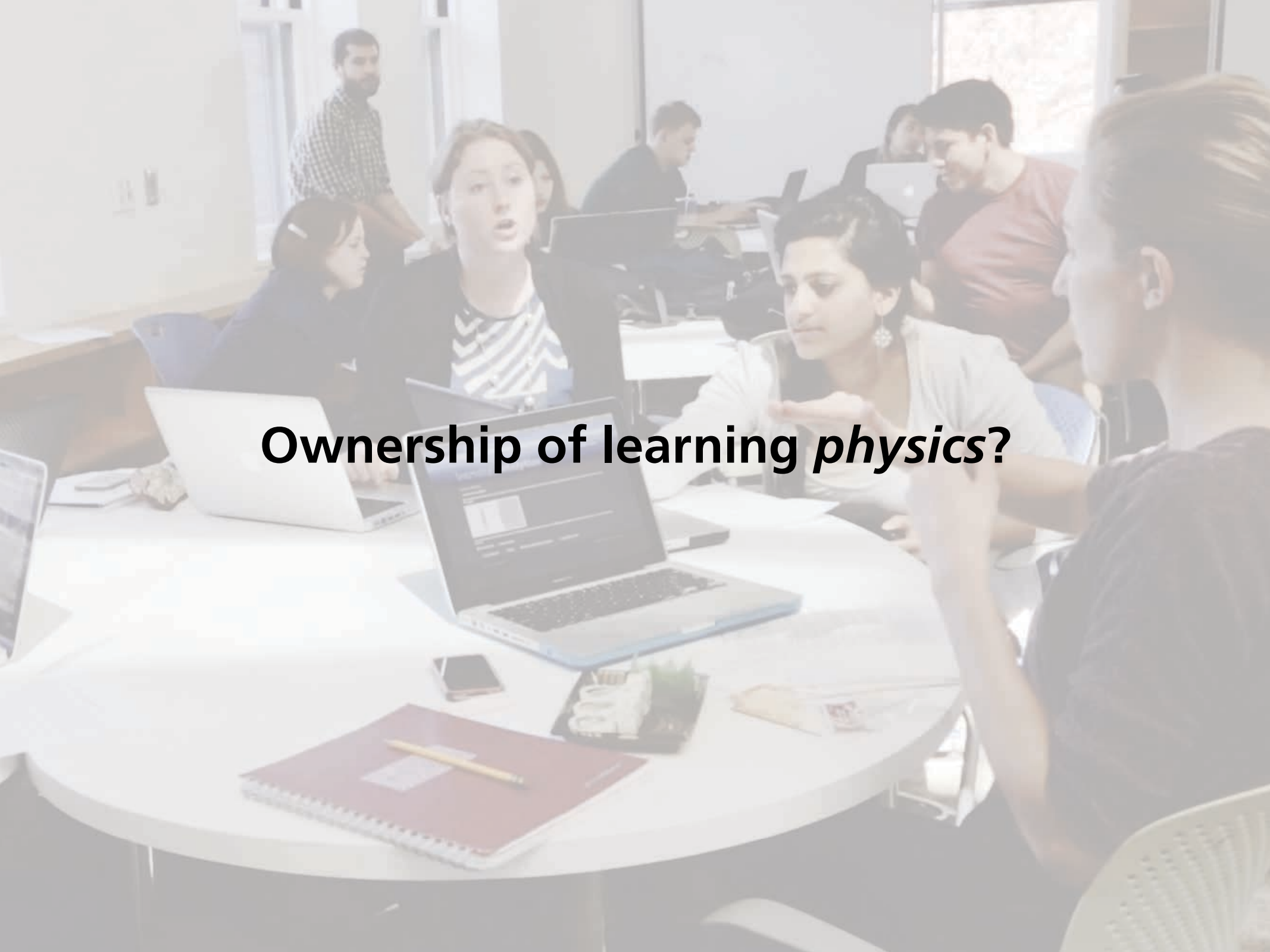
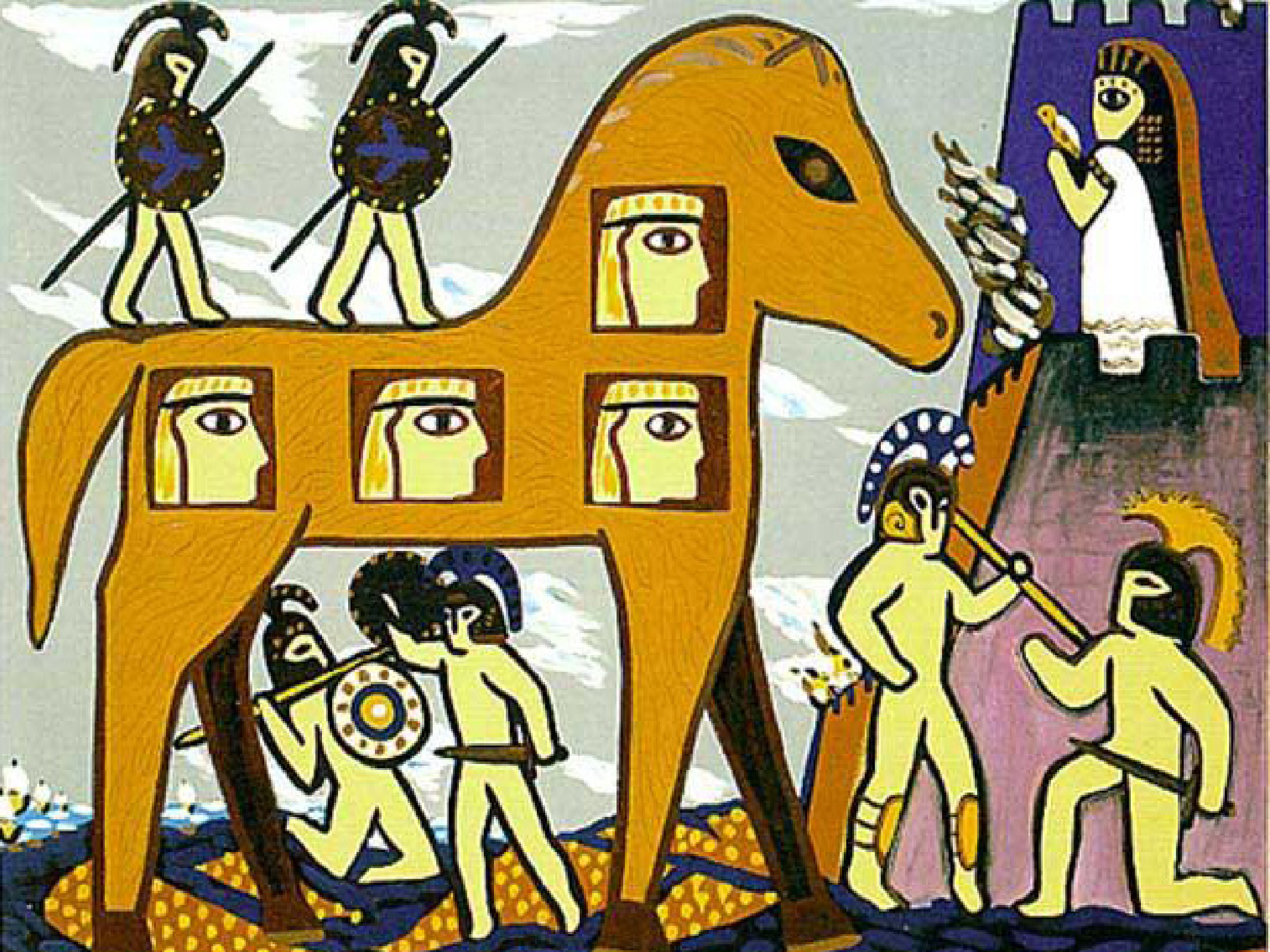
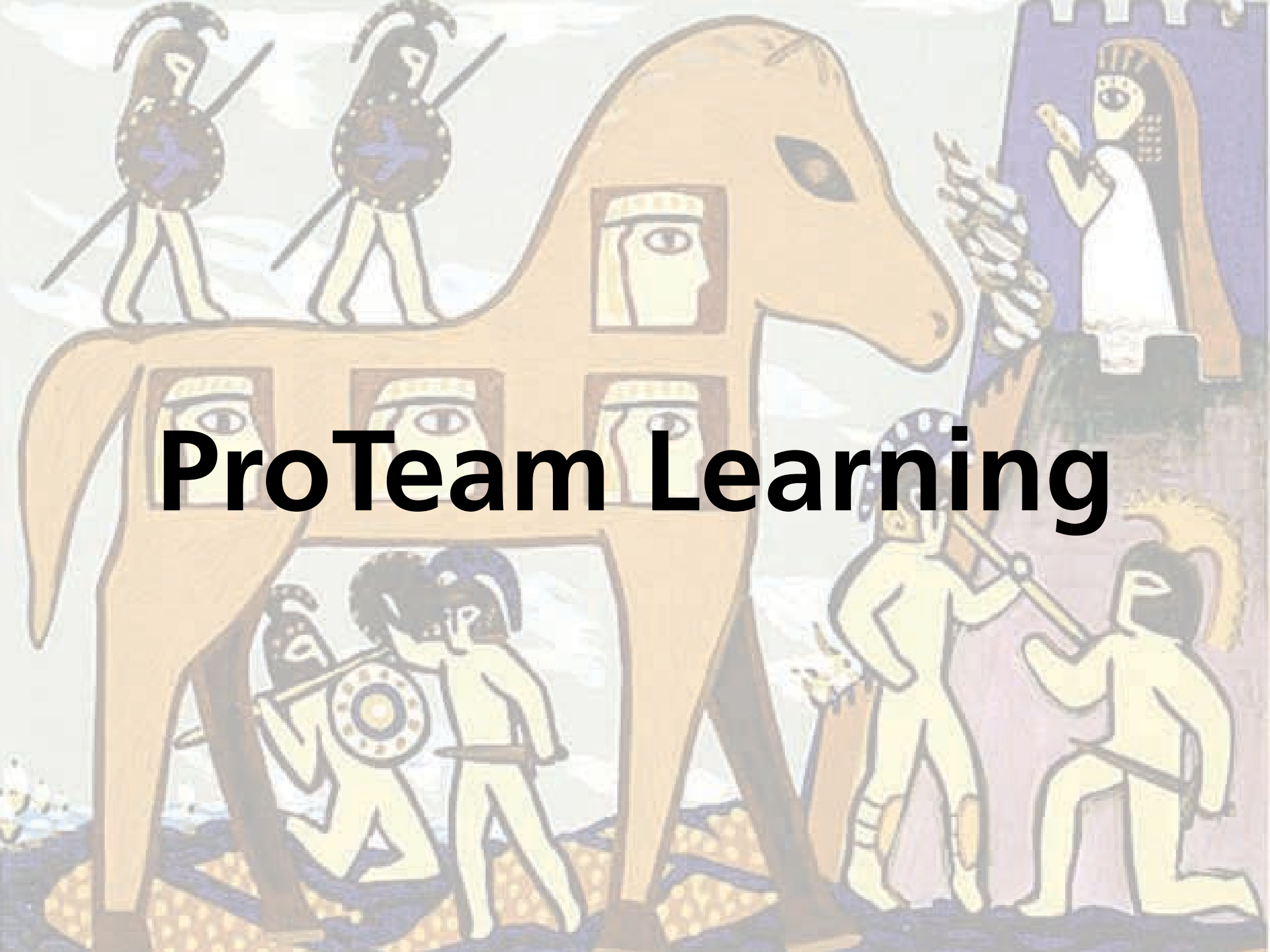

WHO OWNS THE LEARNING?
Preparing Students for Success in the Digital Age
ALAN NOVEMBER



Ownership of learning *physics*?



team & project-based approach



ProTeam Learning

1 design

1 design

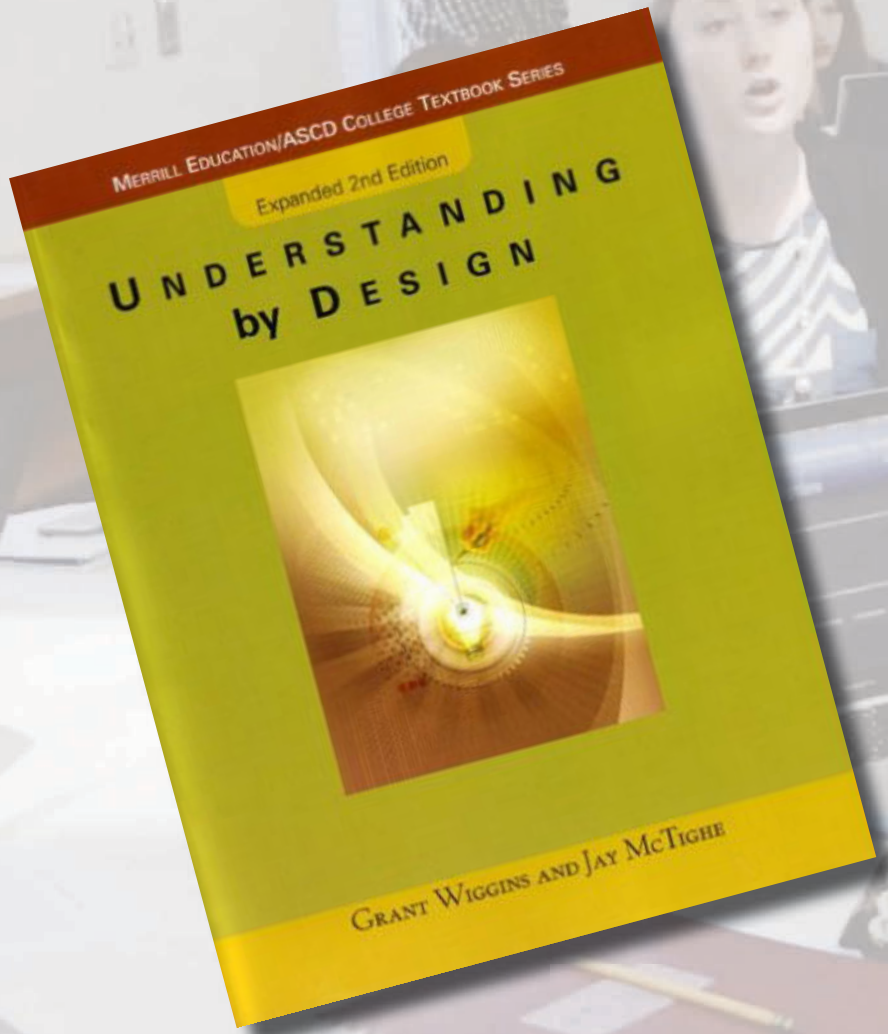
2 approach

1 design

2 approach

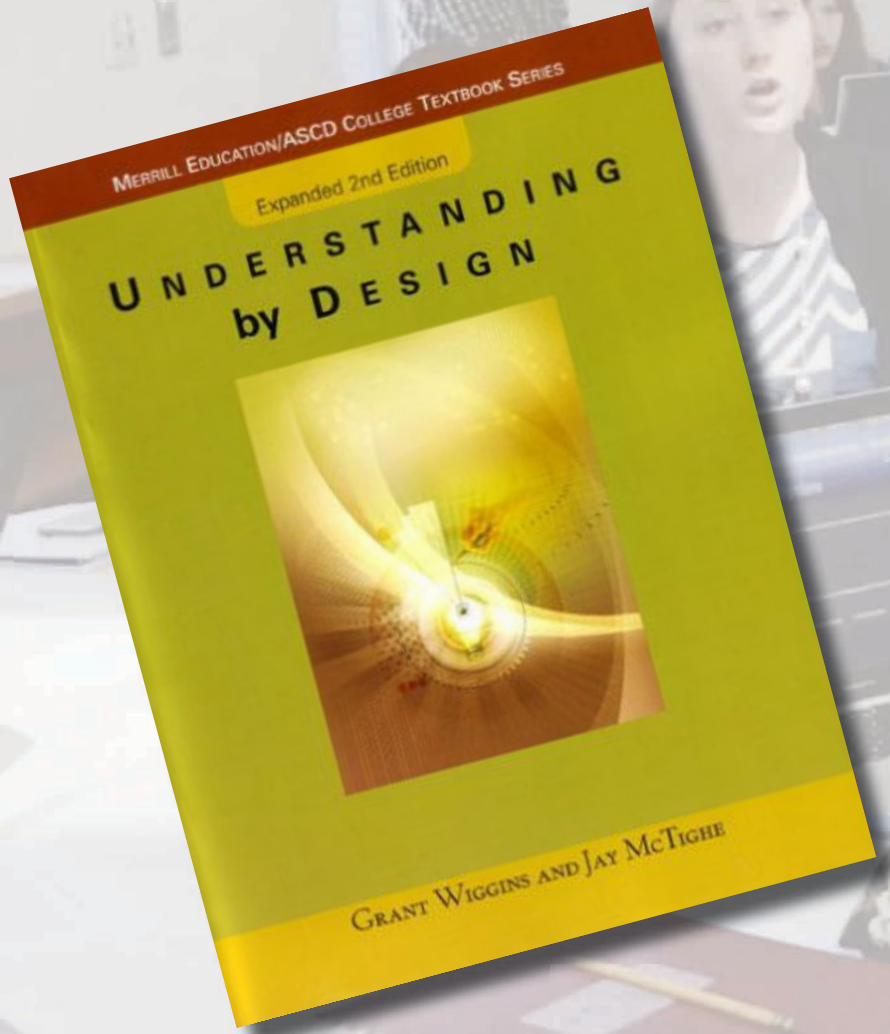
3 results

Setting learning goals



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

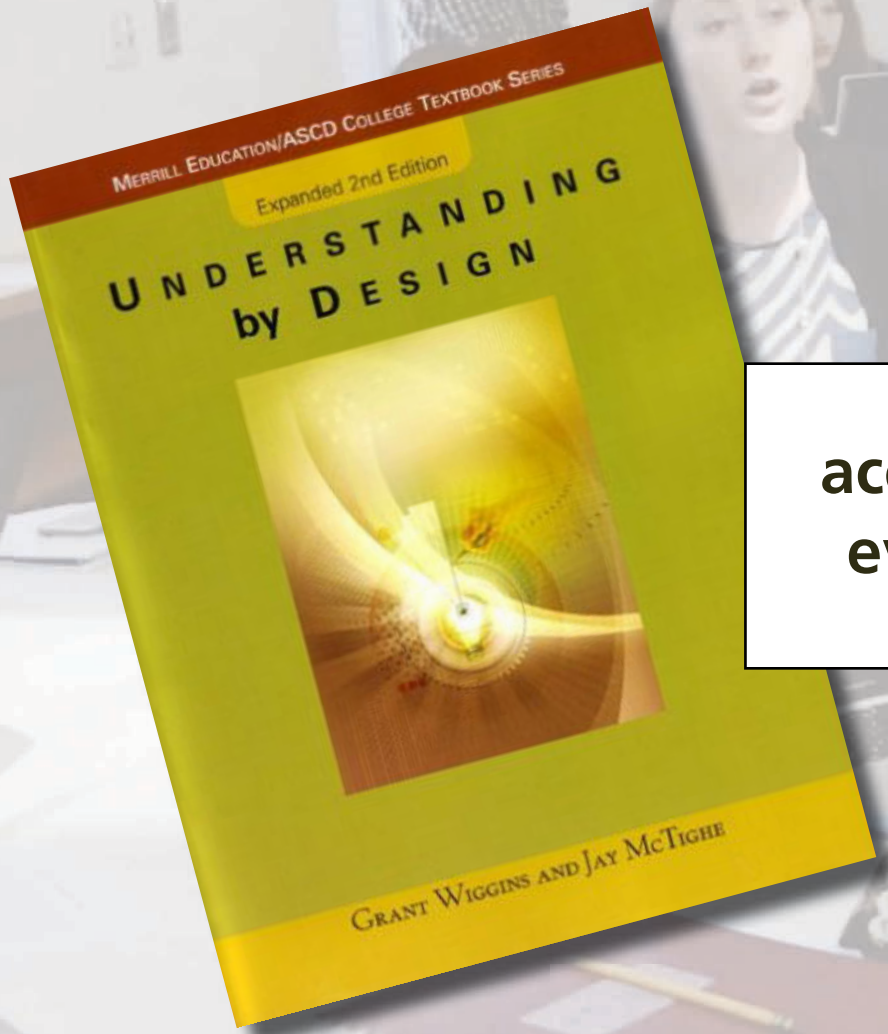
Backward design



desired outcomes

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

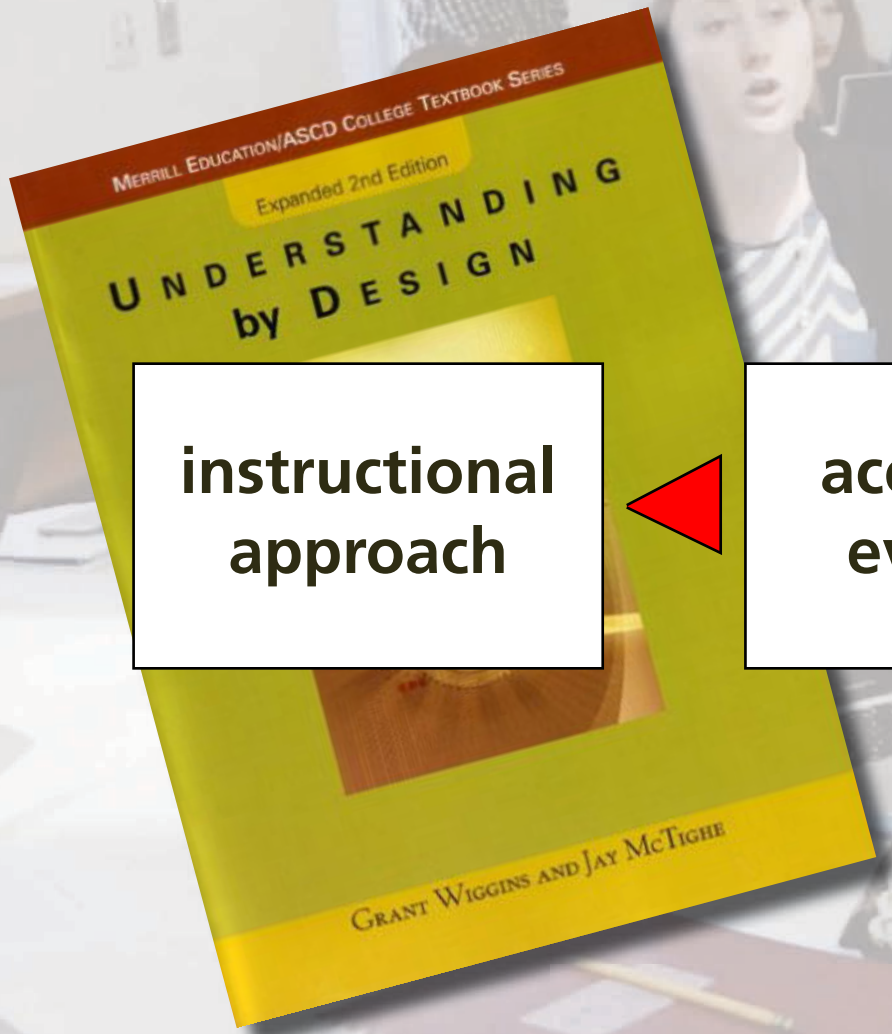
Backward design



acceptable evidence ◀ desired outcomes

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

Backward design



instructional approach ◀ **acceptable evidence** ◀ **desired outcomes**

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

competencies

course goals

COURSE GOALS

After successful completion of this course, you will be able to… (wit

- Use independent study and research to tackle a problem
- Apply the scientific method to advance your knowledge and to desi
- Use a variety of techniques to get a handle on problems: repres
  perform order of magnitude estimates, use dimensional analysi
  symmetries, evaluate units and/or relate the problem to cases v
- Set up, solve, and interpret relevant equations
- Know how to evaluate the correctness of a solution
- Explain assumptions made in a model and know how to justify
- Analyze a system, explain why it works, and how to optimize
- Use information to build a case for a specific design or measu
- Describe how a measurement is performed and the limitatio
- software to control simple experiments and accumulat
  identify sources of uncertainty, and minimiz
  easurement in order to develo
  rts and presentati

content-specific goals

1 design

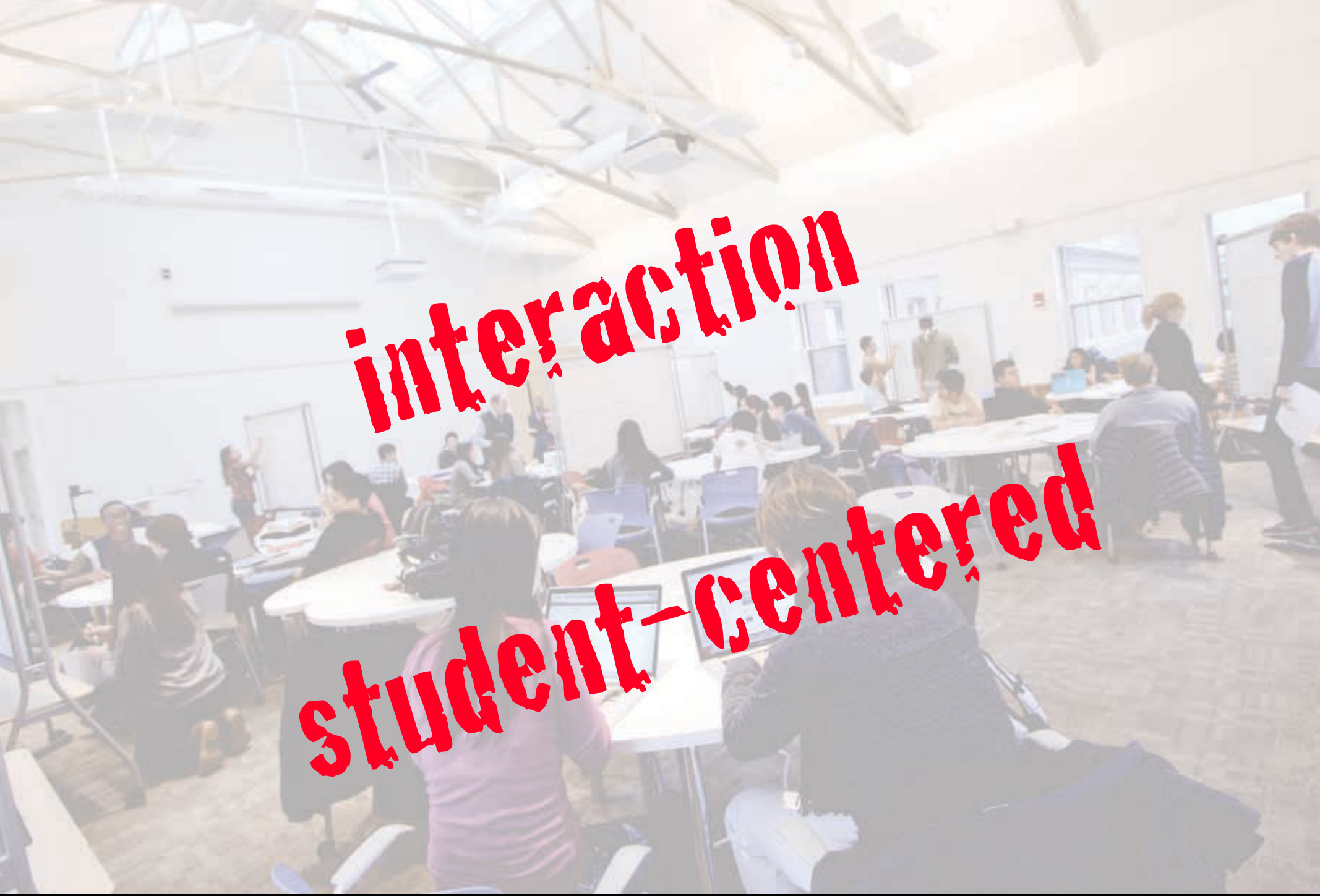
http://bit.ly/ap50visitor

1 design

1 design

1 design

1 design



1 design

1 design

2 approach

1 design

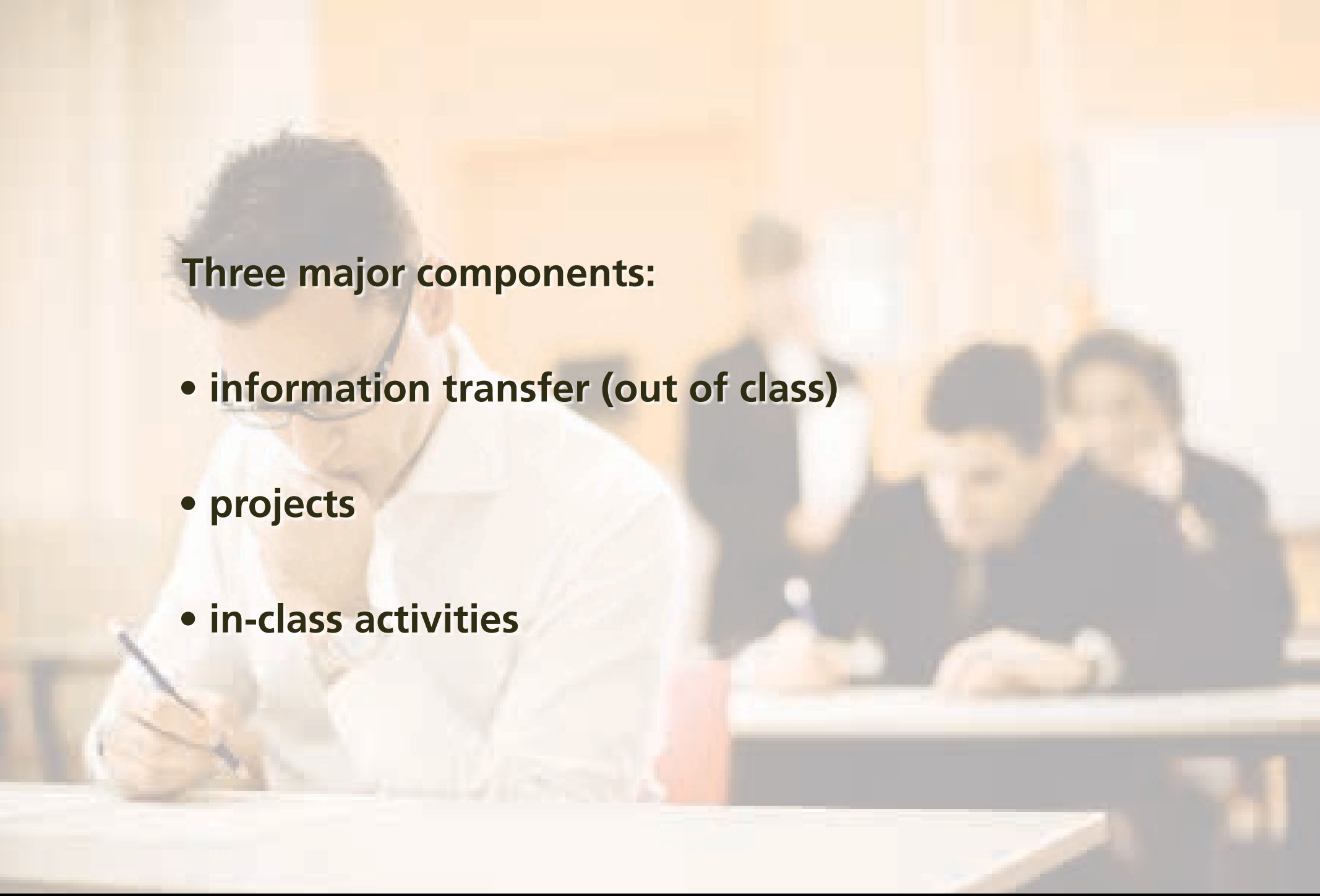
2 approach

1 design

2 approach

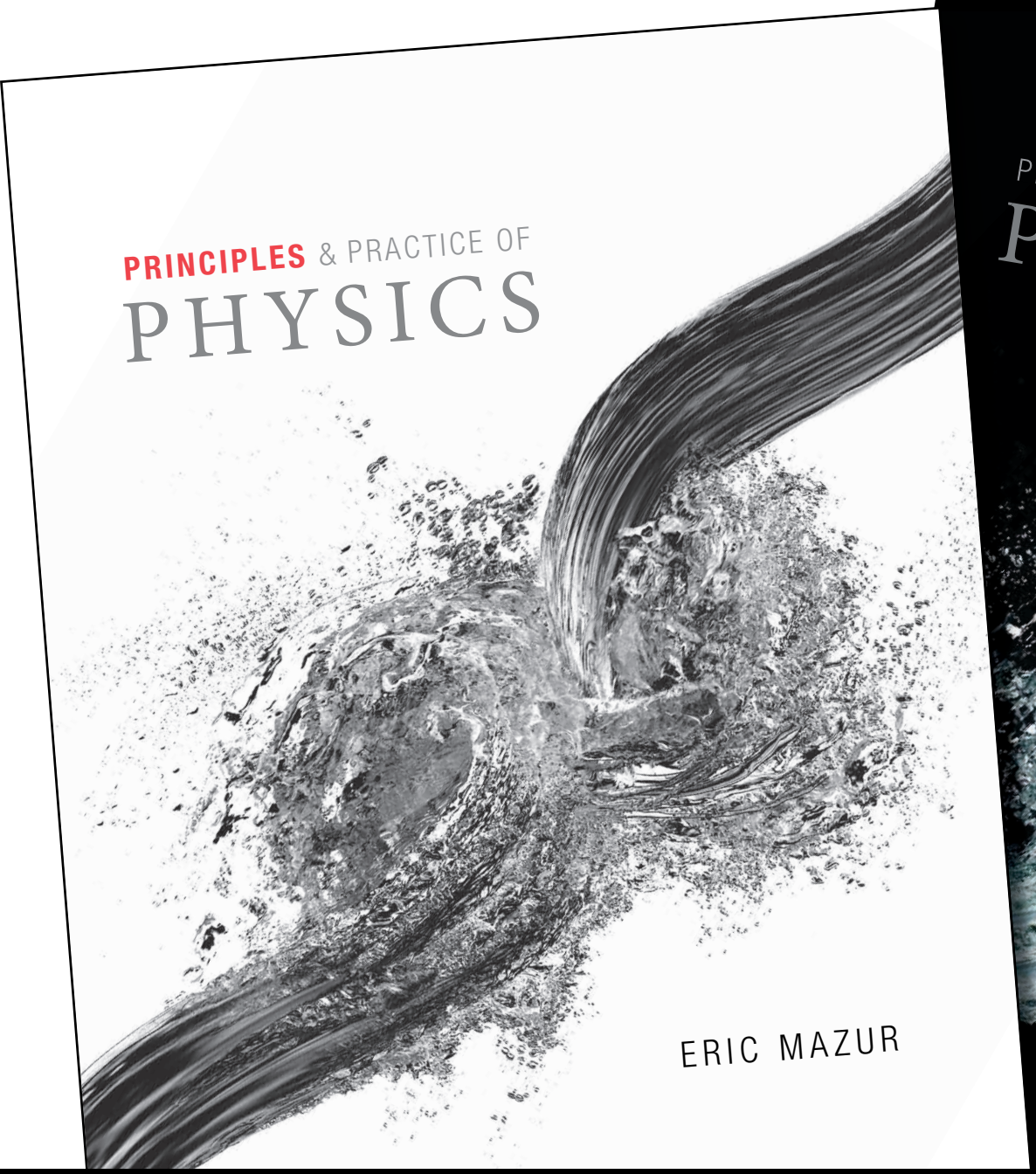
1 design

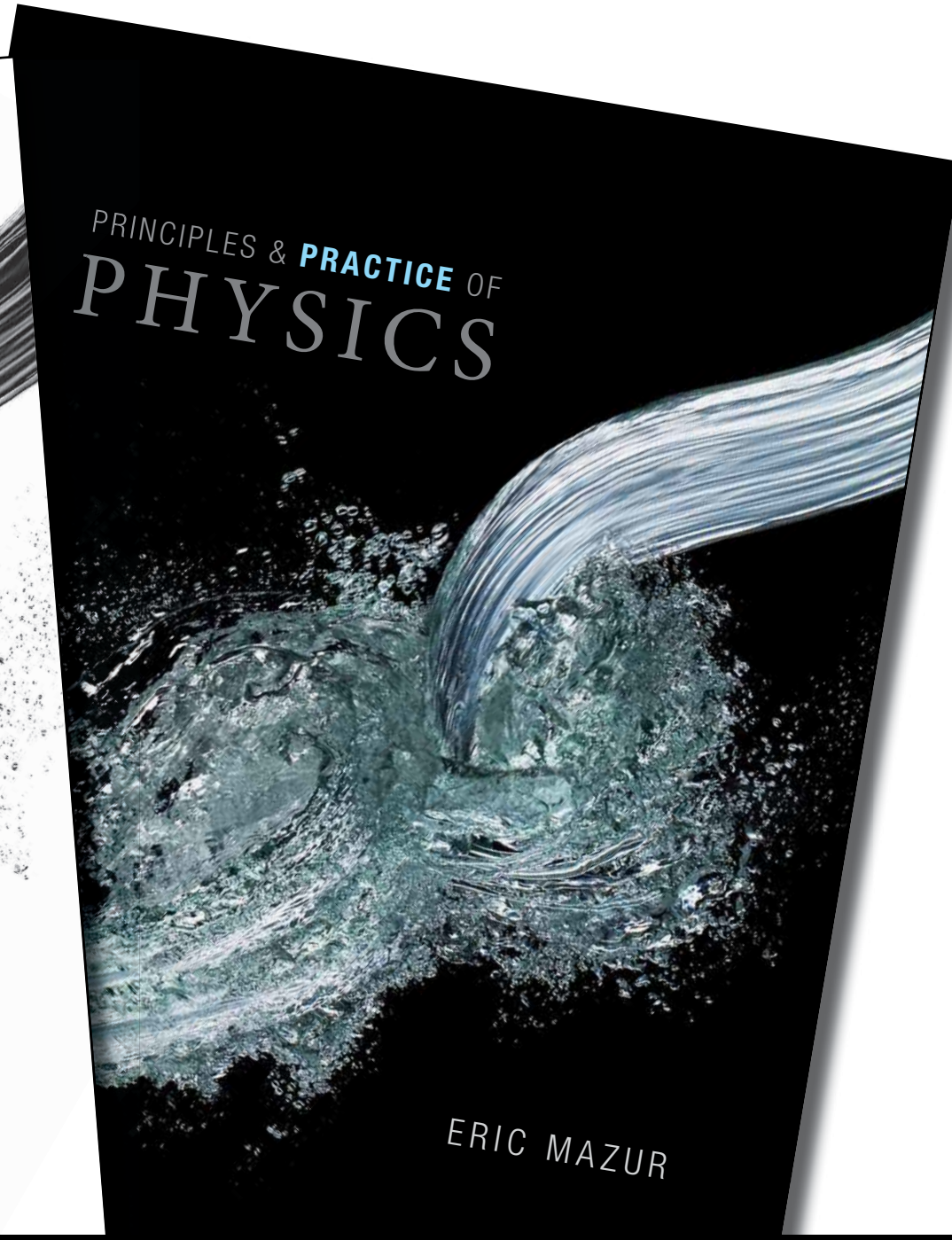
2 approach



Three major components:

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



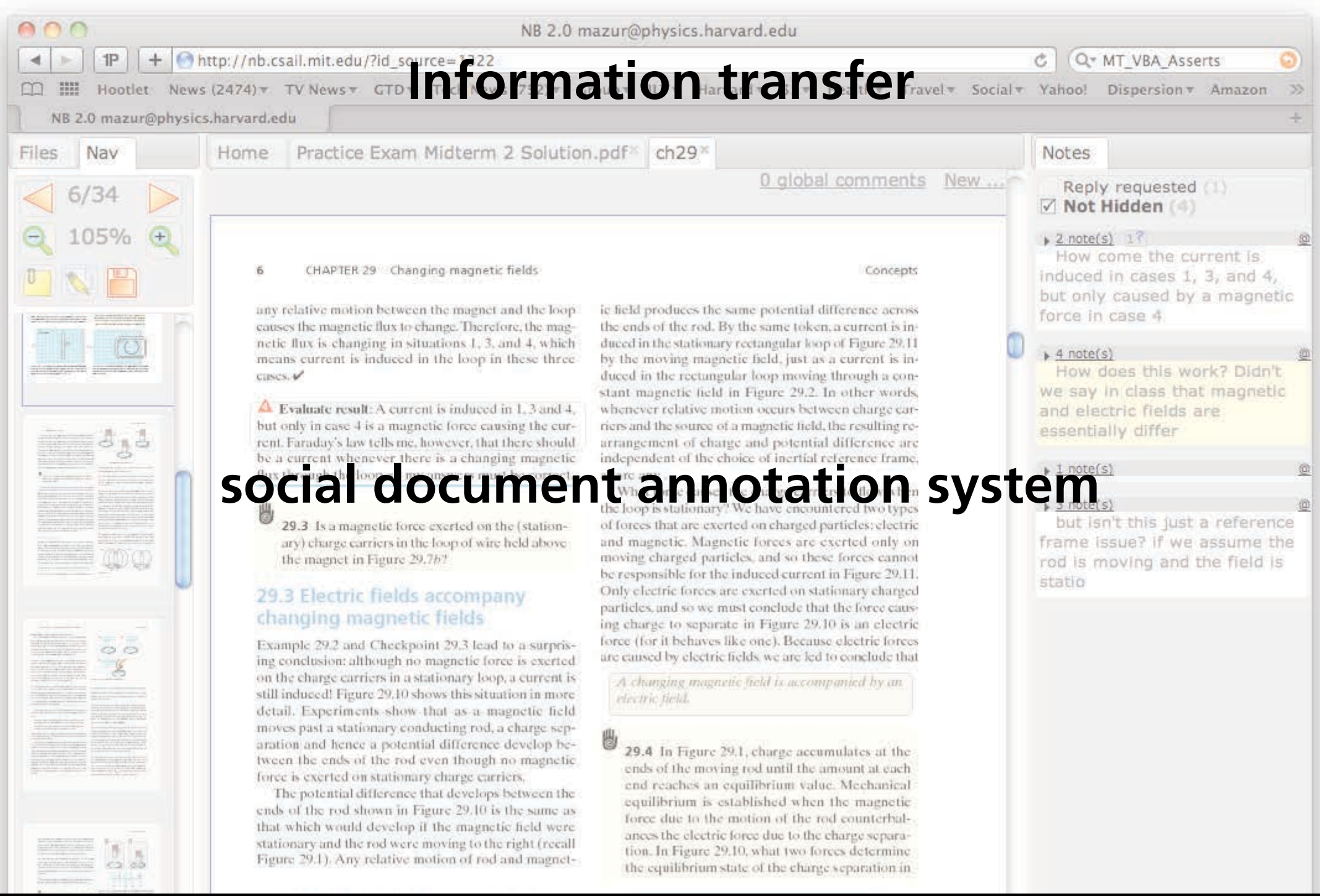


1 design

2 approach

Information transfer

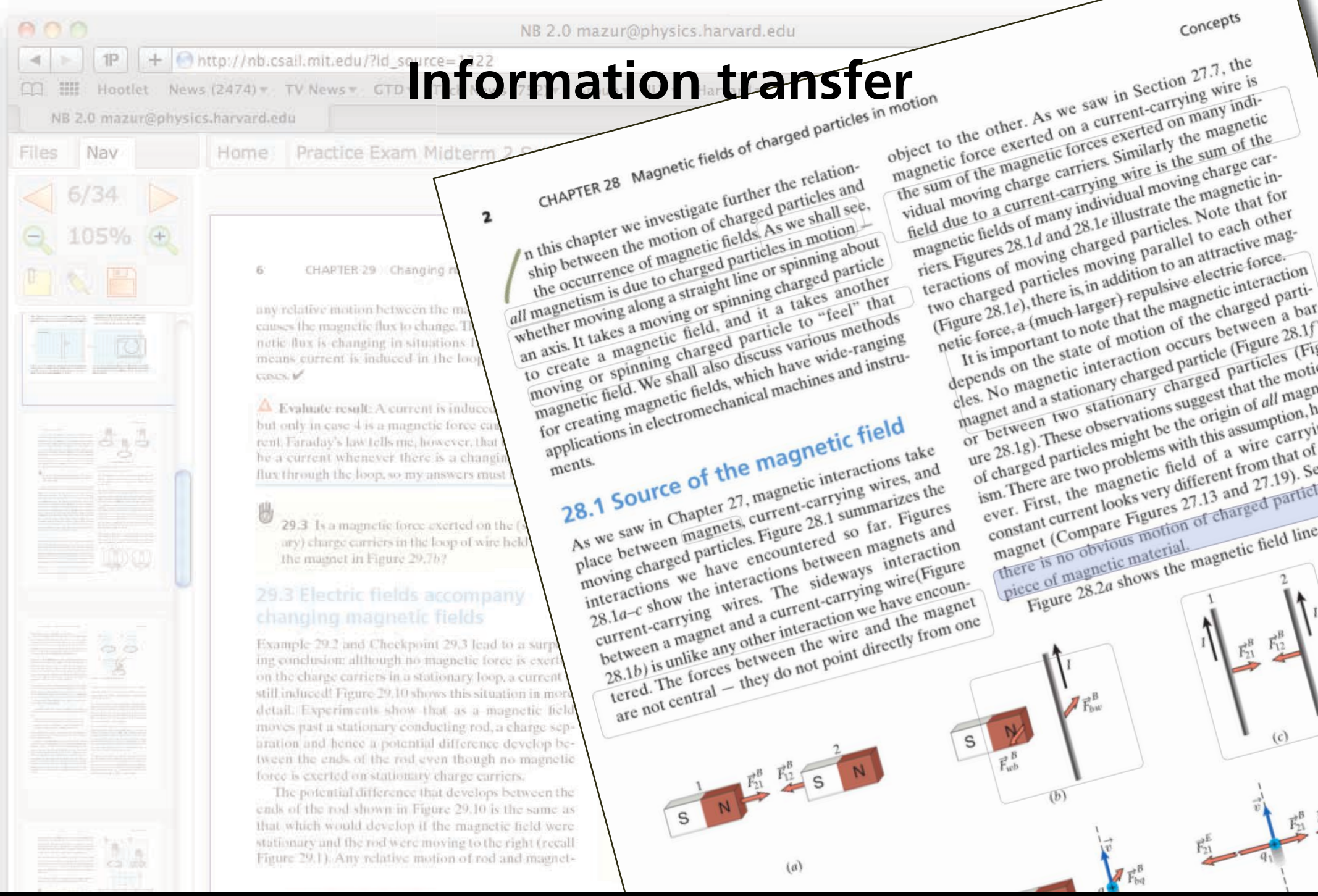
social document annotation system



1 design

2 approach

Information transfer



1 design

2 approach

Information transfer

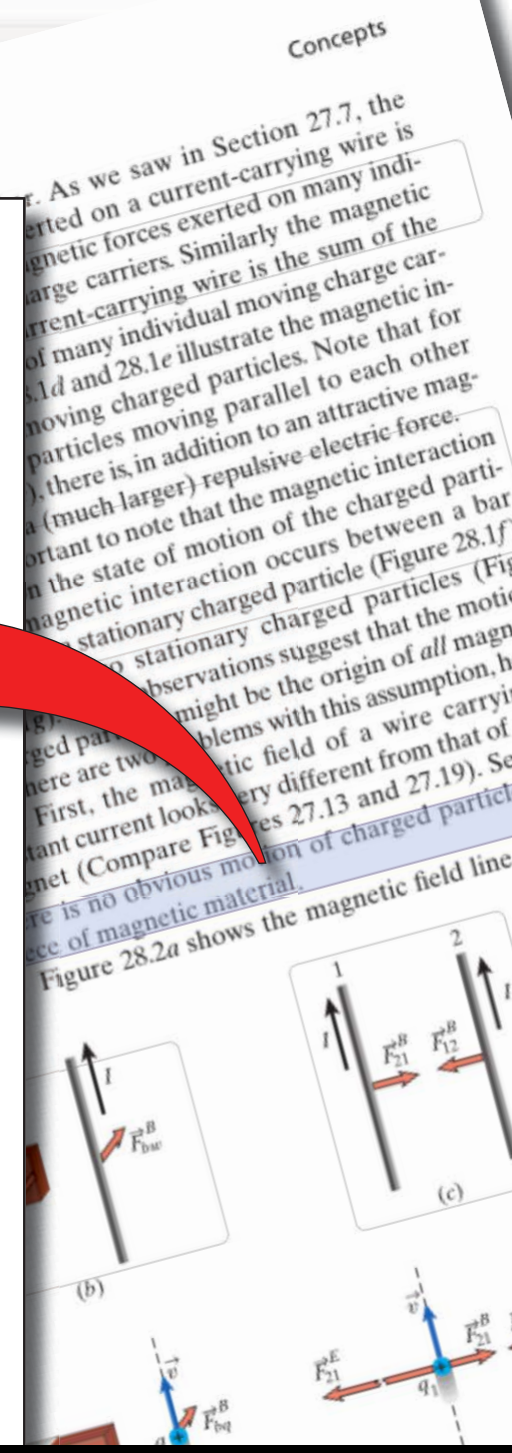
Student 1 – 25 Feb, 04:55PM
Yeah, this is where I'm confused. From the first paragraph: "It takes a moving or spinning charged particle to create a magnetic field..." however there is no obvious motion of charged particles in a piece of magnetic material (bar magnet for example?). How does this reconcile?

Student 2 – 26 Feb, 08:29PM
Maybe they are trying to say that there is no OBVIOUS motion, but they are i
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 ...



1 design 2 approach

Information transfer

Student 1 – 25 Feb, 04:55PM
Yeah, this is where I'm confused. From the first paragraph: "It takes a [illegible] or spinning charged particle to create a magnetic field." [illegible] there is [illegible] motion of charged particles in a piece of magnetic [illegible] (the magnet [illegible] ple?). How does this reconcile?

Student 2 – 26 Feb, [illegible]
Maybe the [illegible] that there is no O[illegible] motion, but they are in fact m[illegible] ent. [illegible]erefore, [illegible] meets their definition that it takes [illegible] ing par[illegible] t[illegible] eat [illegible] magne[illegible] d

Student 3 – 2 Mar, 09:00AM
I agree that the motion is not "obvious" in tha[illegible] no[illegible] visibl[illegible] to t[illegible] make [illegible]ve. [illegible] cause must be atomic.

Student 2 – 2 M[illegible] 37A[illegible]M
Oh the[illegible]ers to th[illegible]ues[illegible]on[illegible] d [illegible] ess n[illegible]estion above - I guess there isn't a force i[illegible] the [illegible] is [illegible]ary, but since even when an object is stationary (thus no [illegible] s m[illegible]tio[illegible] th[illegible] is a magnetic force. It's when everything, including the part[illegible]s, [illegible]st[illegible]nary 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 ...

over 20,000 annotations!

1 design

2 approach

Information transfer

AP50 Spring 2015

Annotation Rubric

Your annotations of the textbook on NB will be evaluated on the basis of quality, quantity, and timeliness, as shown below. Your goal in annotating each chapter is to demonstrate *timely and thoughtful reading of the text*. When we look at your annotations we want them to reflect the effort you put in your study of the text. It is unlikely that that effort will be reflected by just a few annotations per chapter, unless your annotations are unusually thoughtful and stimulate a deep discussion. About 7–20 *thoughtful* annotations per chapter spread out over the chapter is about right, but keep in mind that quality is more important than quantity!

About 4 days after the deadline of the last chapter in each unit, we will provide an overall assessment of your annotations in that unit using the usual three-point scale (0–3), by combining your annotation scores for the three categories.

Quality The textbook replaces the lectures (us reading the textbook to you) so that we can do more interesting things in class. Therefore it is important you read the text thoughtfully and attempt to lay the foundation for the work in class.

2 = Demonstrates thorough and thoughtful reading AND insightful interpretation of the chapter
1 = Demonstrates reading, but no (or only superficial) interpretation of the chapter
0 = Does not demonstrate any thoughtful reading of the chapter

See the examples on the next page to see the quality criterion applied to sample annotations.

Quantity To lay the foundation for understanding the in-class activities, you must at least familiarize yourself with the entire chapter — not just the first few pages.

2 = 7–20 thoughtful annotations that cover each section of the chapter
1 = 7–20 thoughtful annotations, but not each section is annotated
0 = 6 or fewer annotations

Timeliness The work done in class depends on you having done the reading in advance, so completing the reading on schedule is important. Your annotations can be questions, comments, or responses to existing questions or comments. Responses are allowed up to three days beyond the posted deadline.

1 design

2 approach

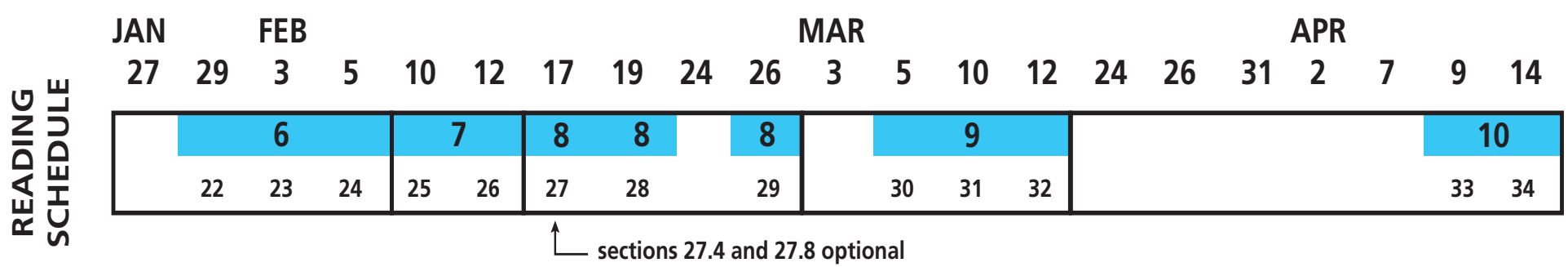
Information transfer

Annotation rubric

- Quality (must be thoughtful)
- Quantity (7–20 thoughtful & distributed)
- Timeliness

1 design 2 approach

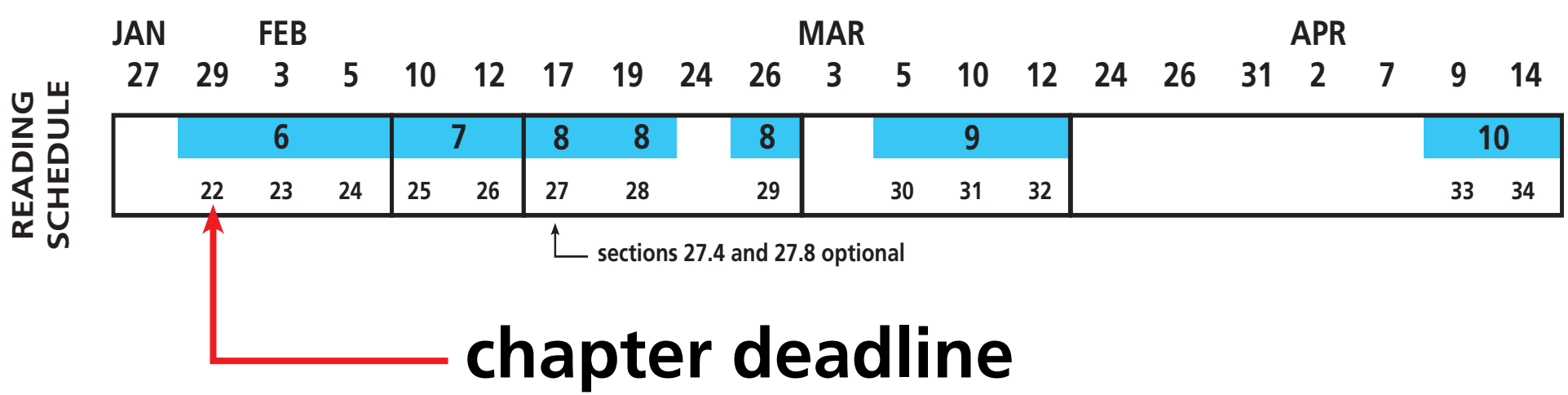
Information transfer



1 design

2 approach

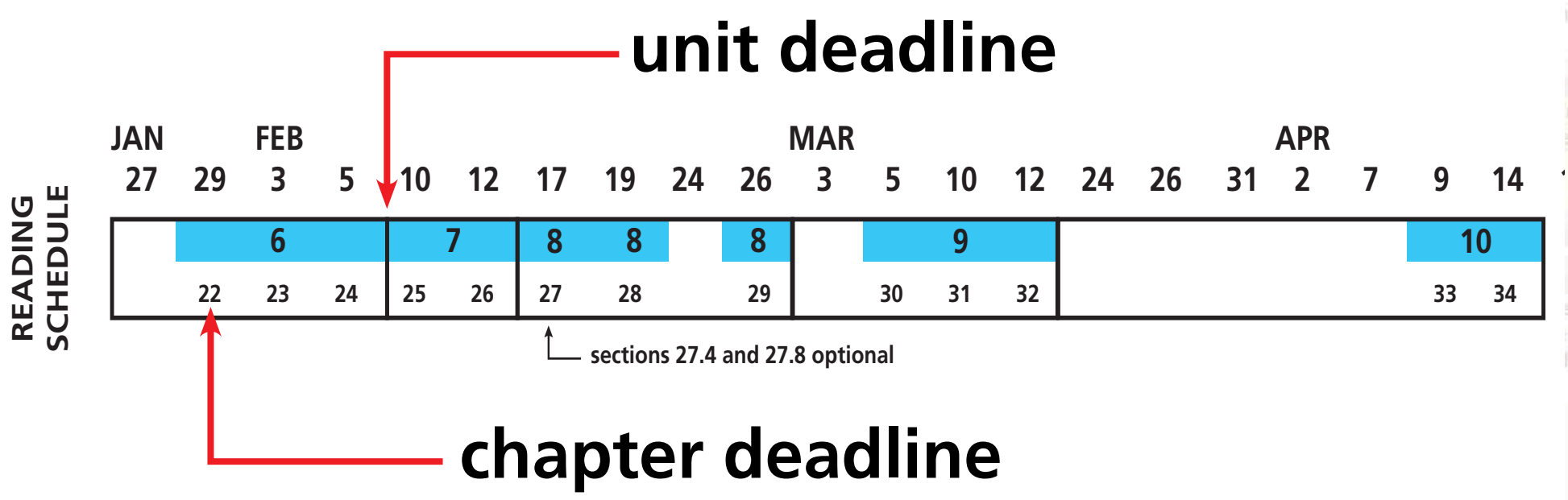
Information transfer



1 design

2 approach

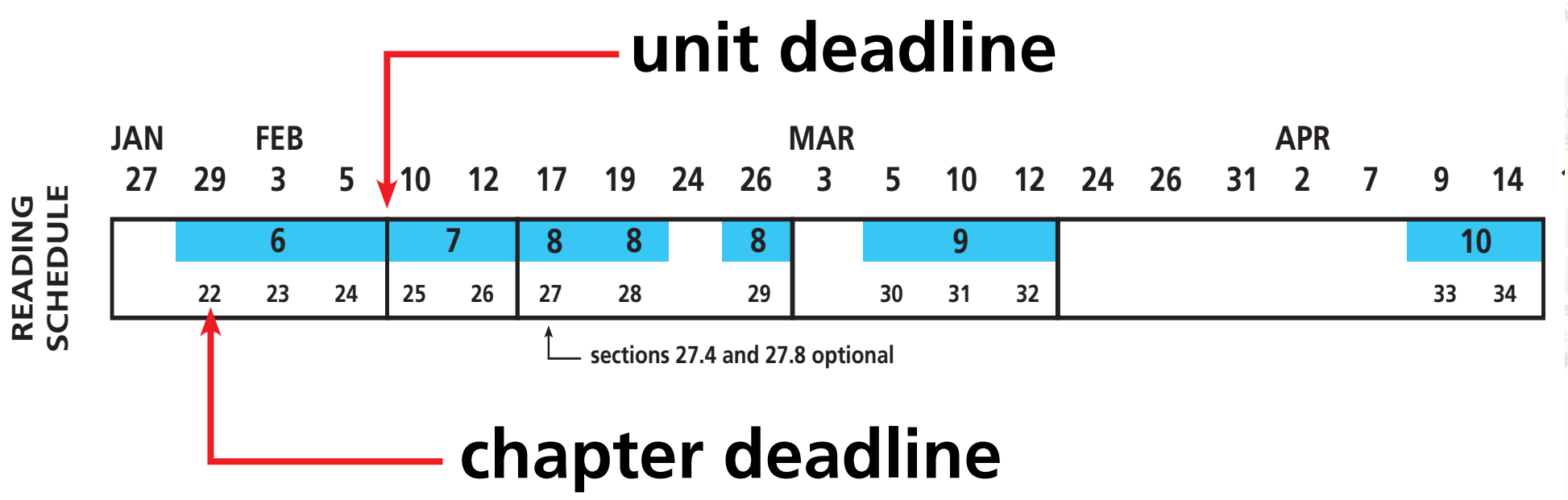
Information transfer



1 design

2 approach

Information transfer

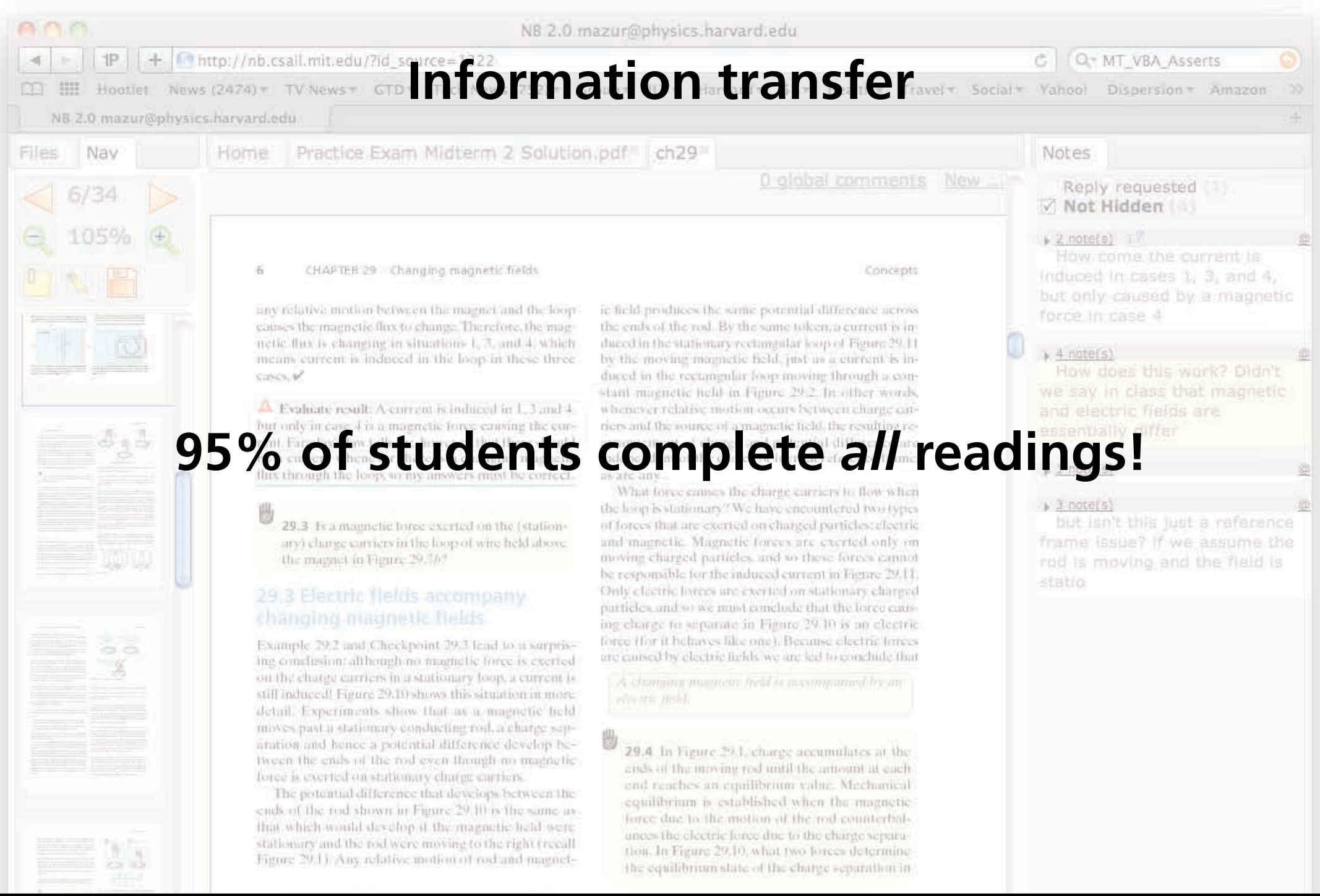


three extra days for answers to questions

1 design 2 approach

Information transfer

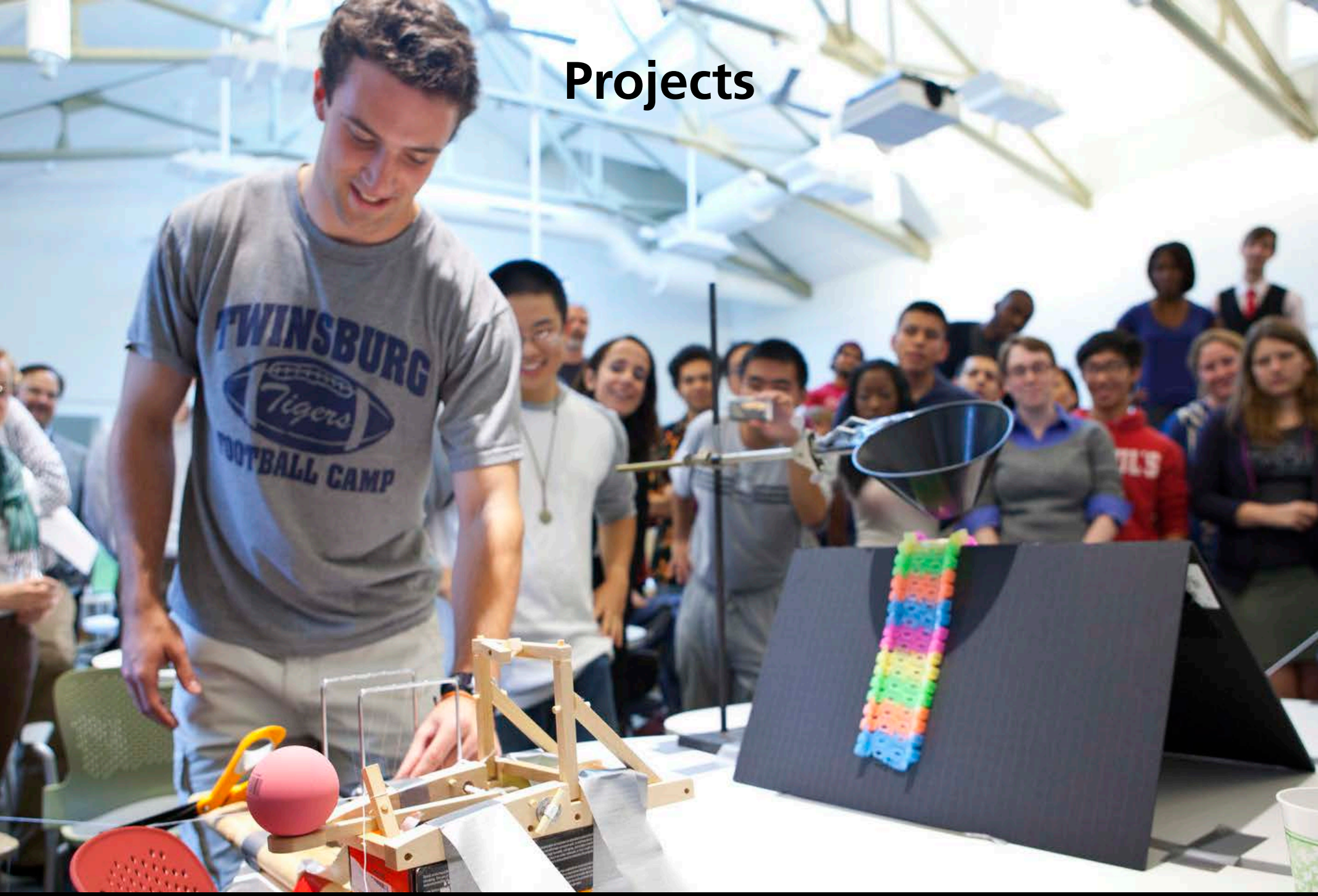
95% of students complete *all* readings!



1 design

2 approach

Projects



1 design

2 approach

Projects

- 1 projects/month (6 over 2 semesters)
- new team formation for each project
- projects not prescriptive, but open-ended
- 3 types of project “fairs”
- external evaluators

Projects

Project fair types:

- design competition
- oral presentation
- poster presentation

Projects

Rule-based team formation using GroupEng

www.GroupEng.org

1 design

2 approach

Projects

Rule-based team formation using GroupEng

- gender
- year
- self-efficacy & learning attitude
- class performance
- exlude previous team mates

www.GroupEng.org

Projects

To be successful, the projects must

- require practical application of skills
- be linked to real world problems
- have compelling narrative (help/do good)

Projects

Fall	Spring
Rube Goldberg	Ecotricity
Mission to Mars	Crack-a-Thon
Symphosium	inSPECT Fair

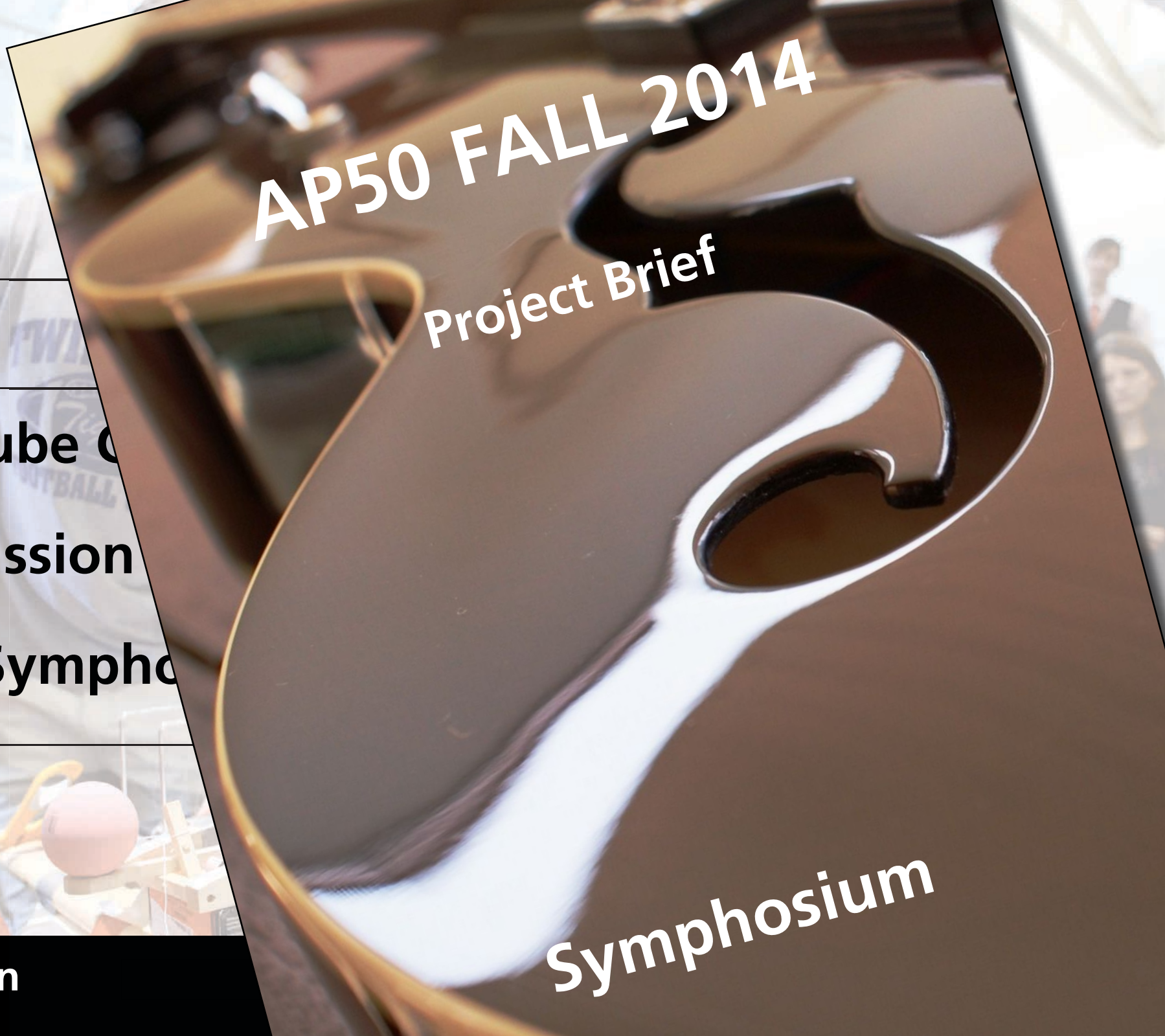
AP50 FALL 2014

Project Brief

Rube G

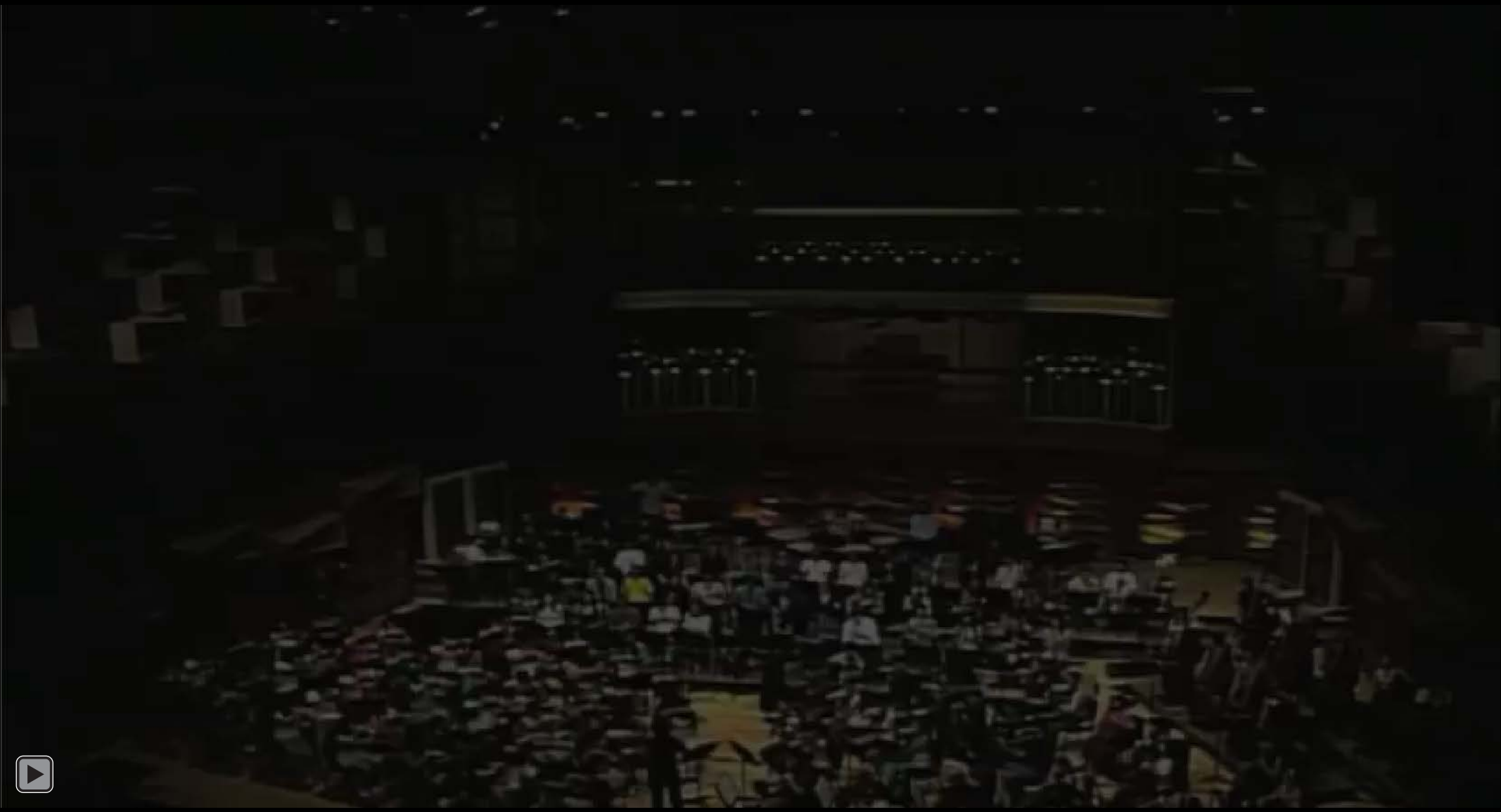
Mission

Sympho



Symphosium

1 design



1 design

2 approach

Projects

1 design

2 approach

Projects

Build a beautifully sounding instrument from recycled parts

1 design

2 approach

Projects

Build a beautifully sounding instrument from recycled parts

- musical range
- *Q*-factor
- harmonic spectrum
- sound level
- tuning stability

Projects

Milestones:

- team contract
- proposal
- fair
- report
- team, peer, and self assessment

Projects

Milestones:

- team contract (at beginning)
- proposal
- fair
- report
- team, peer, and self assessment

Projects

Milestones:

- team contract (at beginning)
- proposal (+1 week)
- fair
- report
- team, peer, and self assessment

Projects

Milestones:

- team contract (at beginning)
- proposal (+1 week)
- fair (+3 weeks)
- report
- team, peer, and self assessment

Projects

Milestones:

- team contract (at beginning)
- proposal (+1 week)
- fair (+3 weeks)
- report (+1 week +3 days for revision)
- team, peer, and self assessment

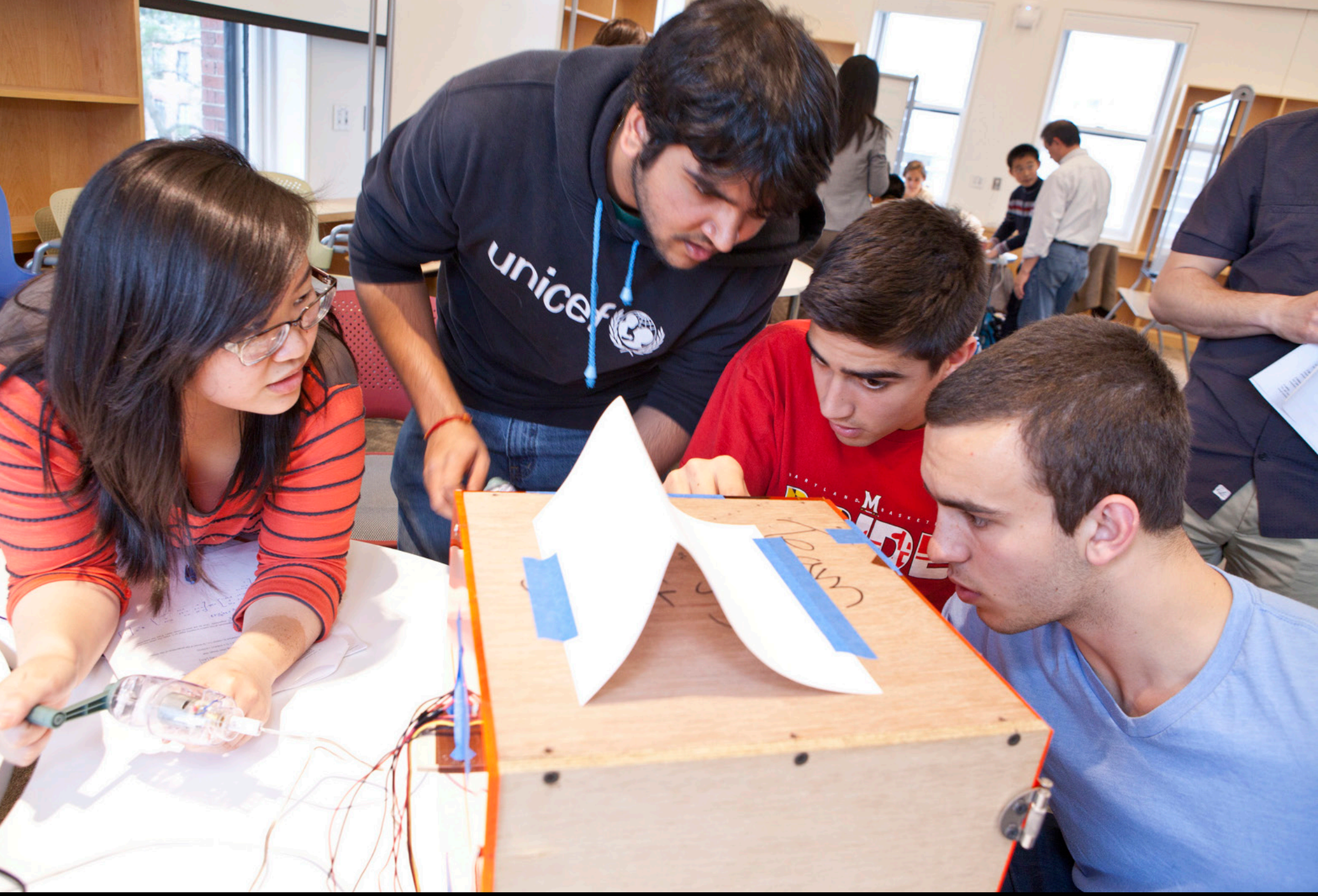
Projects

Milestones:

- team contract (at beginning)
- proposal (+1 week)
- fair (+3 weeks)
- report (+1 week +3 days for revision)
- team, peer, and self assessment (at end)

1 design

2 approach



1 design

2 approach

competition instead of

social good/empathy as motivator

1 design

2 approach

1 design

2 approach

In-class activities

1 design

2 approach

In-class activities

2 weekly 3-hour class periods

In-class activities

understand

LC: Learning Catalytics — 90 min

Instructor poses question
Answer alone
Discuss in team
Answer again

bring device

Tutorial — 60 min

Work on worksheet with team
Explore concepts
Discuss with staff

apply

Estimation Activity — 90 min

Estimate quantities
Develop individual strategy
Discuss and solve as team

EDA: Experimentation Activity — 90 min

Conduct experiment with team
Take measurements
Analyze data
Carry out simulations

bring device

evaluate

Problem Set & Reflection — 90 min

Work problems alone BEFORE class
Discuss with team, mark up
Self-assess & turn in

RAA: Readiness Assurance Activity — 90 min

Part 1: solve problems alone
Open book, open internet
Part 2: solve with team

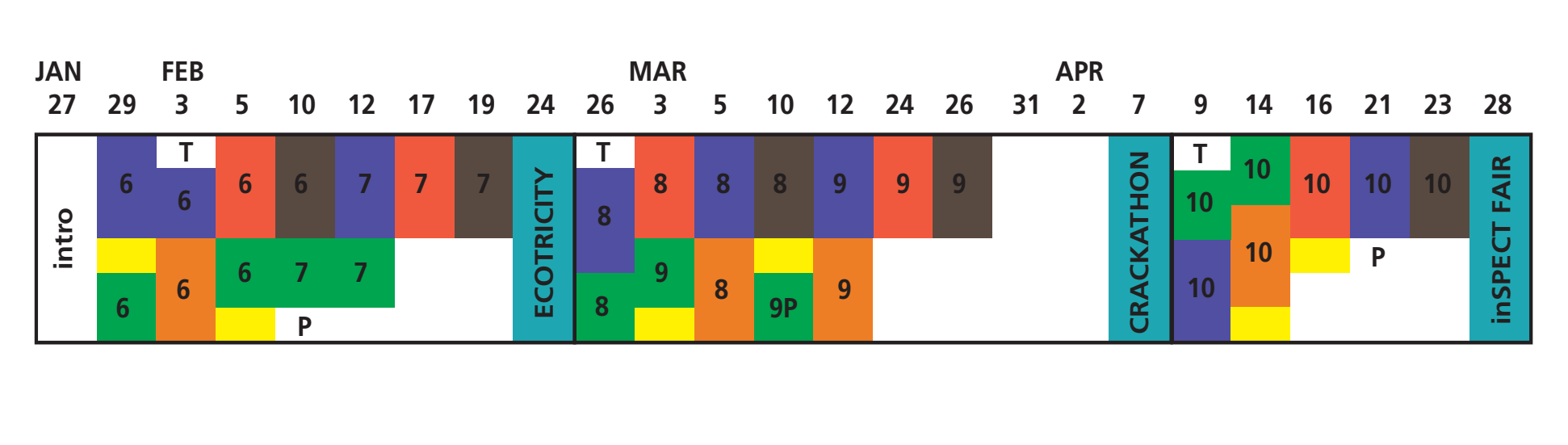
bring device

blend of 6 “best practices”

1 design

2 approach

In-class activities

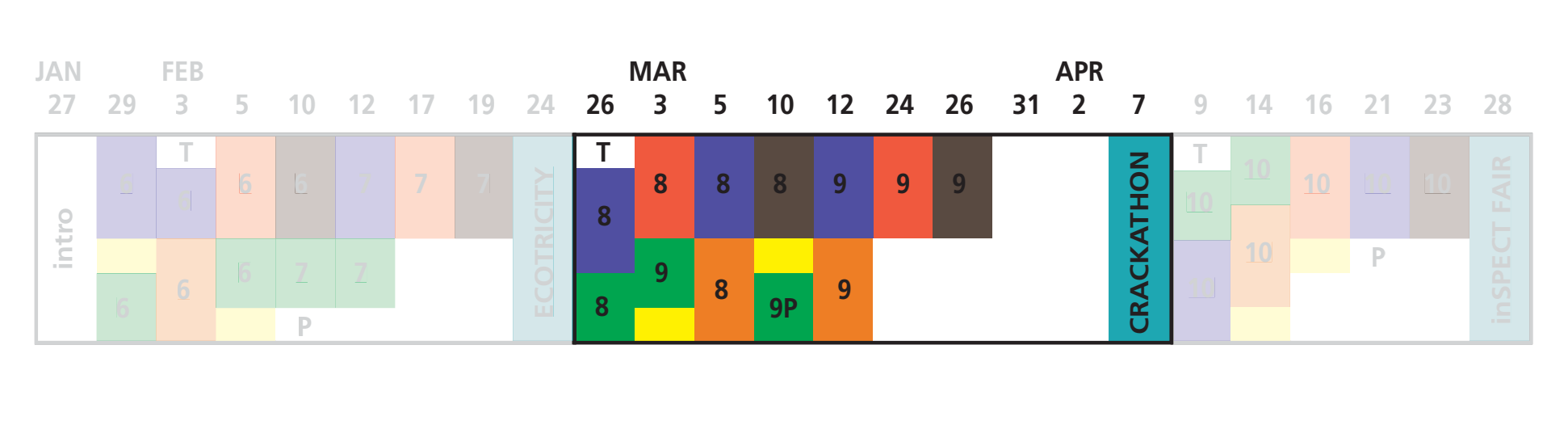


1 design

2 approach

In-class activities

one project

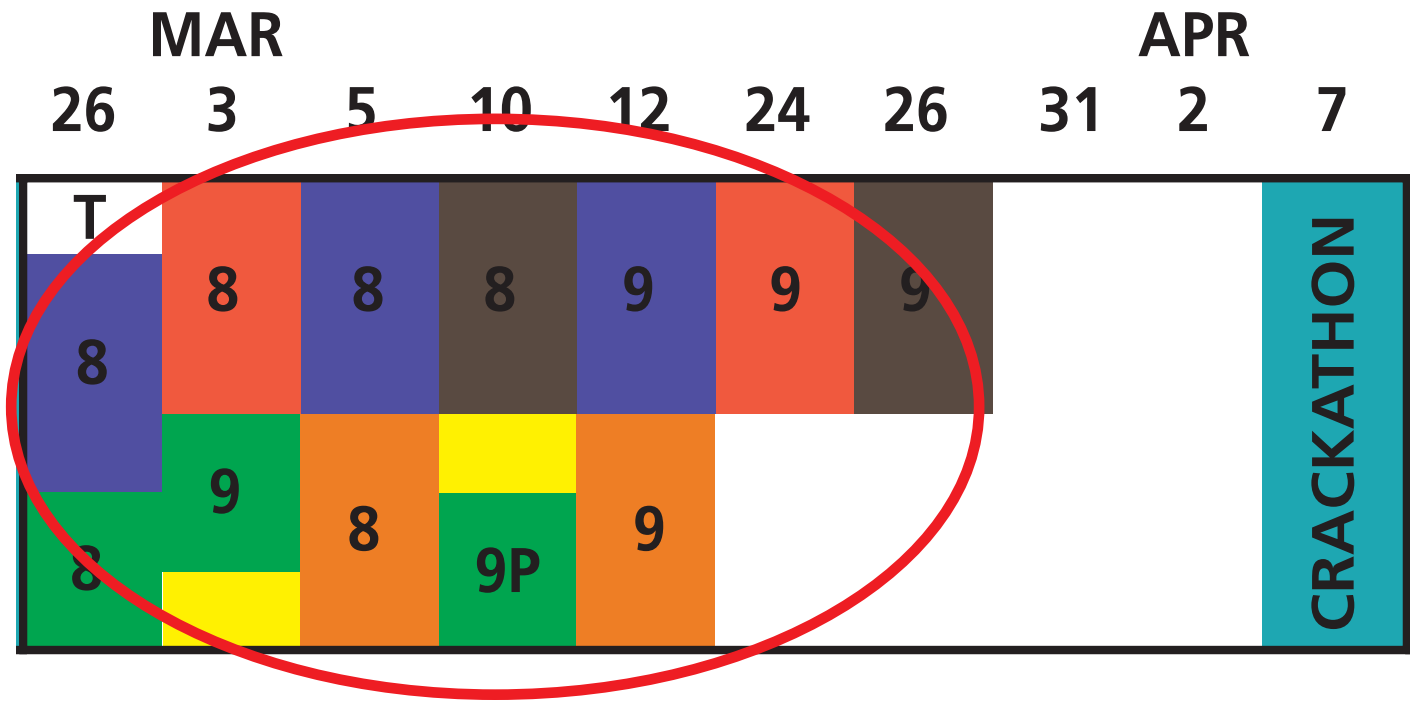


1 design

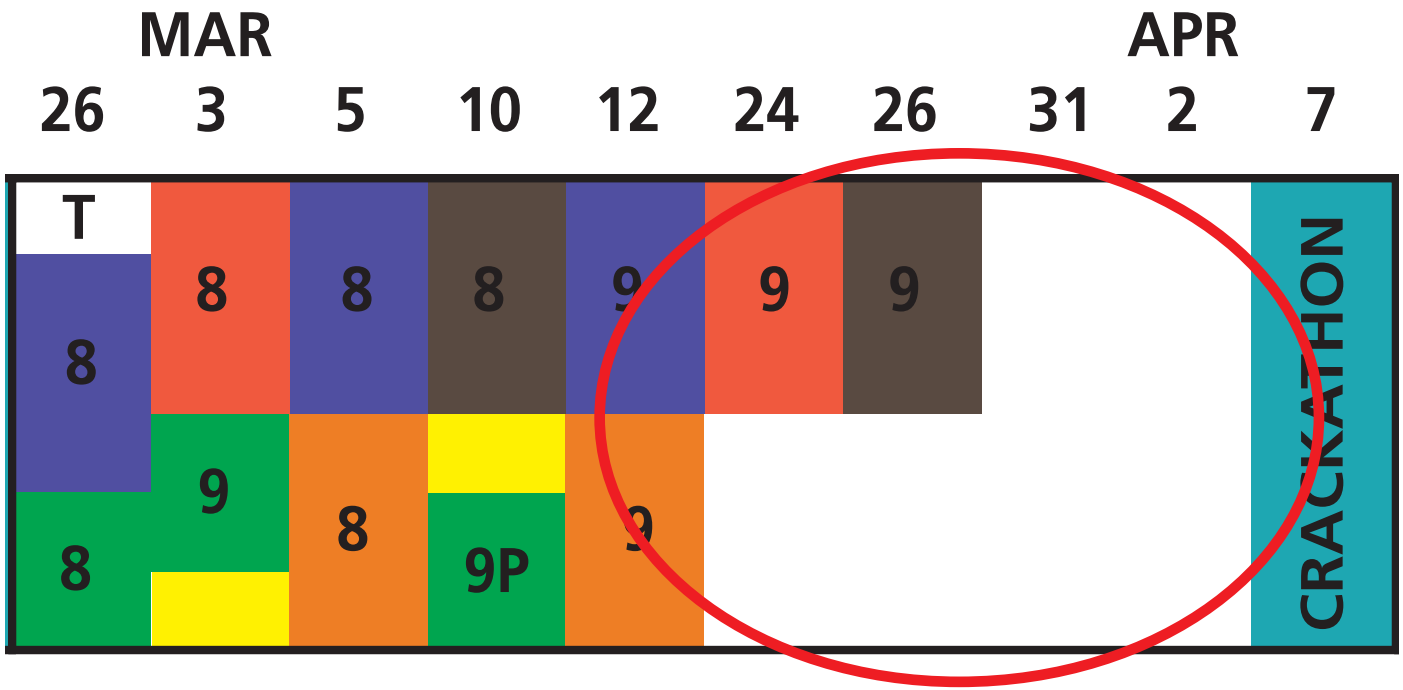
2 approach

In-class activities

2/3 scaffolded, guided



In-class activities



1/3 unguided

1 design

2 approach

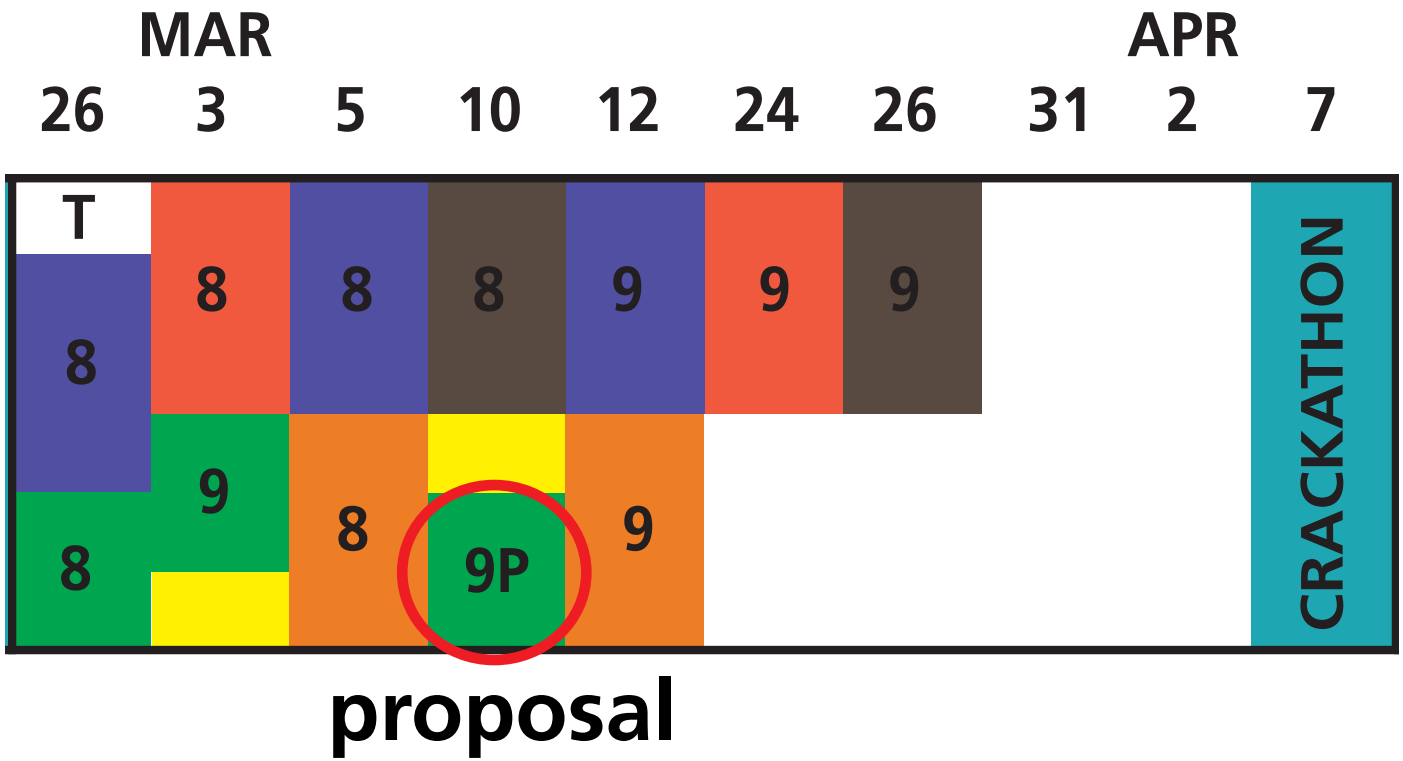
In-class activities

team intro

1 design

2 approach

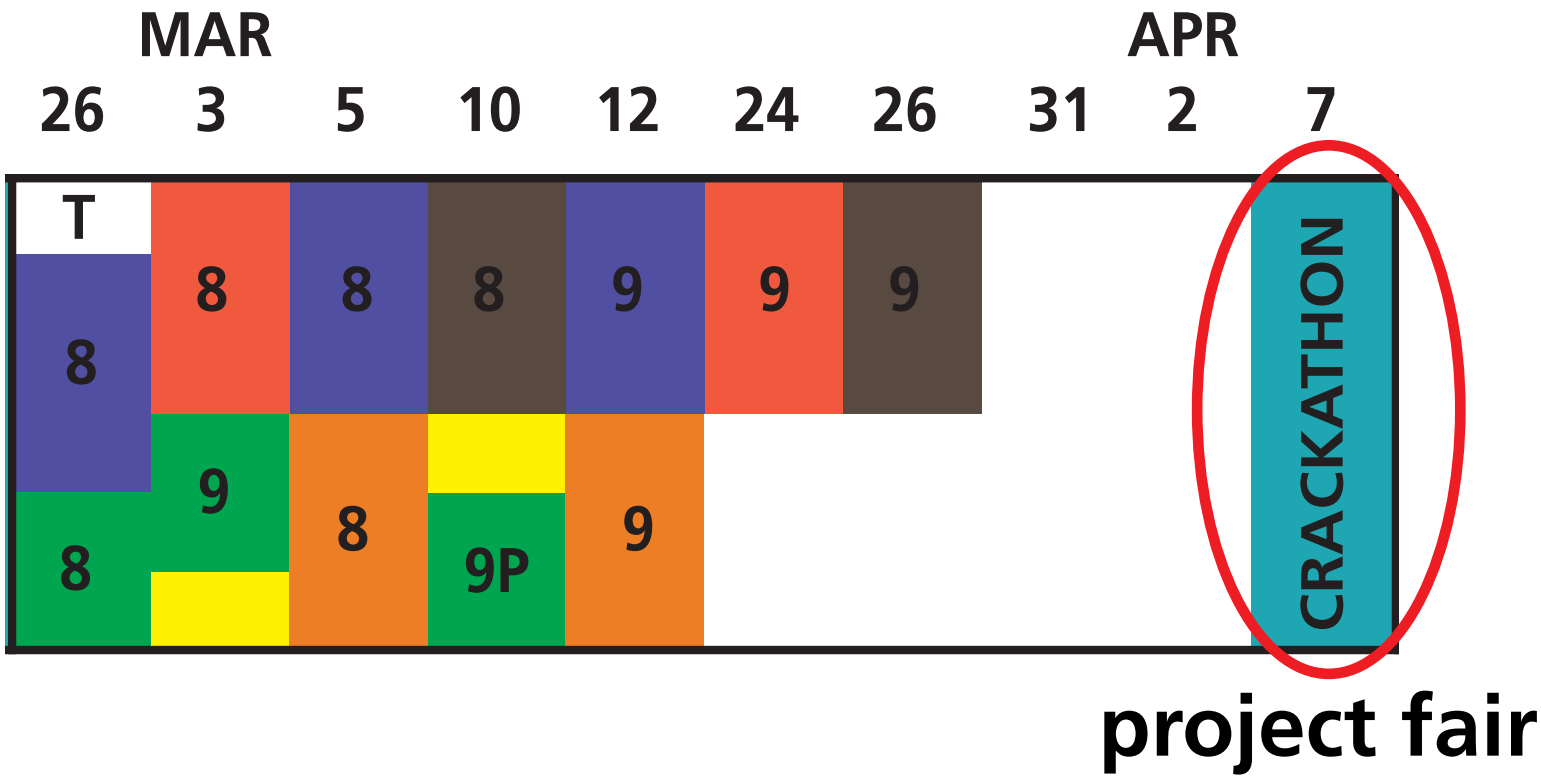
In-class activities



1 design

2 approach

In-class activities



In-class activities

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Carry out simulations

bring device

evaluate

Problem Set & Reflection — 90 min

Work problems alone BEFORE class
Discuss with team, mark up
Self-assess & turn in

RAA: Readiness Assurance Activity — 90 min

Part 1: solve problems alone
Open book, open internet
Part 2: solve with team

bring device