

Using technology to engage students

University of Iowa
Iowa City, IA, 30 April 2010



My point

Technology is not a magic bullet

Introduction

A brief history of Information Technology

- blackboard
- overhead projector
- television
- computer

Introduction

What's wrong with old methods for presenting content?



Book of Hours, Valencia, c. 1460



Belles Heures du Duc de Berry
1408-09
The Way to Calvary

subleantur. Similiter et facta bona manifesta sunt: et que aliter se habent abscondi non possunt. **VI.**

Divitijs sunt sub iugo serui dñs suos quā honore dignos arbitrantur: ne nomine dñi & doctrina blasphemetur. Qui autē fideles habent dños nō detrahāt quia fides sūt: sed magis feruāt q̄a fideles sūt & dilecti: q̄a beneficii participes sunt hęc dōce: & egrotare. Si q̄a aliter doceat: & nō acquiescat sanis sermōibus dñi nri ihesu cristi. et ei que sūd in pietatē ē doctrine: superbus nichil scietis sed languēs circa questiones & pugnas verbore: ex quibus oriuntur inuidie & tentationes blasphemie suspiciones male- & sollicitationes hominū in parte corruptorū & q̄ veritate priuati sūt: existimatiū questū esse pietatē. Est autē questus magnus: pietas cum sufficientia. Nichil enī intulim⁹ in hunc mūdū: hanc dubiū q̄a nec auferre nō possum⁹. Inhabētes autē alimēta et q̄bus regant: hīs dētū sum⁹. Nā q̄ volunt diuites fieri: incidūt in tentationē & in la-

ditia unū: q̄ solus habet immortalitatem & lucē inhabitat inaccessibilē: quē null⁹ hominū vidit sed nec videre potest: cui honor & imperiū sempiternū erunt.

Divites hui⁹ seculi p̄cipe nō subleant sapere: neq̄ sperare in iucato diuitiarū sed in deo vno q̄ p̄stat nobis oīa abūde ad fruendū: bene agere: diuites fieri in bonis operibus: facile tabuete & inuicere: thesaurizare sibi sūd amentū bonū in futurū: ut apphētēt veram vitā. In thimothee depositū custodi: deuitas phanas vocū nouitates et oppositiones falli nōis sciētis: quā quidā prouitētes circa fidem ceciderūt. *Oratio tecū amē.*

Exphat epistola prima ad thimothēem. Inquit argumētū in epistolā secundā terti thimothee scribit de reprobatione in artibus & omnis regule veritatis: & qd futurus sit temporibus nouissimis. & de sua passione: scilicet a roma. Exphat argumētū in epistolā secundā ad thimothēem.

Mulus apostol⁹ hui⁹ ihesu cristi p̄ volūta-
tem dñi sēd in p̄missi-



subleuantur. Similiter et facta bona manifesta sunt: et que aliter se habent abscondi non possunt. **VI.**

Uicūq; sūt sub iugo serui dñi os suos dñi honore dignos arbitrant: ne nōq; dñi & doctrinā hīlāstentur.

Qui autē

nō dētermināt

seruiāt q̄a sūt

ficij participēs

Si q̄a aliter

nis seruūit

que sūd in pie

nichil scētis

ones & pug

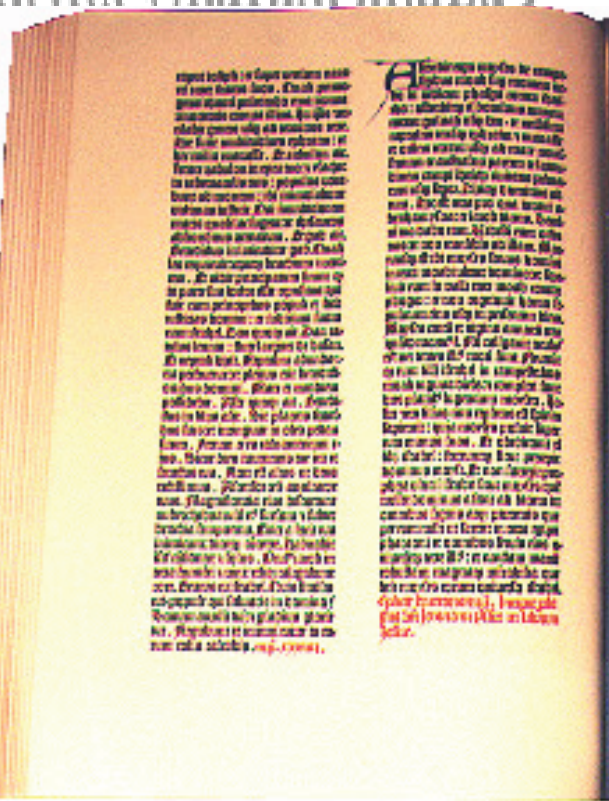
tur inuidie d

spicionez ma

itate corru

sūt: existimāt

autē quēst⁹ magnus: pietas cum sufficiens. Nichil enī intulim⁹ in hunc mūdū: hanc dubiū q̄a nec auferte nō possum⁹. Inhabētes autē alimēta et q̄bus regant: hīs dētū sum⁹. Nā q̄ uolunt dūmītra fieri: inuidiē i cōtantiōnē a rīla-



...et in hunc mundum...

Alteriusque... *...et in hunc mundum...*



Consequenter... *...et in hunc mundum...*

Sed et... *...et in hunc mundum...*

dñi unū: q̄ solus habet immortalitatem & lucē inhabitat inaccessibilē: quē null⁹ homī uidit sed nec uidere potest: nisi hōmō & imperiū sempiternū amittit.

Quitibz hūi⁹ seculi p̄cipe nō sublimetate nemē loq̄at⁹ in iugis diuitiarū

na oīa abūdē

tes fieri i bo-

dimunitate:

ntū bonū in

vitā. Et thi-

deuitas p̄ph-

opositiones

idā p̄mittēt

ria tecū amē.

ad thimōstis

am secunda

regōtatione

uitati: & dñi regit ueritatis: & qd

futus sit tēporibz nouissimis. & de sua

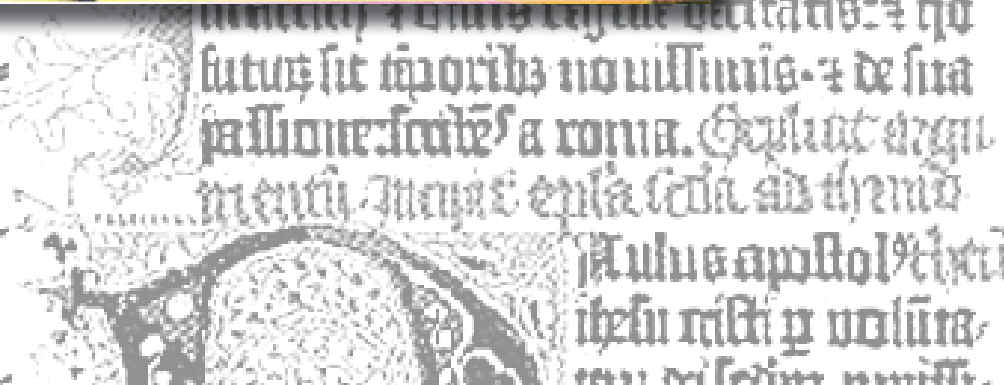
passione scōtē a roma. Gessit argu-

mentū. Inuā ē ep̄la scōa ad thimō

Mulus ap̄stol⁹ thimō

ihesu rāstī p̄ uolūta-

rou dē sedm̄ nūmī-



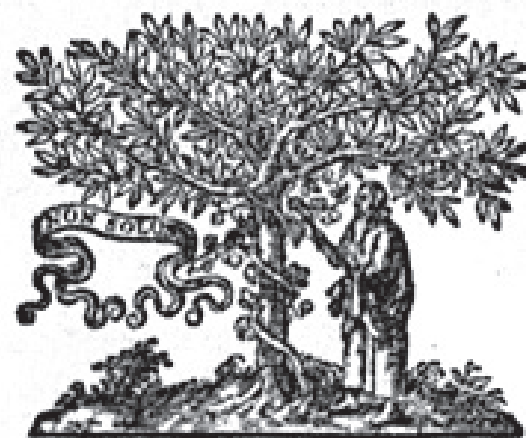


DISCORSI
E
DIMOSTRAZIONI
MATEMATICHE,
intorno à due nuoue scienze

Attenenti alla
MECANICA & i MOVIMENTI LOCALI,

del Signor
GALILEO GALILEI LINCEO,
Filosofo e Matematico primario del Serenissimo
Grand Duca di Toscana.

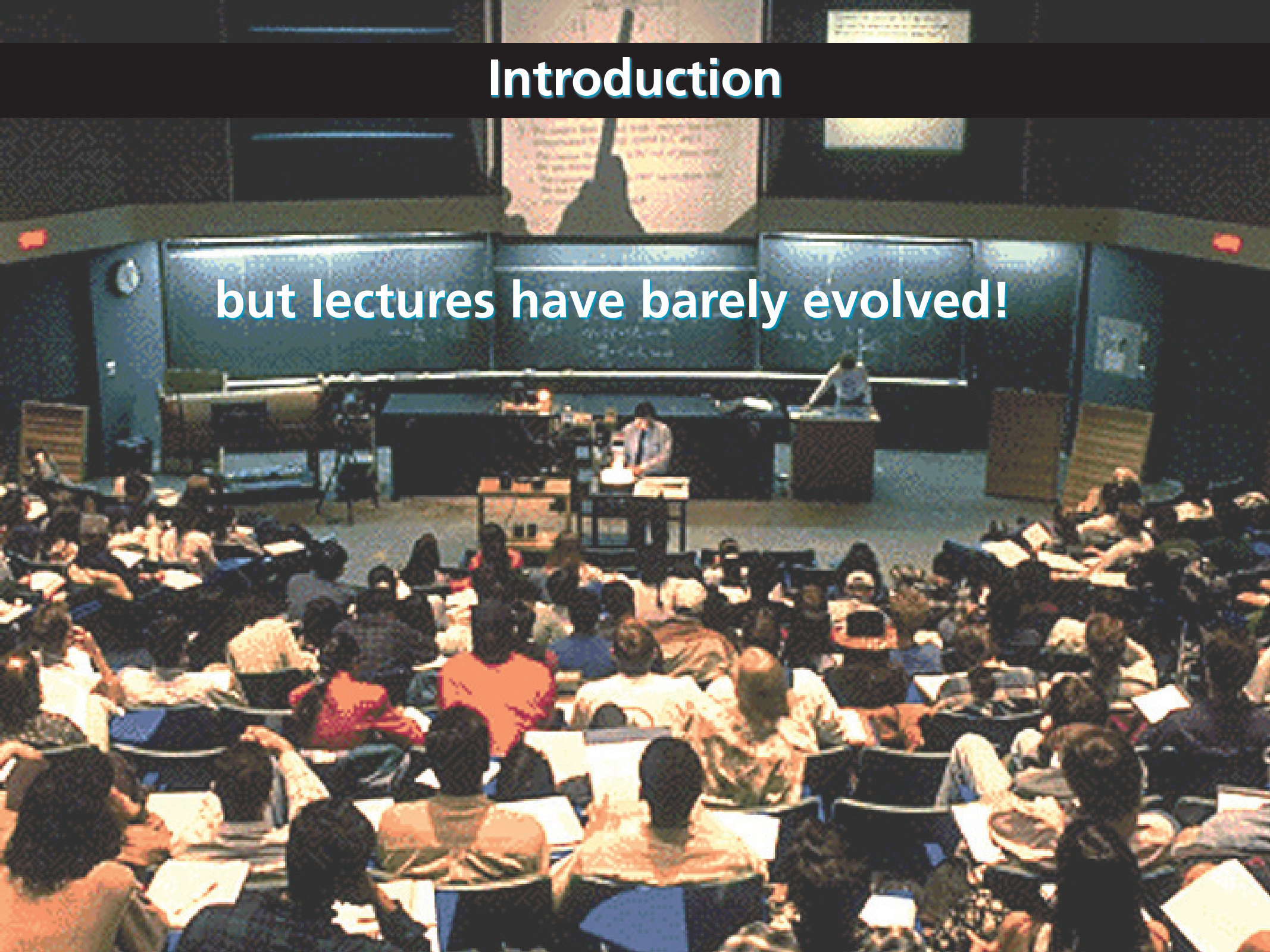
Con vna Appendice del centro di grauità d'alcuni Solidi.



IN LEIDA,
Appresso gli Elsevirii. M. D. C. XXXVIII.

Introduction

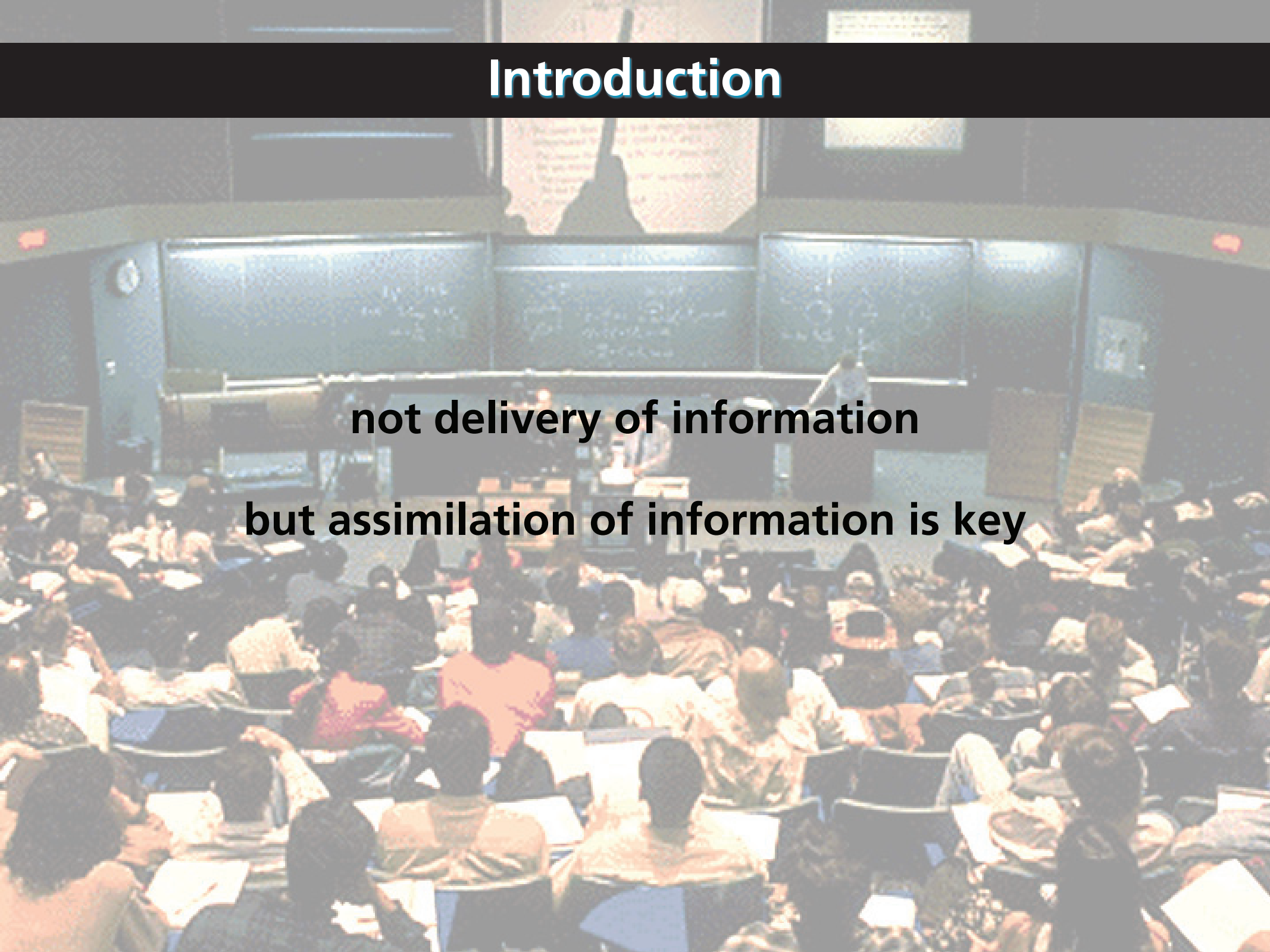
but lectures have barely evolved!



Introduction

not delivery of information

but assimilation of information is key



Introduction

think about educational goals
before introducing technology



Introduction

What constitutes effective use of technology?

- **furtheres educational goals**
- **facilitates new modes of learning**
- **investment commensurate with returns**
- **reusable and flexible**

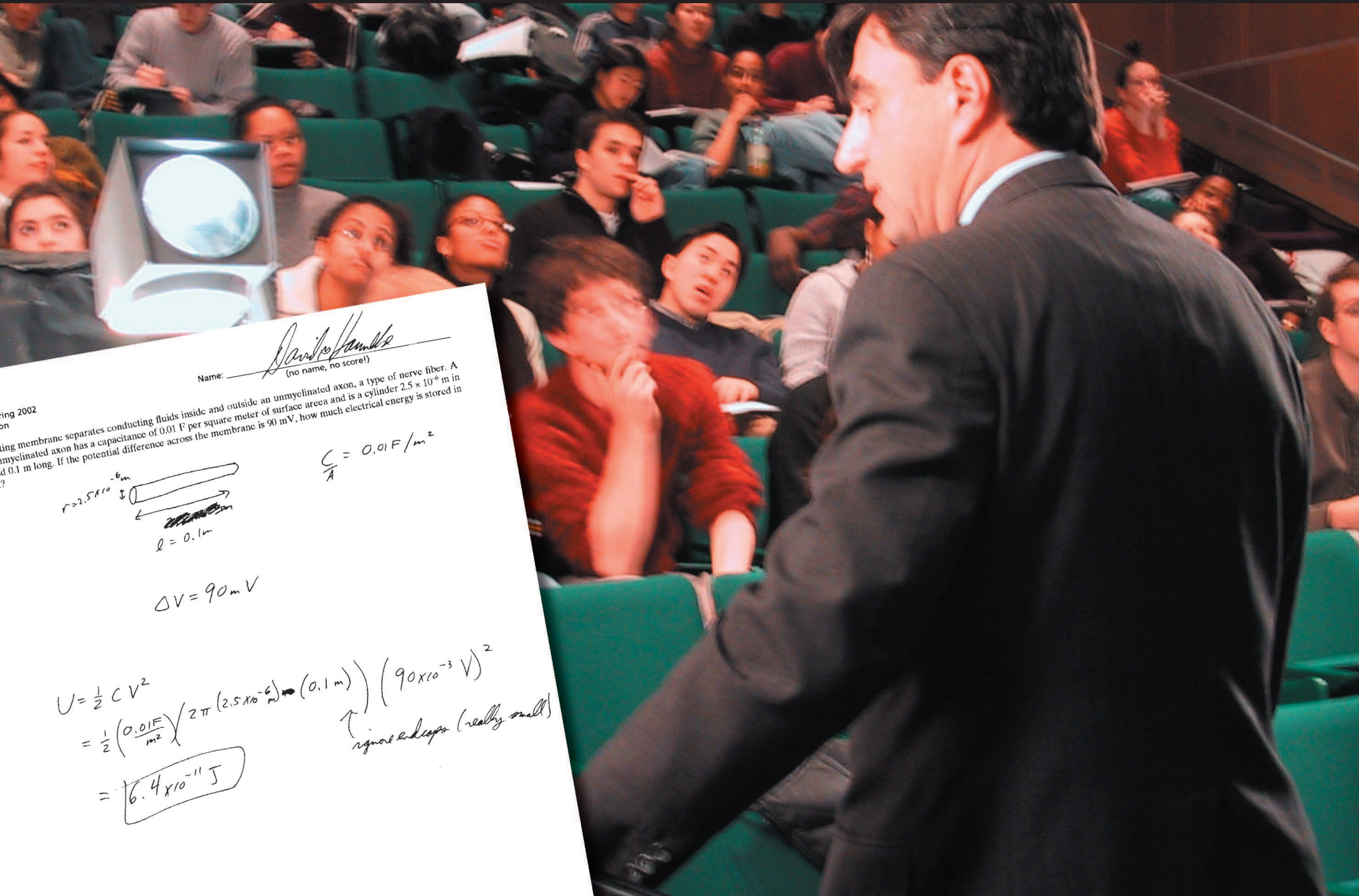
Outline



Outline

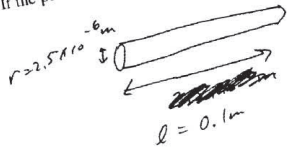
- **Personalizing instruction**
- **Promoting thinking**
- **Integrating instruction**

Personalizing instruction



Name: David Hamilton
(no name, no score!)

ing 2002
on
ing membrane separates conducting fluids inside and outside an unmyelinated axon, a type of nerve fiber. A
unmyelinated axon has a capacitance of 0.01 F per square meter of surface area and is a cylinder 2.5×10^{-6} m in
d 0.1 m long. If the potential difference across the membrane is 90 mV, how much electrical energy is stored in
?



$$\frac{C}{A} = 0.01 \text{ F/m}^2$$

$$\Delta V = 90 \text{ mV}$$

$$U = \frac{1}{2} C V^2$$
$$= \frac{1}{2} \left(\frac{0.01 \text{ F}}{\text{m}^2} \right) \left(2\pi (2.5 \times 10^{-6} \text{ m}) (0.1 \text{ m}) \right) (90 \times 10^{-3} \text{ V})^2$$

↑ ignore a factor (really small)

$$= \boxed{6.4 \times 10^{-11} \text{ J}}$$

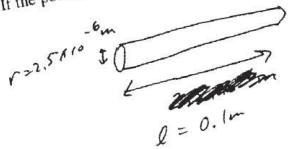
Personalizing instruction

nameless
faces

ing 2002
on

Name: David Hamilton
(no name, no score!)

ing membrane separates conducting fluids inside and outside an unmyelinated axon, a type of nerve fiber. A unmyelinated axon has a capacitance of 0.01 F per square meter of surface area and is a cylinder 2.5×10^{-6} m in radius and 0.1 m long. If the potential difference across the membrane is 90 mV, how much electrical energy is stored in the axon?



$$\frac{C}{A} = 0.01 \text{ F/m}^2$$

$$\Delta V = 90 \text{ mV}$$

$$U = \frac{1}{2} C V^2$$
$$= \frac{1}{2} \left(\frac{0.01 \text{ F}}{\text{m}^2} \right) \left(2\pi (2.5 \times 10^{-6} \text{ m}) (0.1 \text{ m}) \right) (90 \times 10^{-3} \text{ V})^2$$

↑ ignore a factor (really small)

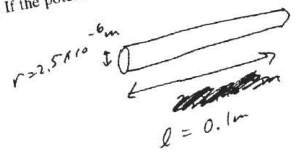
$$= \boxed{6.4 \times 10^{-11} \text{ J}}$$

Personalizing instruction

nameless
faces

Name: Daniel Samuels
(no name, no score!)

ing 2002
on
ing membrane separates conducting fluids inside and outside an unmyelinated axon, a type of nerve fiber. A
unmyelinated axon has a capacitance of 0.01 F per square meter of surface area and is a cylinder 2.5×10^{-6} m in
d 0.1 m long. If the potential difference across the membrane is 90 mV, how much electrical energy is stored in
?



$C = 0.01 \text{ F/m}^2$
**faceless
names**

$$\Delta V = 90 \text{ mV}$$

$$U = \frac{1}{2} C V^2$$
$$= \frac{1}{2} \left(\frac{0.01 \text{ F}}{\text{m}^2} \right) \left(2\pi (2.5 \times 10^{-6} \text{ m}) (0.1 \text{ m}) \right) (90 \times 10^{-3} \text{ V})^2$$

↑ ignore a factor (really small)

$$= \boxed{6.4 \times 10^{-11} \text{ J}}$$

Personalizing instruction

**instructor:
busy delivering information**

A large lecture hall with an instructor at a podium and students seated at desks. The instructor is standing at a podium in the center of the stage, facing the audience. The students are seated in rows of desks, filling the lecture hall. The room has a curved wall and a large screen at the front. The text "instructor: busy delivering information" is overlaid on the image.

Personalizing instruction

A large lecture hall with an instructor at a podium and students seated at desks. The instructor is standing at a podium in the center of the stage, facing the audience. The students are seated in rows of desks, filling the lecture hall. The room has a curved wall and a large screen at the front. The text "Personalizing instruction" is overlaid at the top of the image.

**instructor:
busy delivering information**

**students:
busy taking down information**

Personalizing instruction

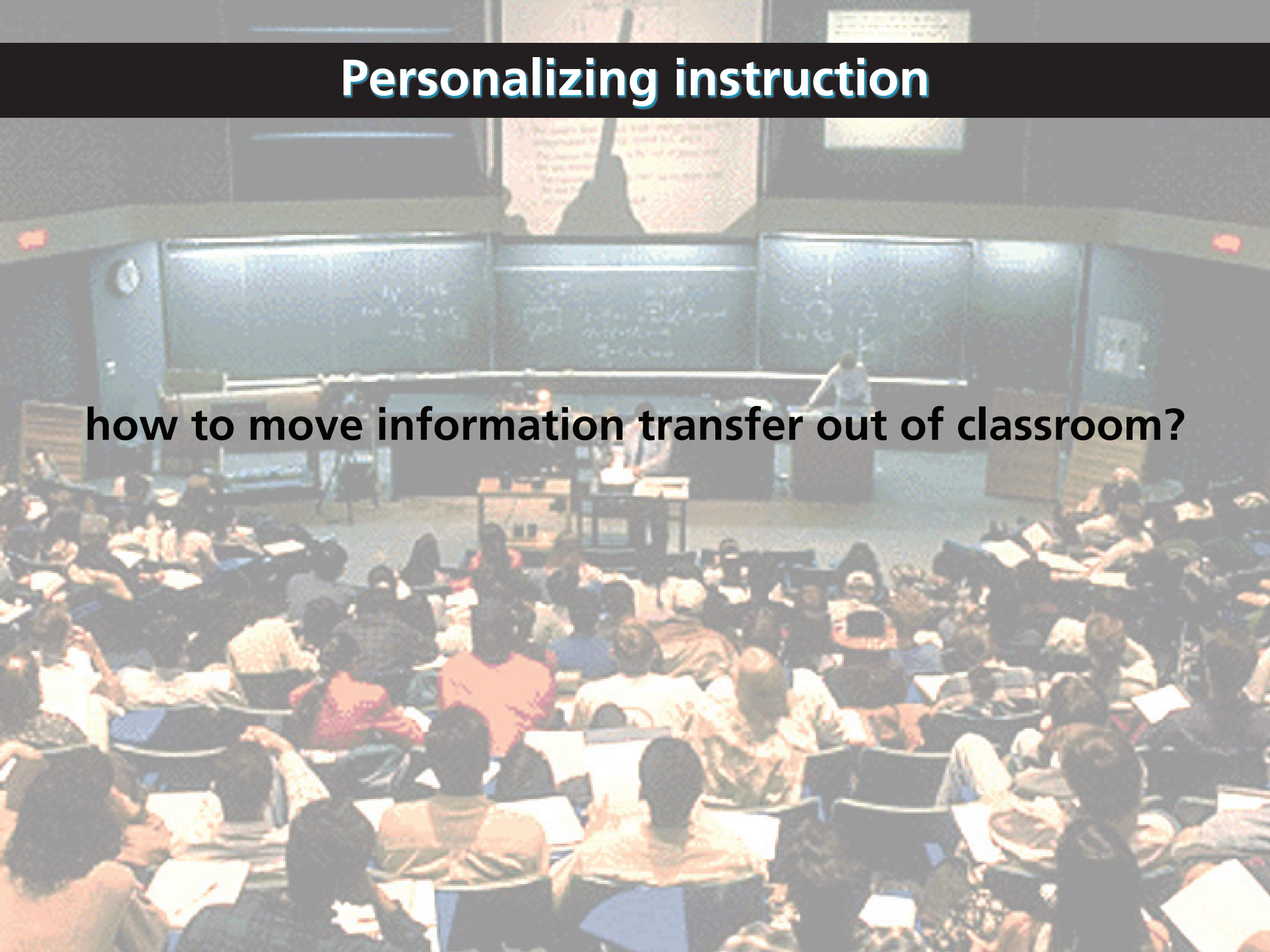
A large lecture hall with an instructor at a podium and many students seated at desks. The room is filled with students, and the instructor is standing at the front, addressing the class. The text is overlaid on the image.

instructor:
can't address individual student needs

students:
no time to think

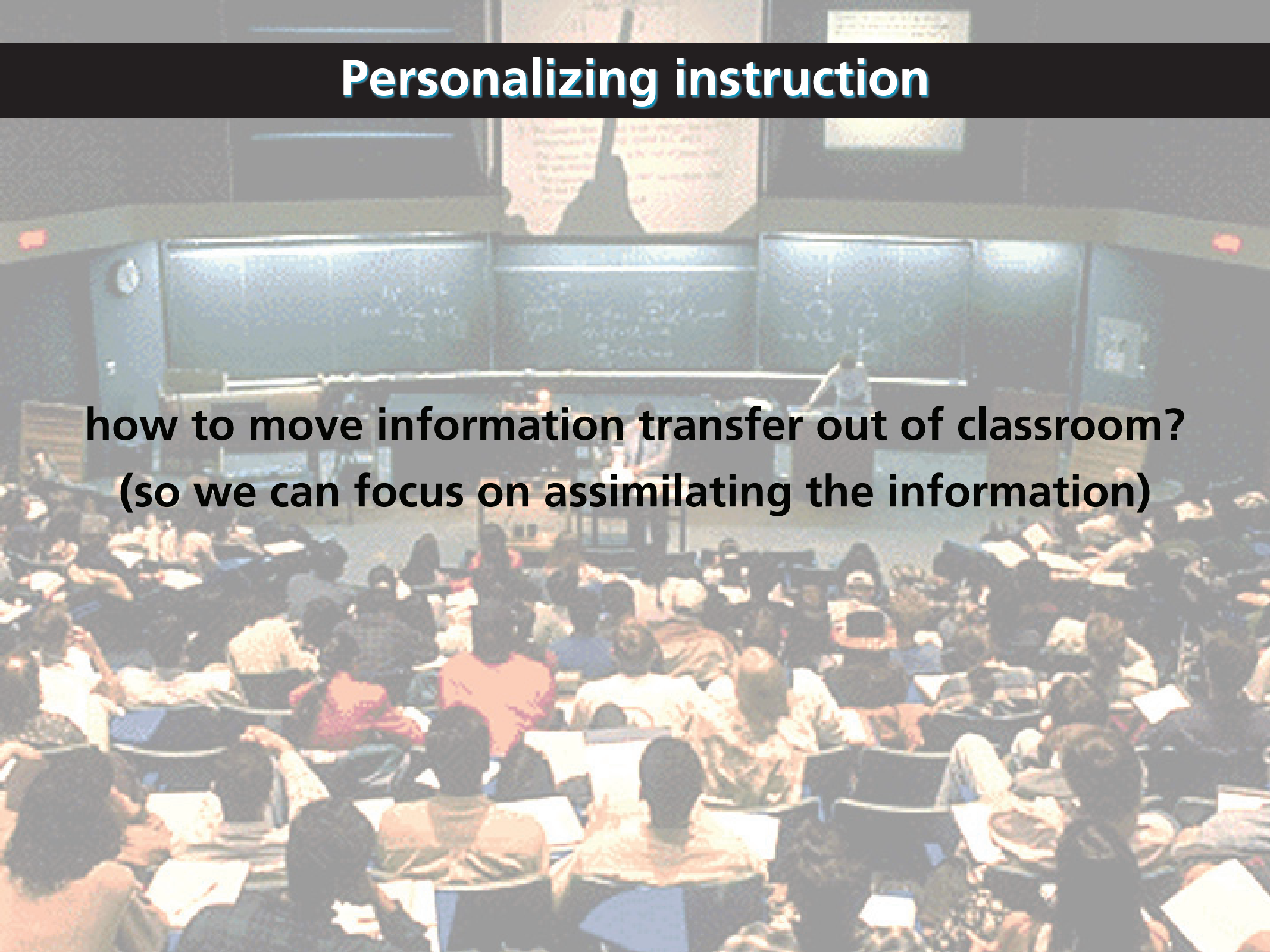
Personalizing instruction

how to move information transfer out of classroom?

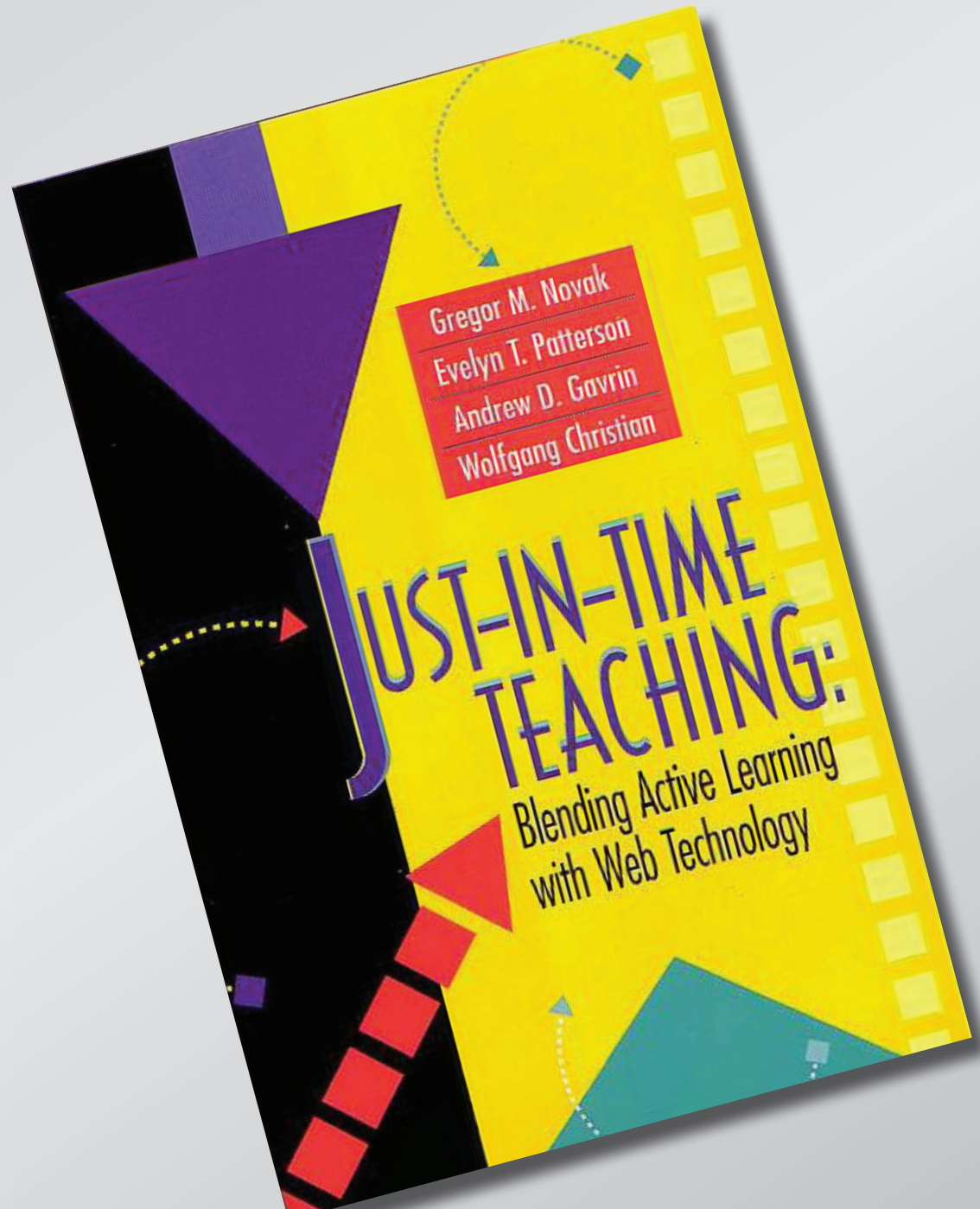


Personalizing instruction

**how to move information transfer out of classroom?
(so we can focus on assimilating the information)**

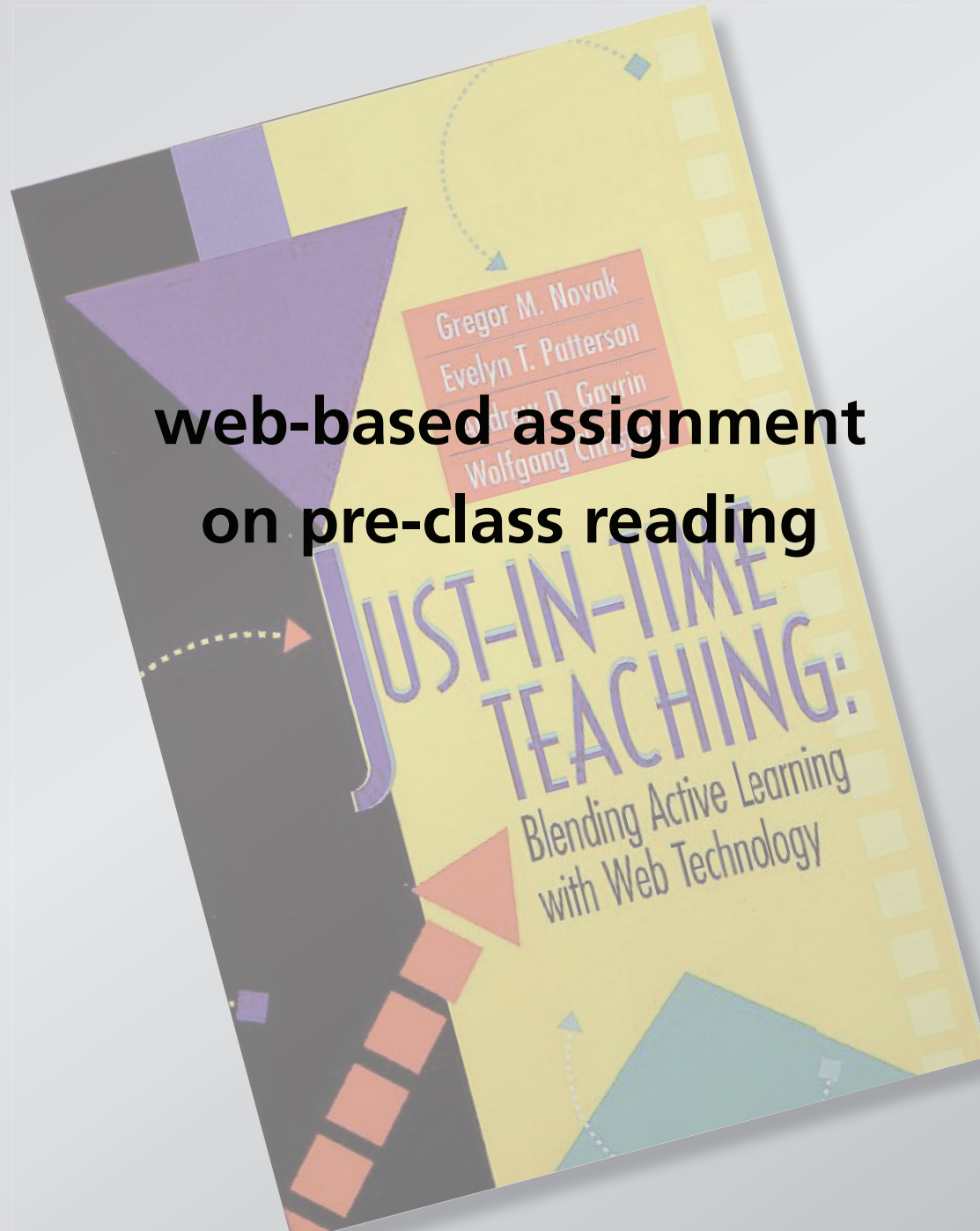


Personalizing instruction



Personalizing instruction

**web-based assignment
on pre-class reading**



Personalizing instruction

ILT: Students

http://www.conceptest.org/

ILT DEAS Apple Visualization HPC Education Local Info IBM Culture General Computer Mazur

Physics 1b

Logged in as Eric Mazur
Sign out

HOME READING LECTURES ASSIGNMENTS FORUMS NEWS HANDOUTS ?

Courses > Physics 1b > Reading > Changing magnetic fields II > < Student Responses

Please tell us briefly what **single** point of the reading you found most difficult or confusing. If you did not find any part of it difficult or confusing, please tell us what parts you found most interesting.






See notebook for an overview of common difficulties.

Click name to respond

Flag similarities closer than: go

1 - 100 of 153 answers > >|

Total of 7 responses sent to students for this assignment

Student	Answer	Time	Response
	Vijay Gnaseh The derivation of equations for magnetic energy was tricky (33.8). What is the conceptual meaning of "dq" in the equations 33.30-33.31? red	12/31/1969 6:59:59 pm	0 / 1
	Jhon Yunog In section 33.7, it talks about how inductance. I'm still baffled as to exactly what inductance is. I understand that it is the constant of proportionality between the emf and the rate of change of current, but what is the practical application of knowing something like this?	12/31/1969 6:59:59 pm	0 / 1
	Ciha - Jnug Tasy The text relates different ways of calculating induced emfs, and finds that Faraday's Law tells us that the induced current produces a magnetic flux to counteract increases in flux through loops. Such applications have been used in toroidal coils. Have there been any other tested shapes of materials and technology that might better and more efficiently use the fundamentals of the law? red	7/31/2000 12:00:00 am	0 / 1
	Mici Artgia I did not find any part confusing. I found the concept of inductance to be most interesting because it provides yet another parallel between electrostatics and magnetism.	4/6/2003 4:59:00 pm	0 / 1
	Kroi Susear Undemeath equation 33.14 there is a note in parenthesis that says that the induced field in NOT an electrostatic field, and so the quantity calculated above is NOT electrostatic work. I understand that the field is different from a normal electric field since it's not created by discreet point	4/7/2003 2:13:13 pm	0 / 1

E-MAIL
Manage email connection
Email (3)

COMING UP
5/2 Assignment 1

TOOLS
Run Similarity Check

QUICK LINKS
Standardized tests
Students

Sections
Select Section

© 2002 Eric Mazur
All rights reserved
Report a problem

SITE ADMIN
Users
Conceptests
Topics
Bugs
Standardized test

Personalizing instruction

Benefits

- connects names and faces
- prepares students for class
- “asynchronous” instruction
- more focused class time

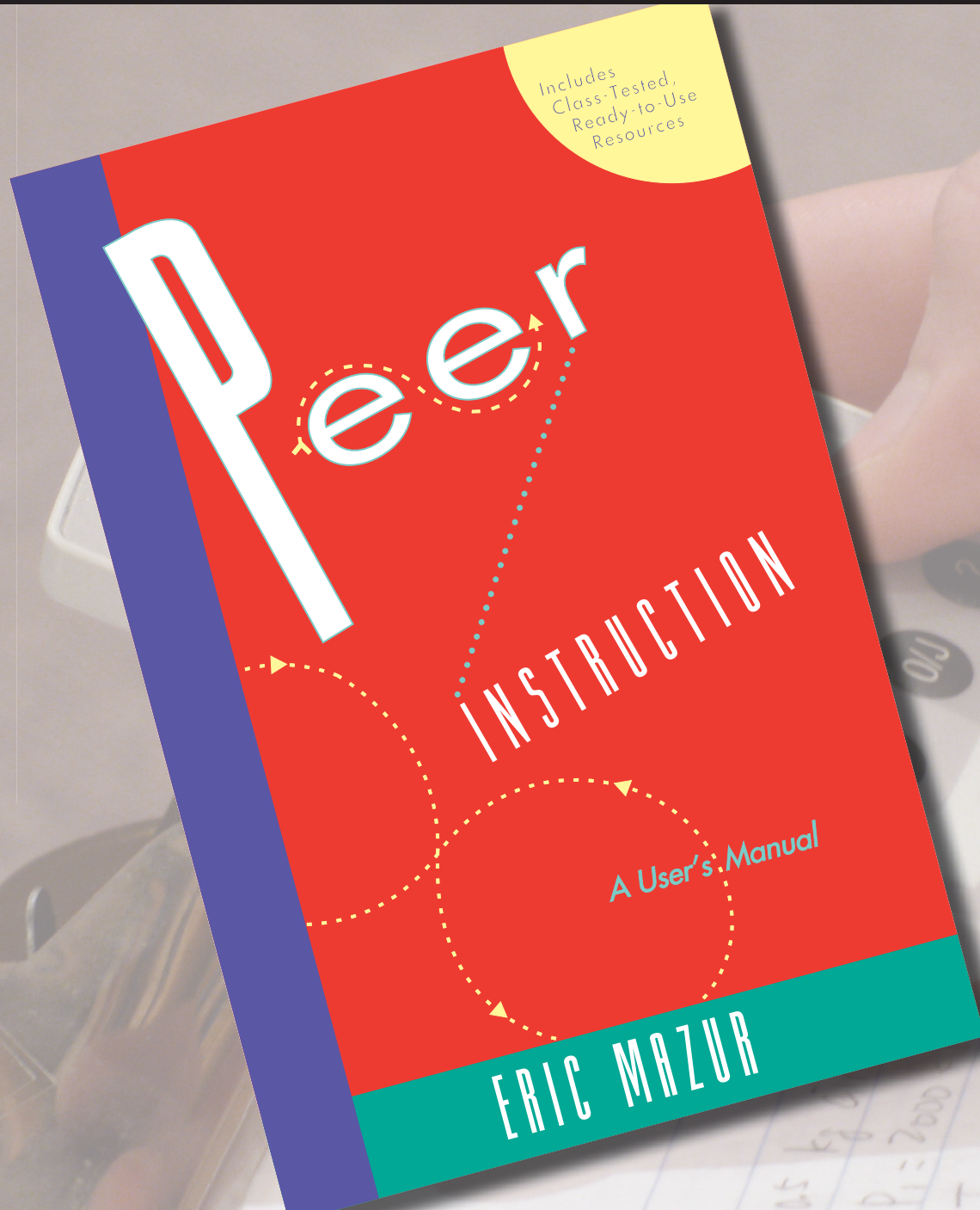
The screenshot shows a web browser window titled "ILT: Students" with the URL "http://www.concepttest.org/". The page is for "Physics 1b" and is logged in as "Eric Mazur". The navigation menu includes HOME, READING, LECTURES, ASSIGNMENTS, FORUMS, NEWS, and HANDOUTS. The main content area displays a question about magnetic energy and a list of student responses. The responses are shown in a table with columns for Student, Answer, Time, and Response.

Student	Answer	Time	Response
	The equations for magnetic energy was tricky. It is confusing because of the use of "dq" in the equations 33.30-33.31?	12/31/1969 6:59:59 pm	0 / 1
	Jhon Yunog In section 33.7, it talks about how inductance. I'm still baffled as to exactly what inductance is. I understand that it is the constant of proportionality between the emf and the rate of change of current, but what is the practical application of knowing something like this?	12/31/1969 6:59:59 pm	0 / 1
	Lina - Jnug Easy The text relates different ways of calculating induced emfs, and finds that Faraday's Law tells us that the induced current produces a magnetic flux to counteract increases in flux through loops. Such applications have been used in toroidal coils. Have there been any other tested shapes of materials and technology that might better and more efficiently use the fundamentals of the law? red	7/31/2000 12:00:00 am	0 / 1
	Mici Artaja I did not find any part confusing. I found the concept of inductance to be interesting because it provides yet another parallel between electricity and magnetism.	4/6/2003 4:59:00 pm	0 / 1
	Kroi Susear Undemeath equation 33.14 there is a note in parenthesis that says that the induced field is NOT an electrostatic field, and so the quantity calculated above is NOT electrostatic work. I understand that the field is different from a normal electric field since it's not created by discreet point	4/7/2003 2:13:13 pm	0 / 1

Outline

- Personalizing instruction
- Promoting thinking
- Integrating instruction

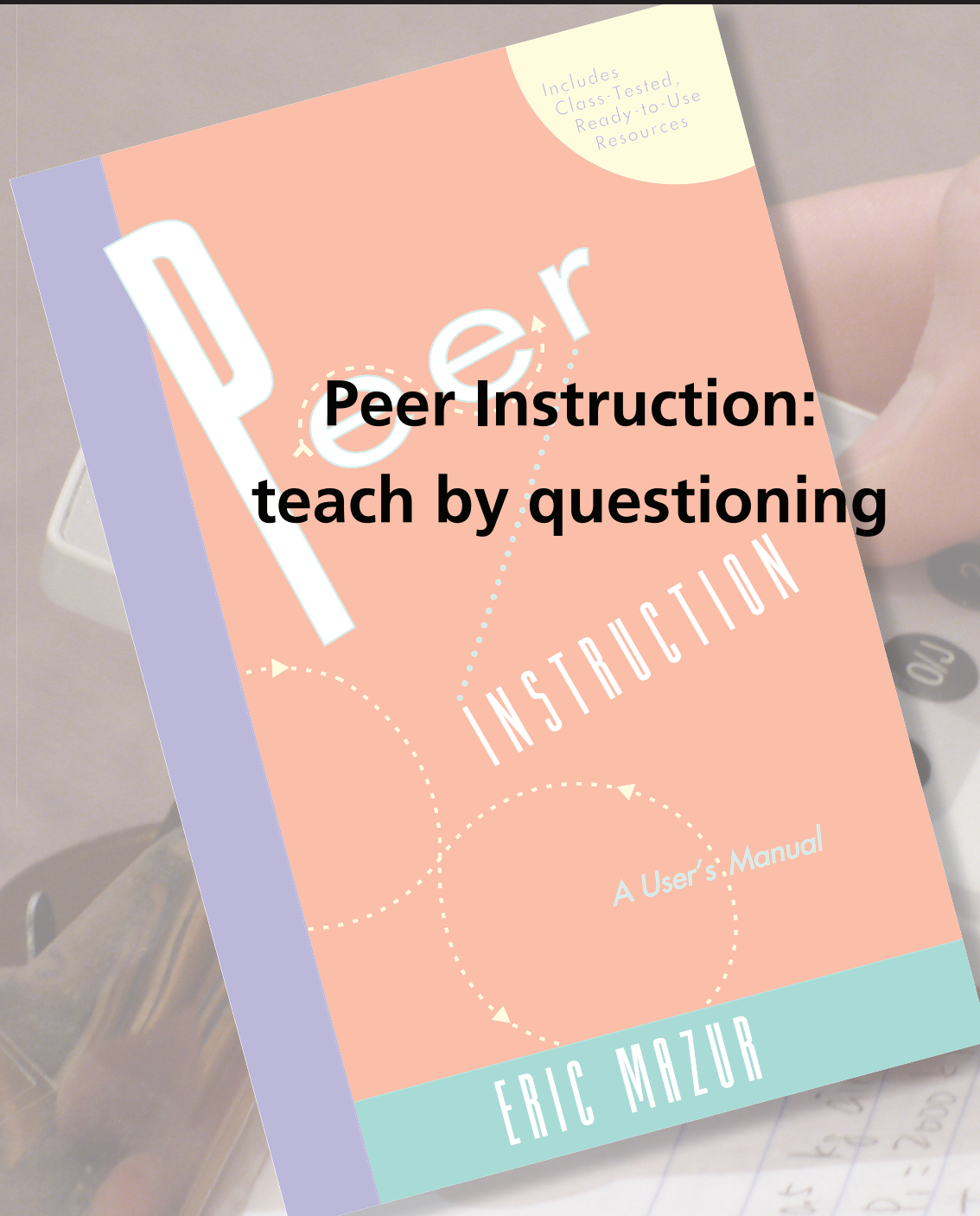
Promoting thinking



Handwritten notes on a piece of paper, including the following text:

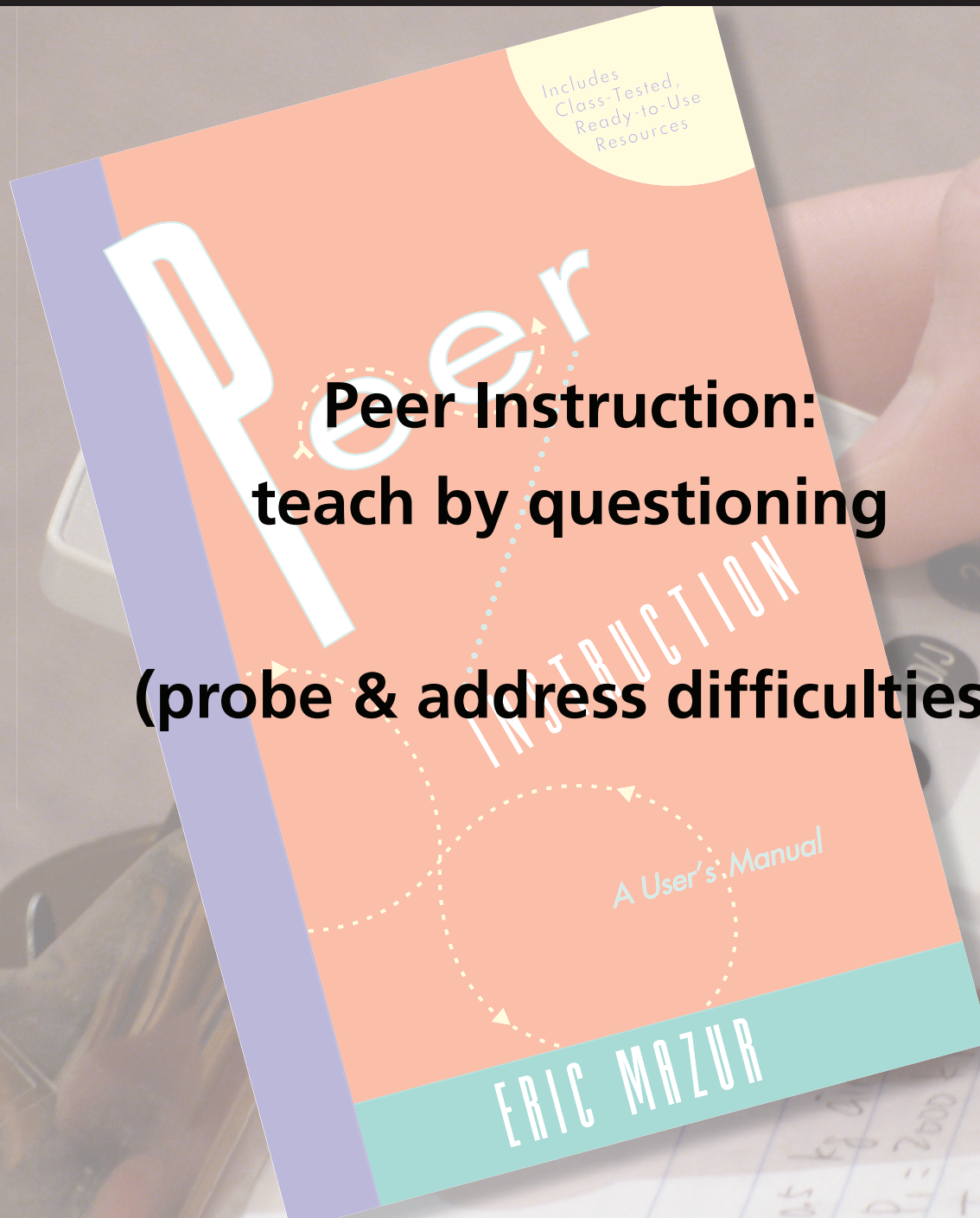
$P_1 = 2000$
 $T_1 = 1000\text{ K}$
 $V_1 = 0.03\text{ m}^3$
 $T_2 = 400\text{ K}$
Pressure of

Promoting thinking



**Peer Instruction:
teach by questioning**

Promoting thinking



**Peer Instruction:
teach by questioning
(probe & address difficulties)**

A User's Manual

ERIC MAZUR

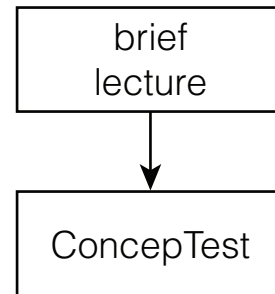
Handwritten notes on lined paper:

$P_1 = 2000 \text{ e}$
 $T_1 = 1000 \text{ K}$
 $V_1 = 0.03 \text{ m}^3$
 $T_2 = 400 \text{ K}$
Pressure of d

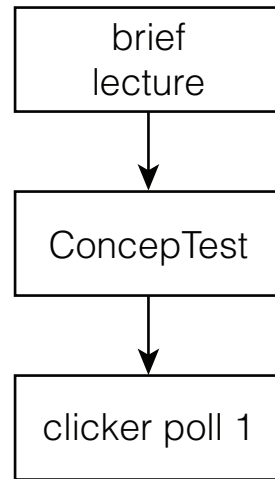
Promoting thinking

brief
lecture

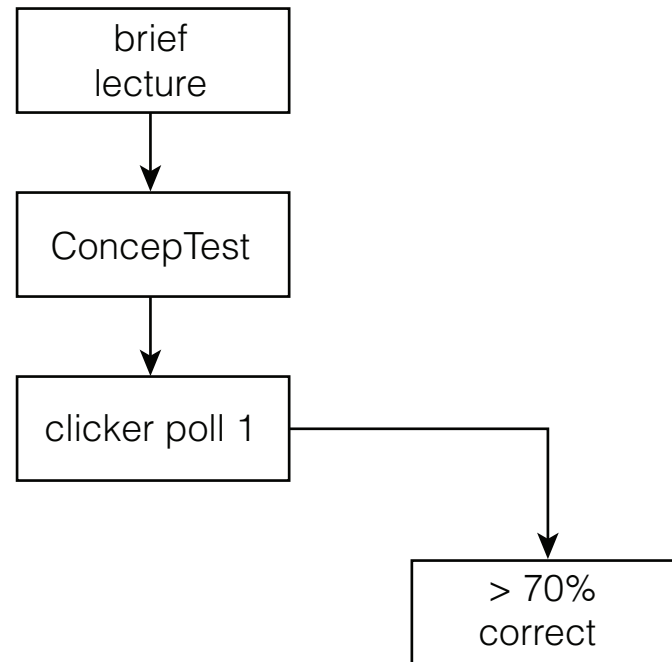
Promoting thinking



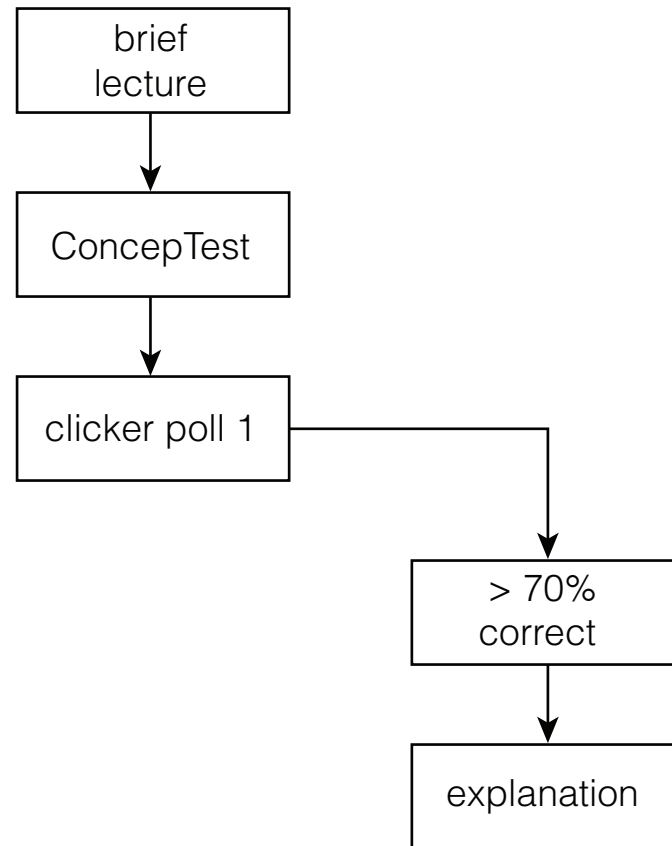
Promoting thinking



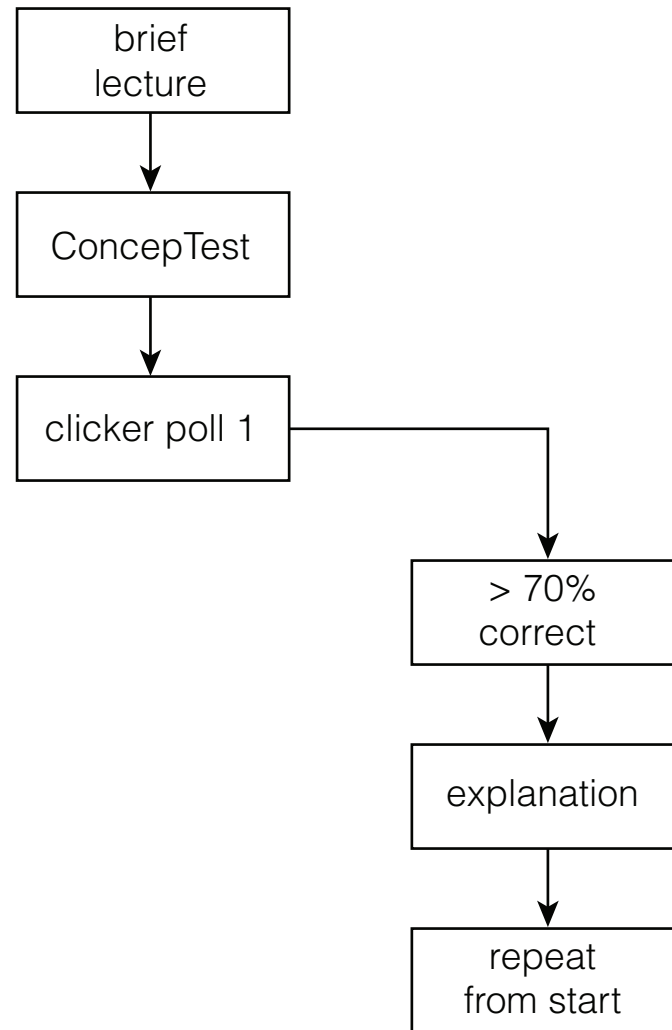
Promoting thinking



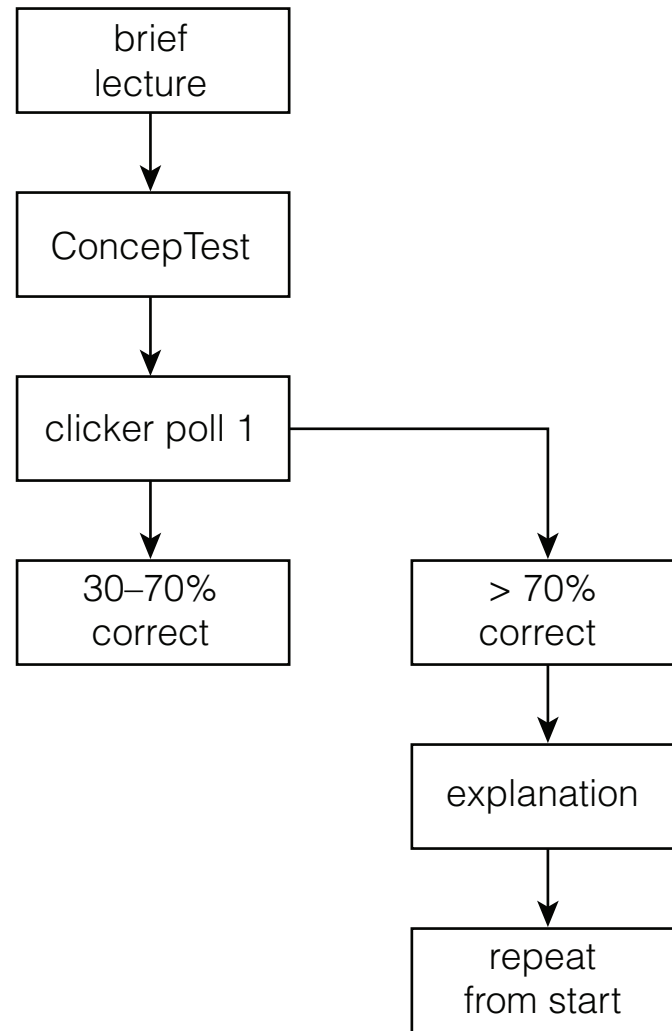
Promoting thinking



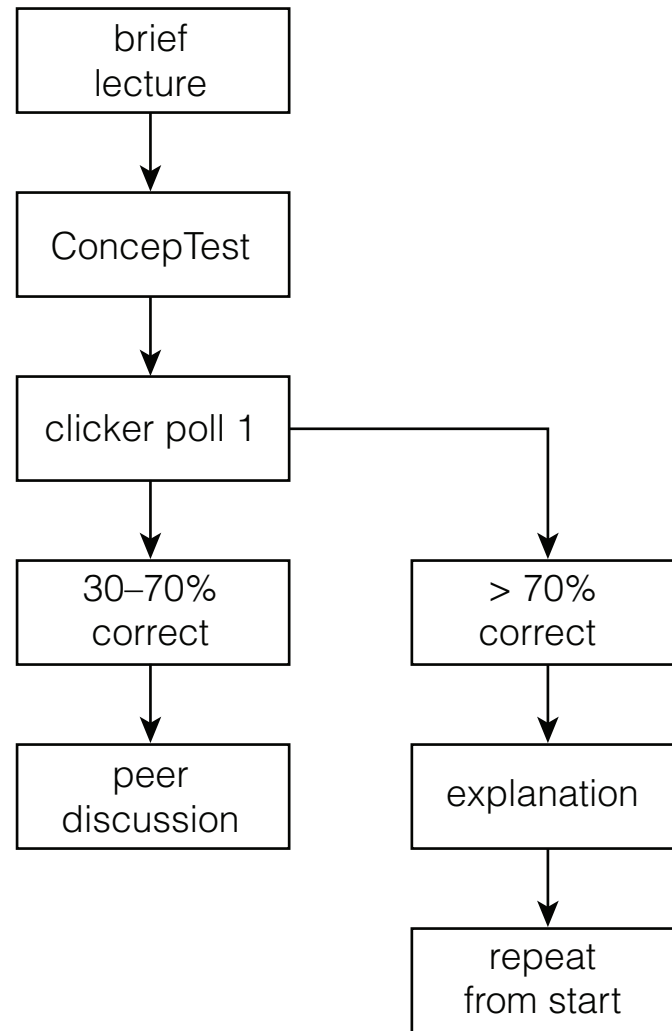
Promoting thinking



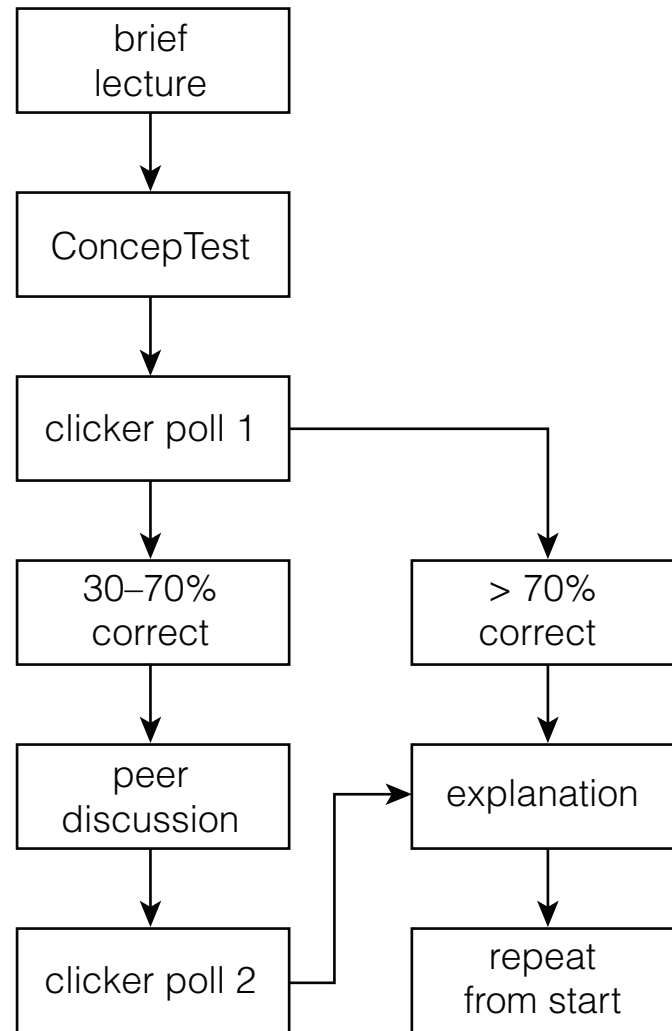
Promoting thinking



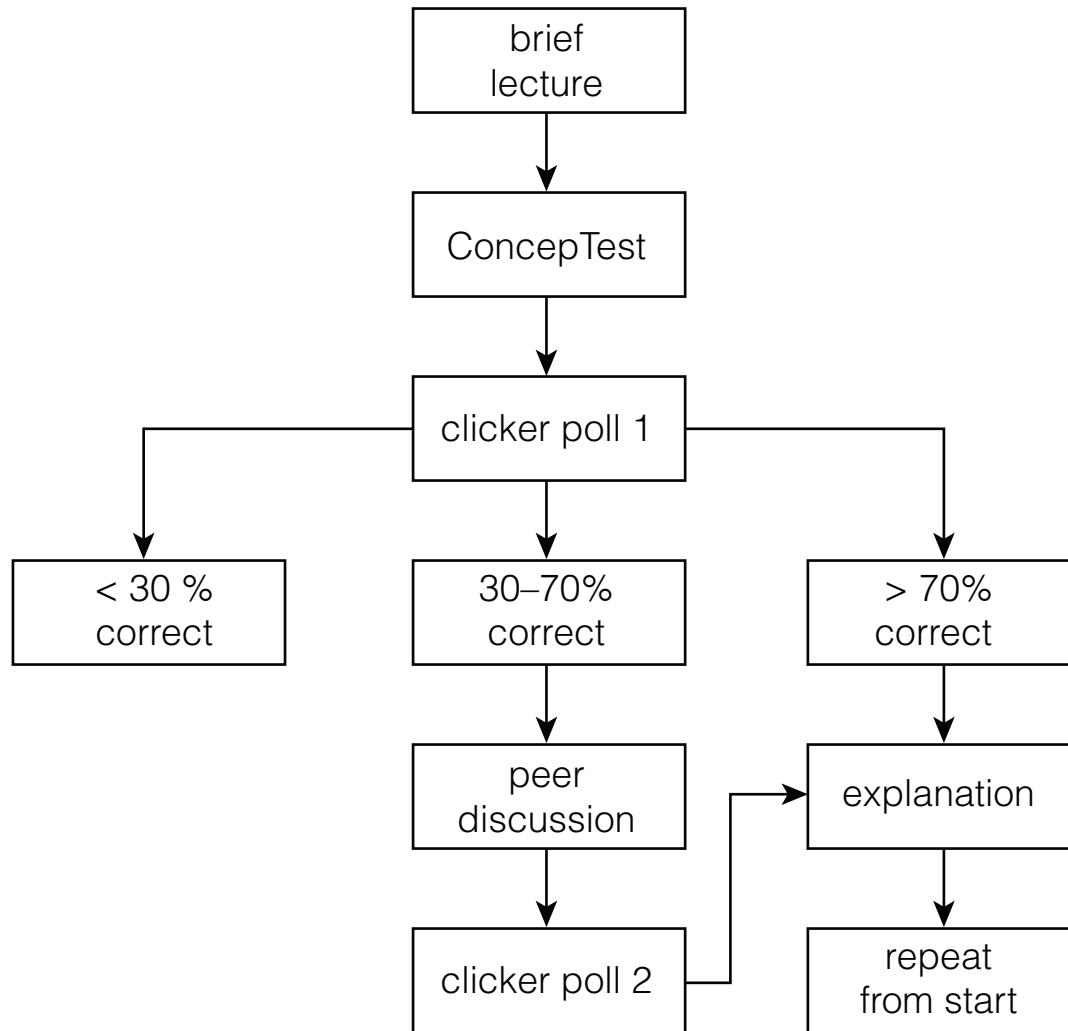
Promoting thinking



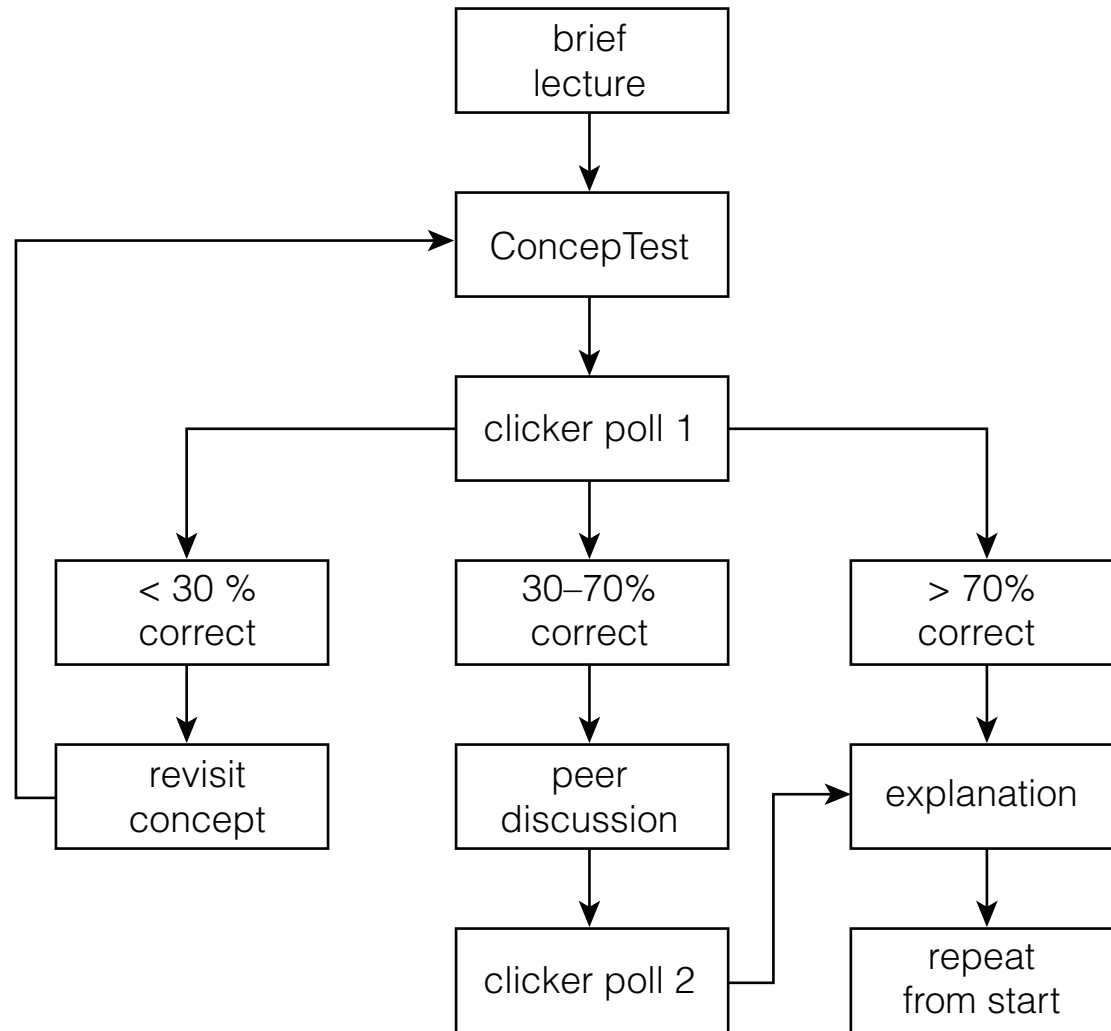
Promoting thinking



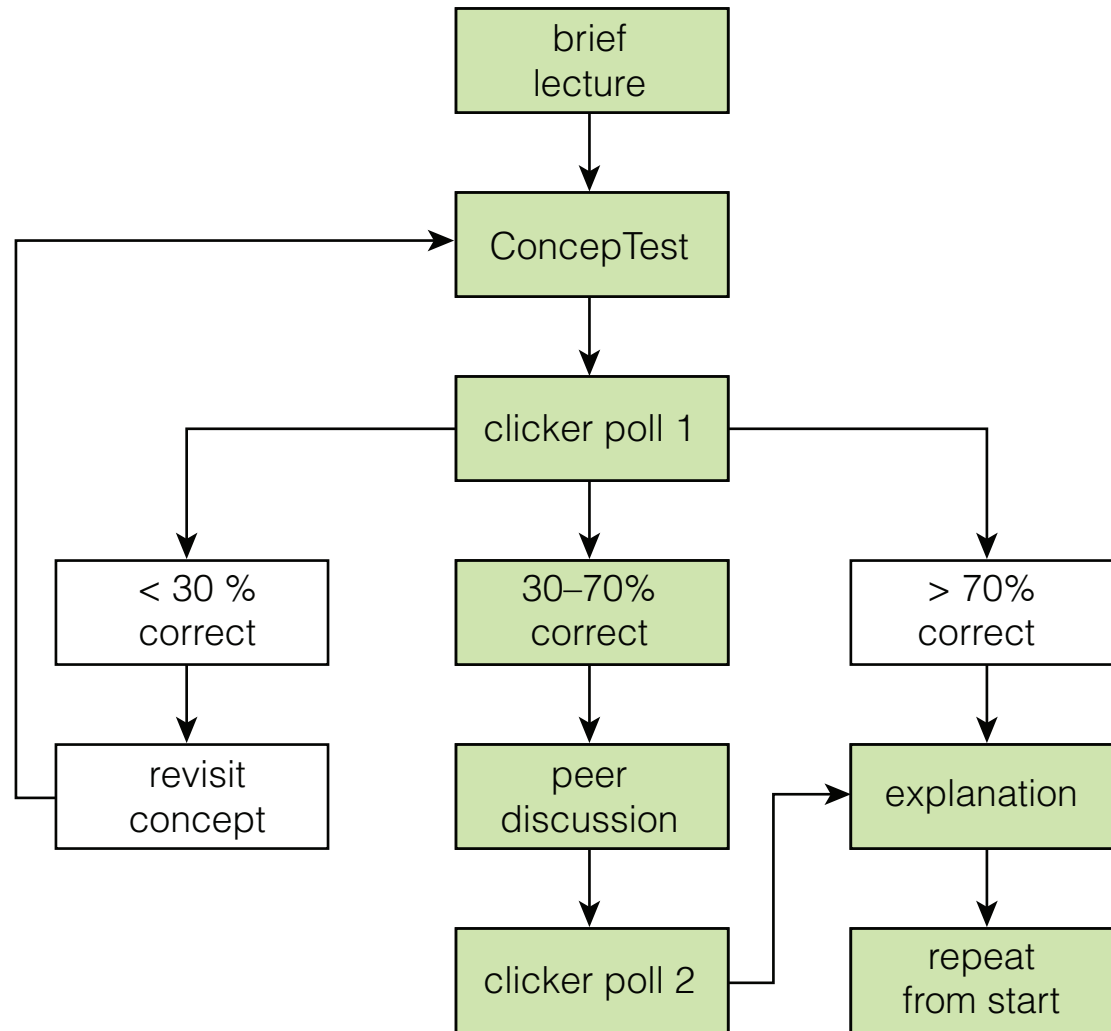
Promoting thinking



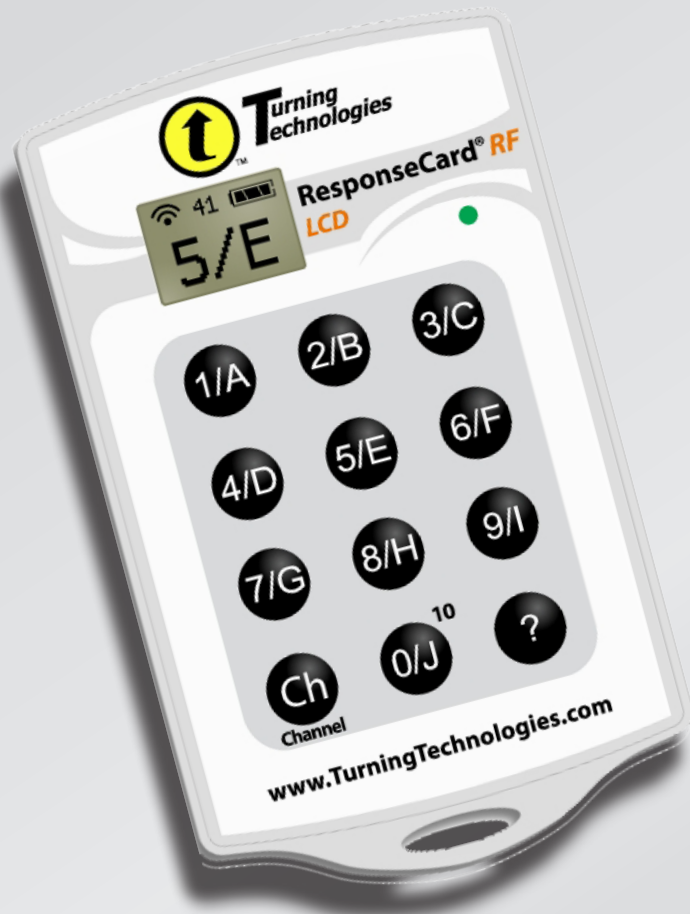
Promoting thinking



Promoting thinking



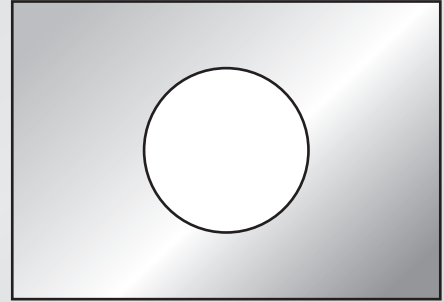
Promoting thinking



- no ON/OFF button
- only last “click” counts
- display shows recorded answer

Promoting thinking

Consider a rectangular metal plate with a circular hole in it.

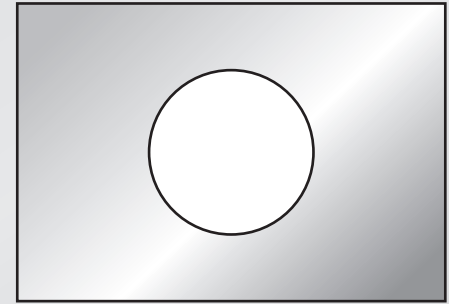


Promoting thinking

Consider a rectangular metal plate with a circular hole in it.

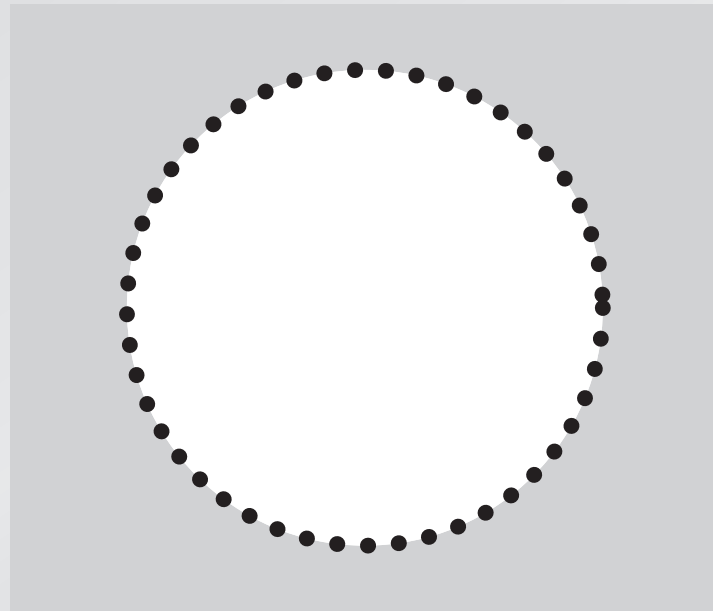
When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.



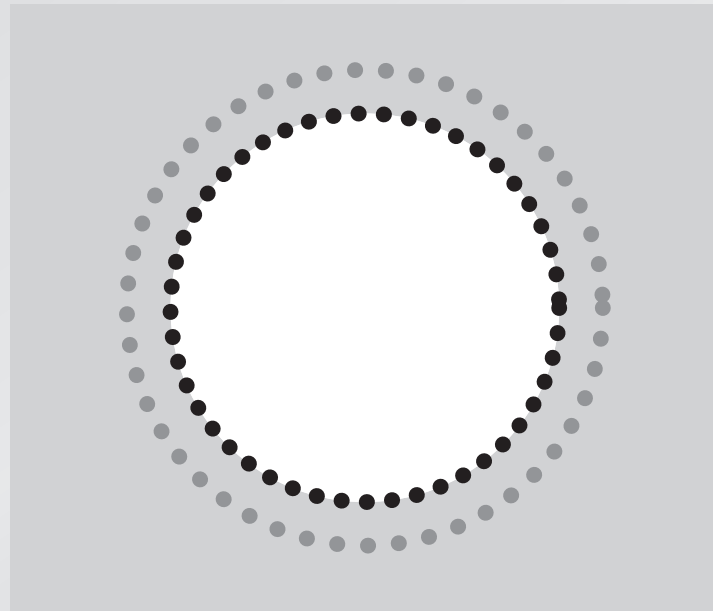
Promoting thinking

consider the atoms at the rim of the hole



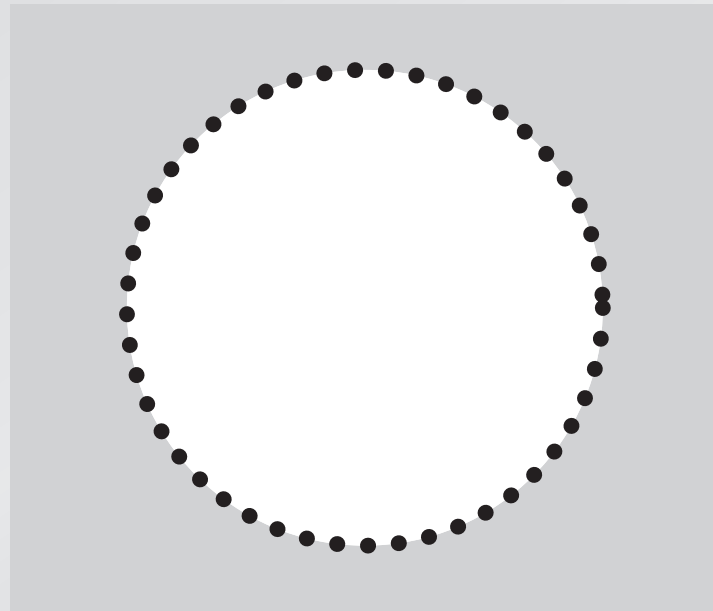
Promoting thinking

consider the atoms at the rim of the hole



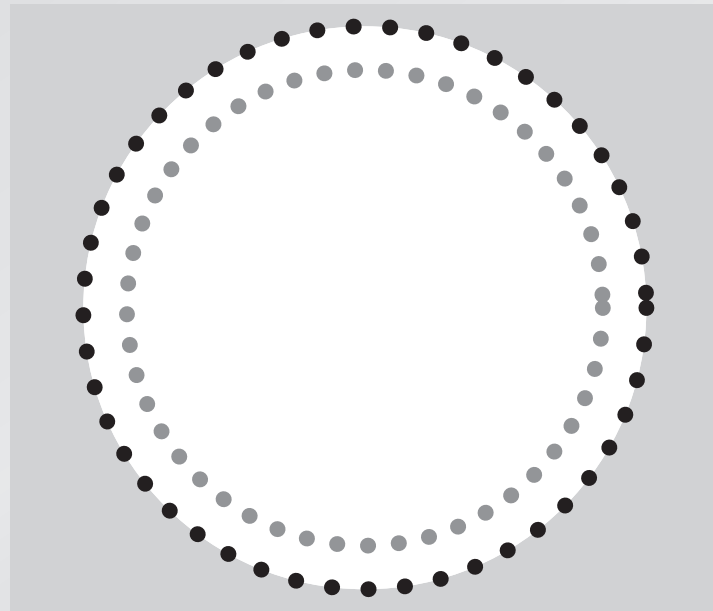
Promoting thinking

consider the atoms at the rim of the hole



Promoting thinking

consider the atoms at the rim of the hole



Promoting thinking

you all got engaged!

Promoting thinking

Benefits:

- engages students
- gets students to collaborate
- provides real-time feedback



Promoting thinking

Some hurdles:

- finding materials
- collecting and managing feedback
- making questions available to students

The screenshot shows a web browser window titled "ILT: Manage" with the URL "http://www.conceptest.org". The page is for a physics lecture on "Changing magnetic fields II 4/8". It features a navigation menu with "HOME", "READING", "LECTURES", "ASSIGNMENTS", "FORUMS", "NEWS", and "HANDOUTS". The main content area displays a question about a magnet falling through a tube, with a diagram showing a magnet falling through a tube with a magnetic field B indicated. The question asks for the magnet's speed compared to a freely-falling magnet. The answer is provided as: 1. more slowly, 2. exactly the same way, 3. faster. A hint and a detailed answer are also shown. The page includes a sidebar with "E-MAIL", "COMING UP", "TOOLS", and "QUICK LINKS" sections. The footer contains copyright information and a "Select Section" dropdown menu.

Outline

- Personalizing instruction
- Promoting thinking
- Integrating instruction

Integrating instruction

The screenshot shows a web browser window titled "ILT: Login" with the URL "http://www.concepttests.org/". The browser's address bar and search bar are visible. The website's header is a blue bar with the text "Interactive Learning Toolkit".

SIGN IN

E-Mail ([register](#))
mazur@physics.harvard

Password ([forgot?](#))
.....

Remember me ([security](#))

© 2002 Eric Mazur
All rights reserved
[Report a problem](#)

The Interactive Learning Toolkit helps you implement innovative teaching ideas, such as [Peer Instruction](#) and [Just-in-Time-Teaching](#), and to monitor your students' learning. Our goal is to help you focus on teaching by streamlining the organizational work that accompanies the teaching of a course. Select materials for class use from a large class-tested database and organize (and possibly share) your own materials. Administer your courses, design course Web pages, and interact with your students online.

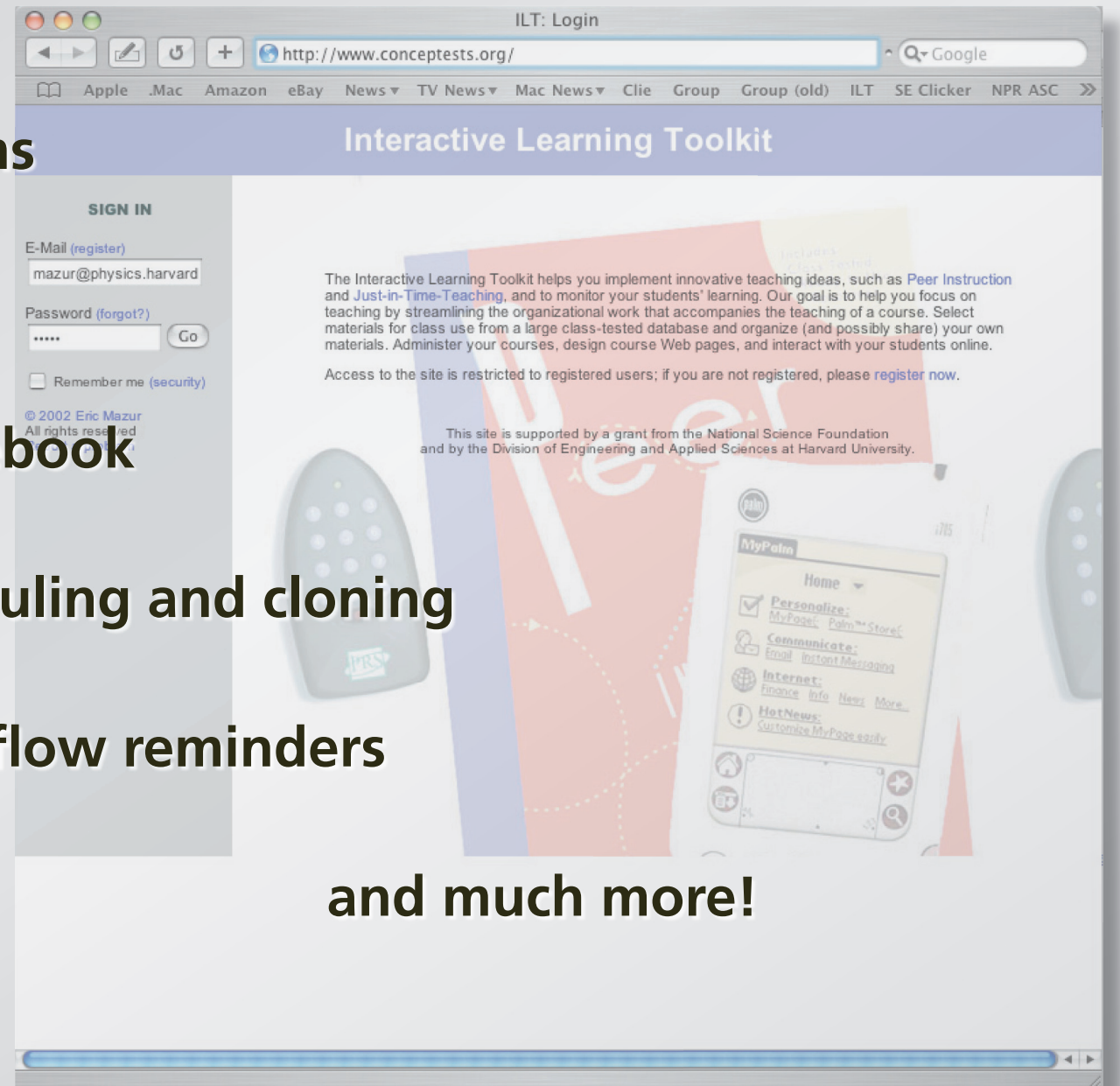
Access to the site is restricted to registered users; if you are not registered, please [register now](#).

This site is supported by a grant from the National Science Foundation and by the Division of Engineering and Applied Sciences at Harvard University.

The background features a large graphic with the word "Peer" in a stylized font, overlaid on a red and blue background. Below the text, there are images of a Palm OS handheld device and a MyPalm screen displaying a home menu with options like "Personalize", "Communicate", "Internet", and "HotNews".

Integrating instruction

- forums
- email
- gradebook
- scheduling and cloning
- workflow reminders



and much more!

Integrating instruction

online assessment module

- easy to administer
- easy to implement
- easy results!

The screenshot shows a web browser window titled "ILT-BQ: Results" with the URL "http://qemp.deas.harvard.edu". The page is for "Physics 1b" and is dated "February 2006". It is logged in as "Eric Mazur". The navigation menu includes HOME, READING, LECTURES, ASSIGNMENTS, FORUMS, NEWS, and HANDOUTS. The main content area displays "Results" for a "Physics Background Questionnaire".

Question 1: The figure below shows a boy swinging on a rope, starting at a point higher than P . Consider the following distinct forces:

1. A downward force of gravity.
2. A force exerted by the rope pointing from P to O .
3. A force in the direction of the boy's motion.
4. A force pointing from O to P .

Which of the above forces is (are) acting on the boy when he is at position P ?

Bar chart for Question 1:

Force	Count
1	126
2	7
3	32
4	9

Question 2: An elevator is being lifted up an elevator shaft at a constant speed by a steel cable as shown in the figure below. All frictional effects are negligible. In this situation, forces on the elevator are such that:

- A. the upward force by the cable is greater than the downward force of gravity.
- B. the upward force by the cable is equal to the downward force of gravity.
- C. the upward force by the cable is smaller than the downward force of gravity.
- D. the upward force by the cable is greater than the sum of the downward force of gravity and a downward force due to the air.
- E. none of the above. (The elevator goes up because the cable is being shortened, not because an upward force is exerted on the elevator by the cable.)

Bar chart for Question 2:

Option	Count
A	59
B	105
C	7
D	7

The interface also includes a sidebar with "E-MAIL", "TOOLS", "QUICK LINKS", and "SITE ADMIN" sections.

Integrating instruction

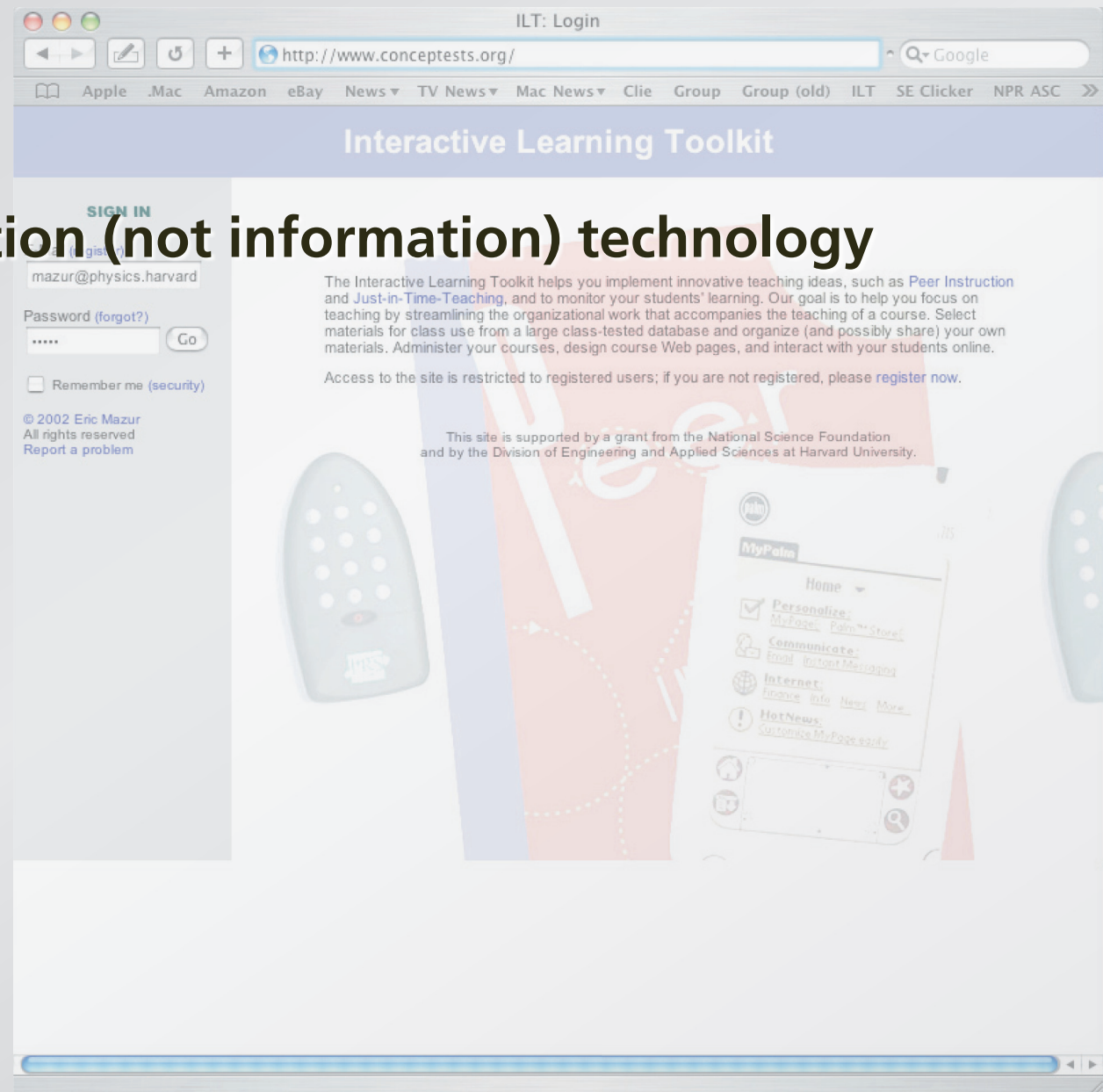
Available assessment instruments

- **Force Concept Inventory**
- **Conceptual Survey on Electricity and Magnetism**
- **Lawson's test for scientific reasoning**
- **Astronomy Diagnostic Test**
- **Maryland Physics Expectation Test**

over 25,000 students tested!

Summary

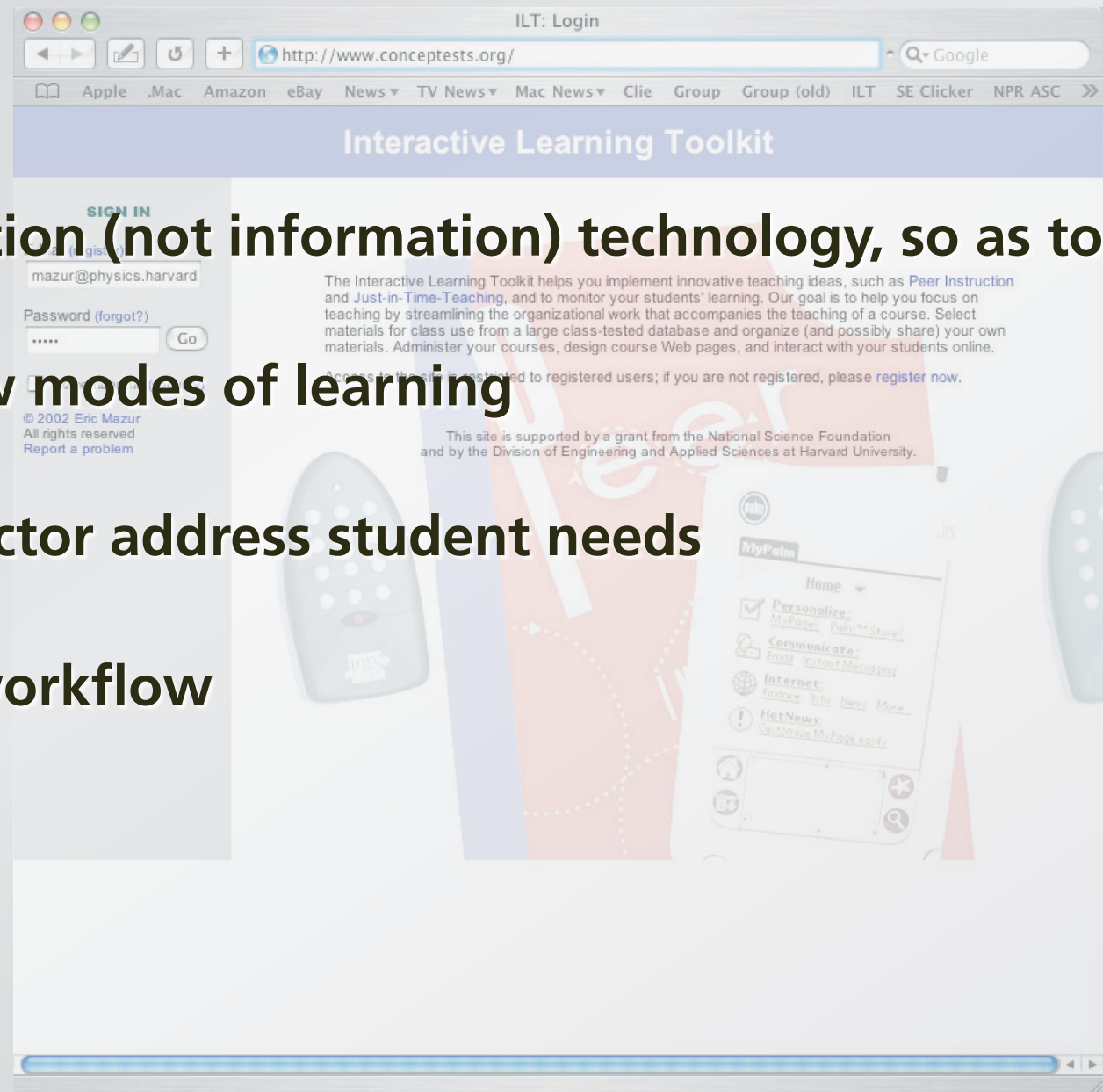
we need education (not information) technology



Summary

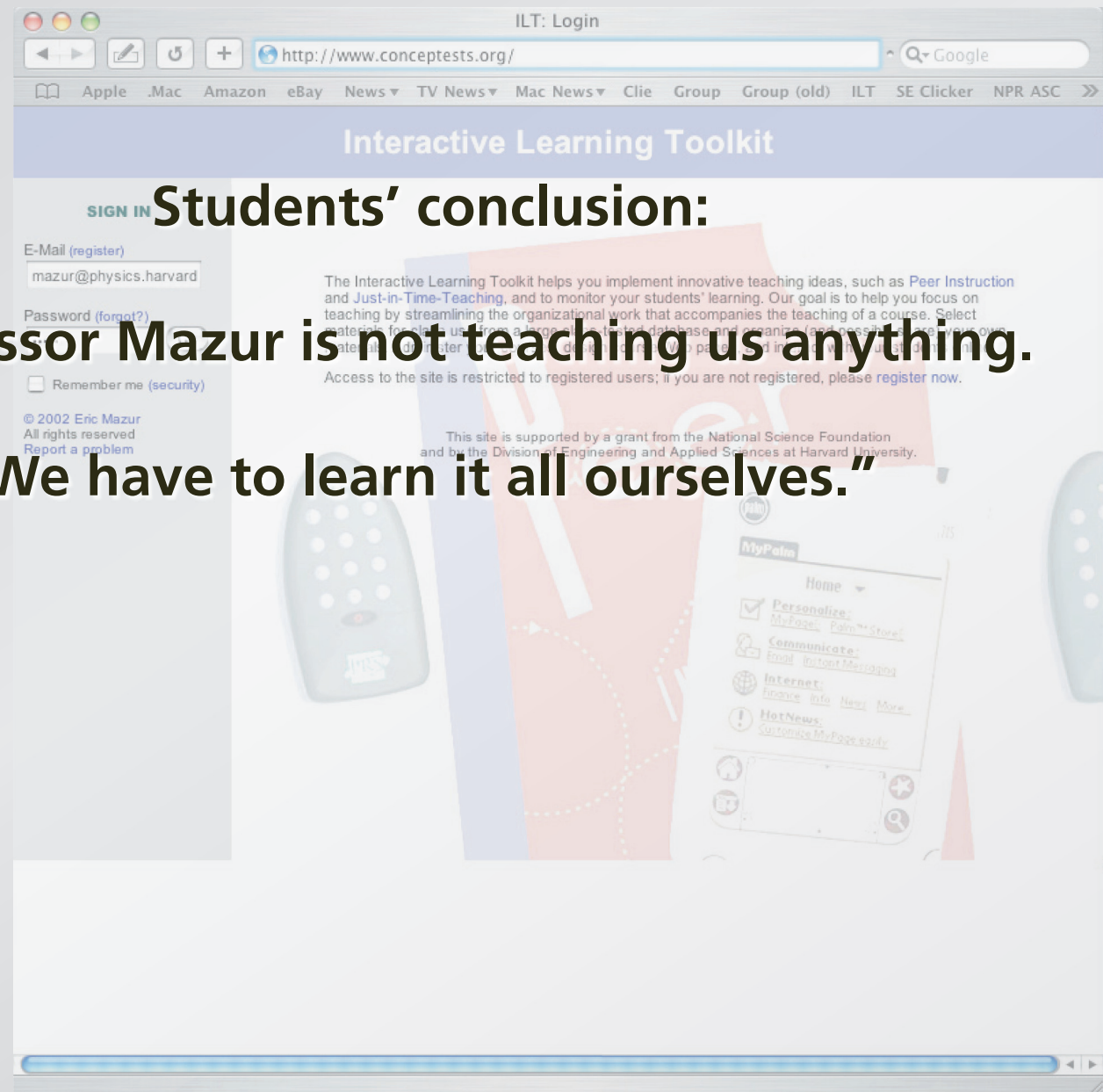
we need education (not information) technology, so as to:

- enable new modes of learning
- help instructor address student needs
- facilitate workflow



Summary

Students' conclusion:
**"Professor Mazur is not teaching us anything.
We have to learn it all ourselves."**



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