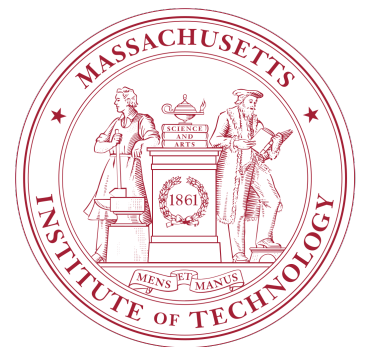




Struttura e impatto di didattiche alternative: *la metodologia TEAL e l'esperienza di ESG*

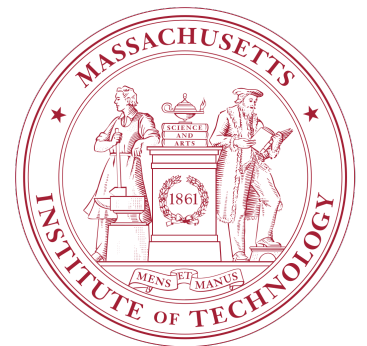
Dott.ssa Paola Rebusco
pao@mit.edu





Obiettivi

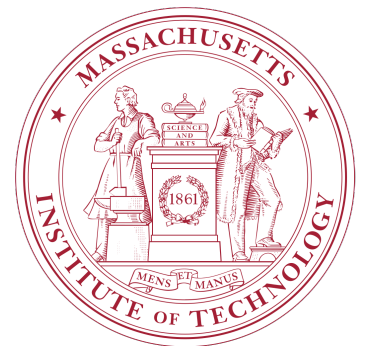
- Raccontarvi i metodi di insegnamento della fisica al MIT
- ...e magari ispirarvi a provare qualcosa di diverso nelle vostre classi





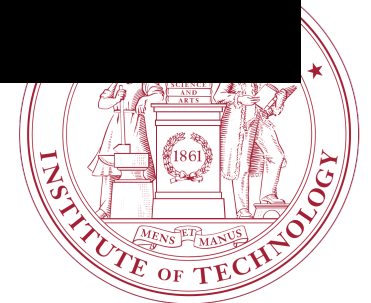
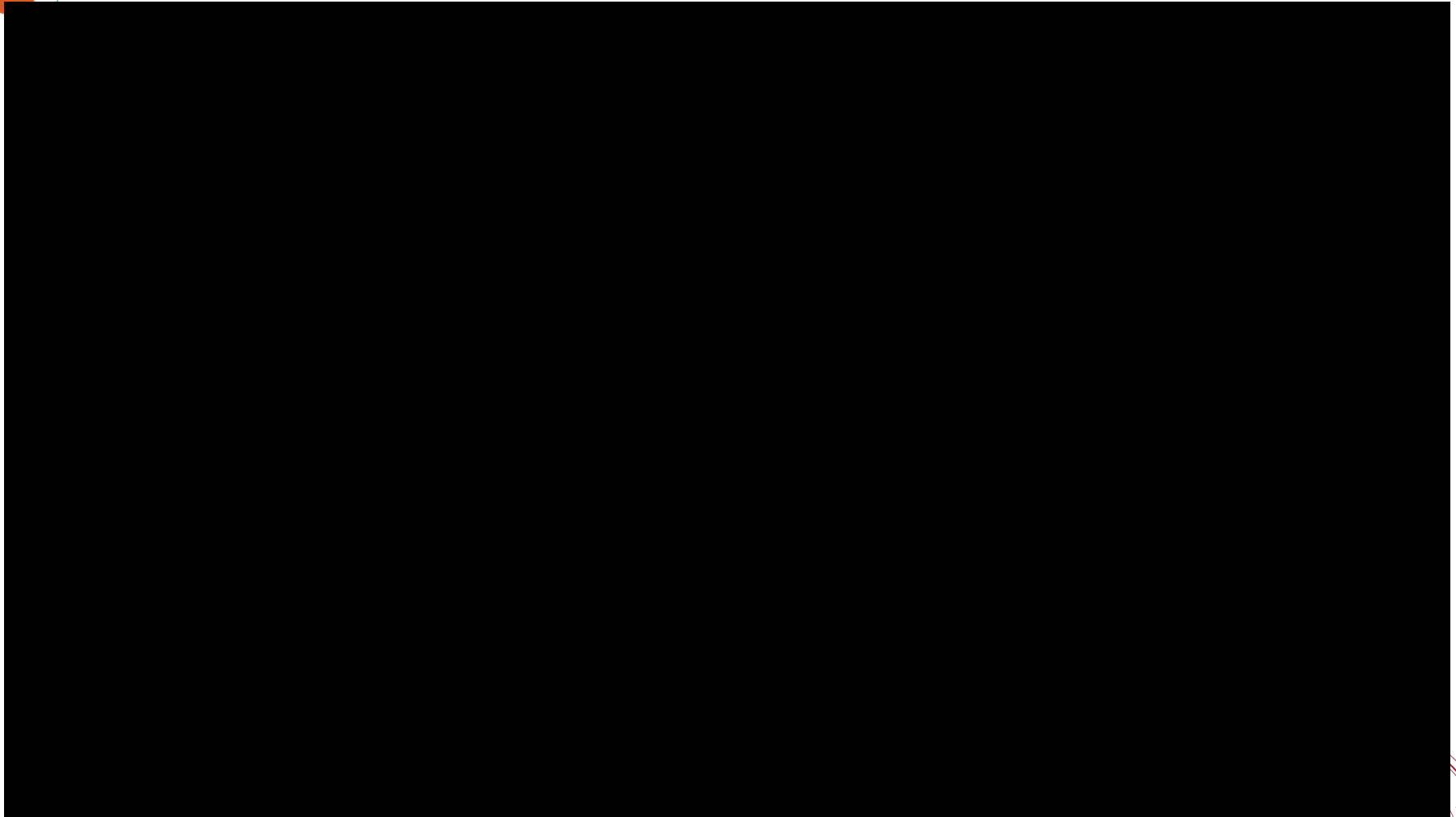
PREMESSA: Fisica per tutti

- tutti gli studenti del MIT hanno una base di materie comuni a tutti i corsi di laurea (**General Institute Requirements**): *fisica, analisi, chimica, biologia*
- Gli studenti del I anno possono fare domanda per partecipare alle lezioni nell'Experimental Study Group (ESG) piuttosto che nelle classi "normali"





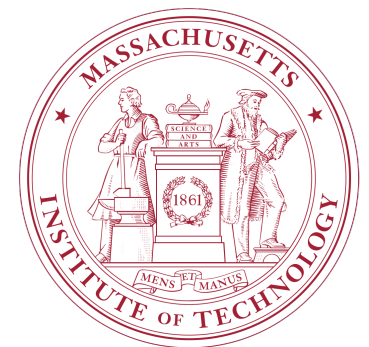
Cos'è l'Experimental Study Group (ESG)?





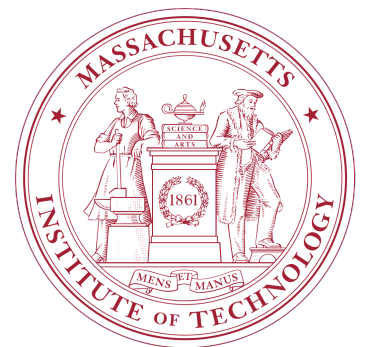
Cos'è l'ESG (dal 1969)?

- Una comunità accademica per gli studenti del primo anno in cui imparare il curriculum base in **classi piccole** (6-12 alunni) e **interattive**
- Un ambiente in cui professori e *lecturers* possono **sperimentare** nuovi approcci didattici
- Un luogo in cui **gli studenti** degli anni successivi possono ritornare a fare da **assistenti** nell'insegnamento
- ...





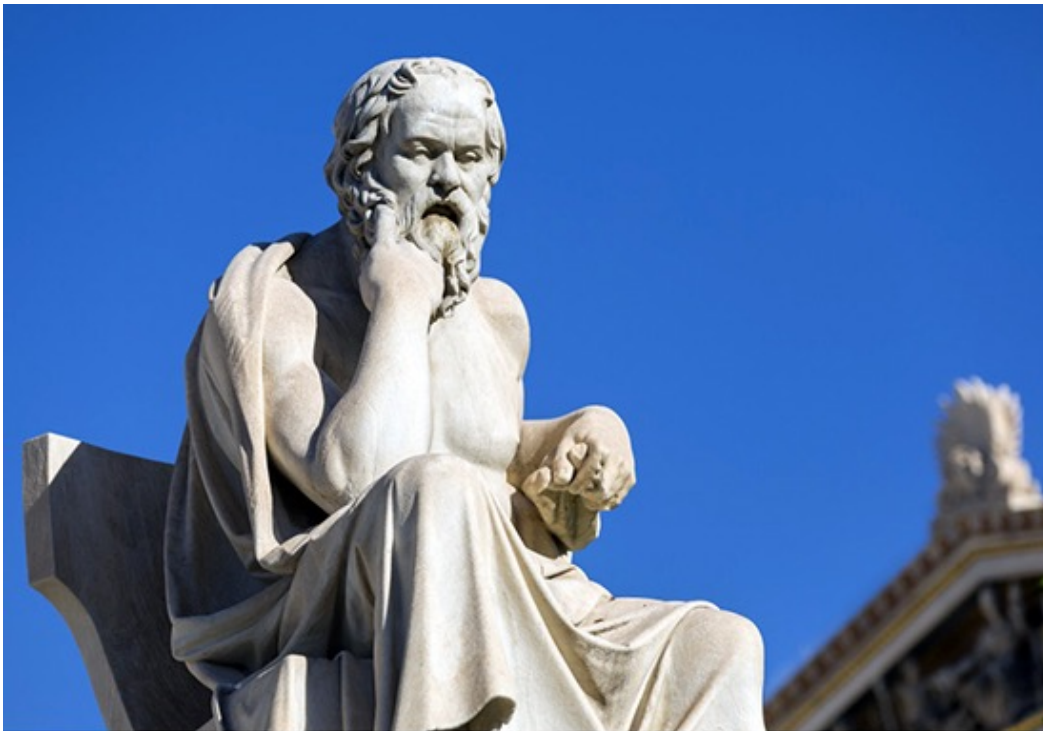
Come insegniamo all'ESG?



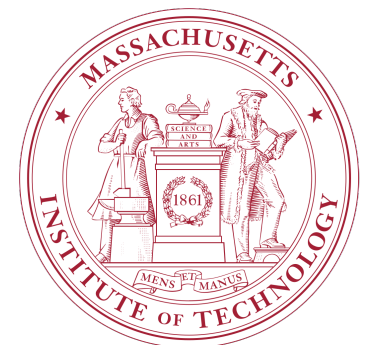


“Nuova” pedagogia

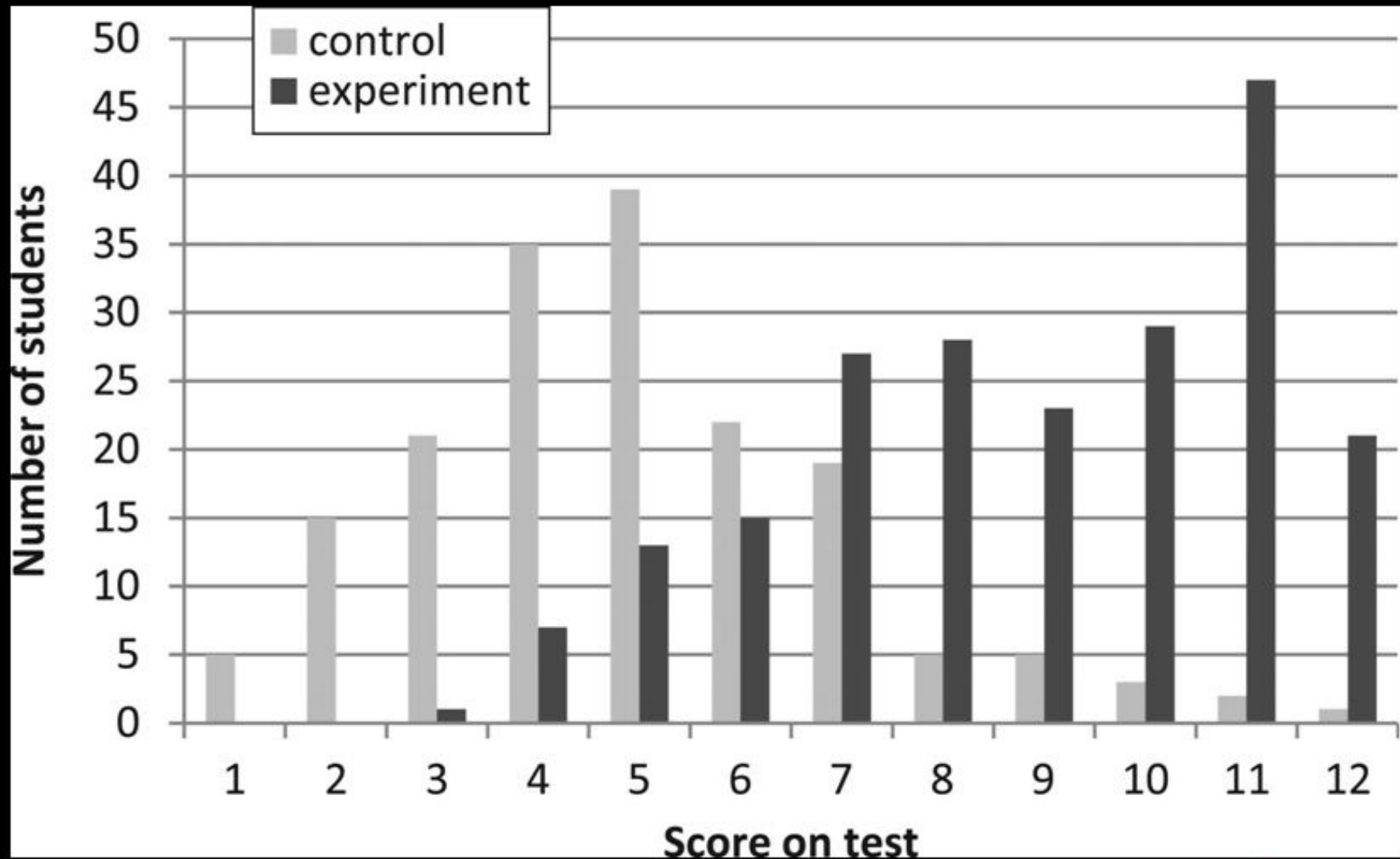
- **Active learning – apprendimento attivo**



Approccio
socratico



Active Learning



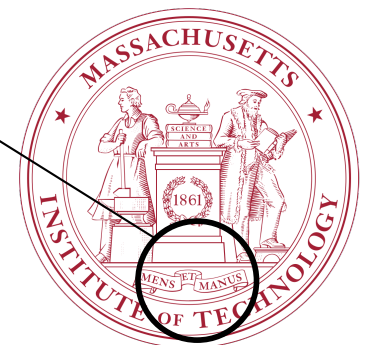
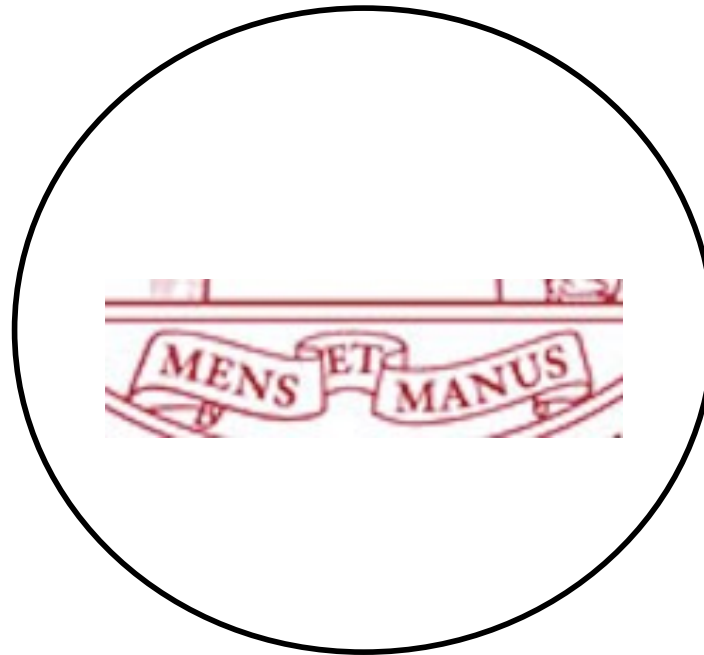
L Deslauriers et al. Science 2011;332:862-864

**Fig. 1 Histogram of 270 physic student scores for the two sections:
Experiment w/ quizzes and active learning. Control without.**



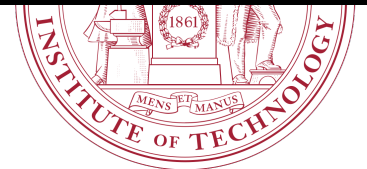
“Nuova” pedagogia

- Active learning – apprendimento attivo
- **Hands-on learning - imparare facendo (?)**
- **Project enhanced learning – apprendimento potenziato da progetti**





Hands-on learning

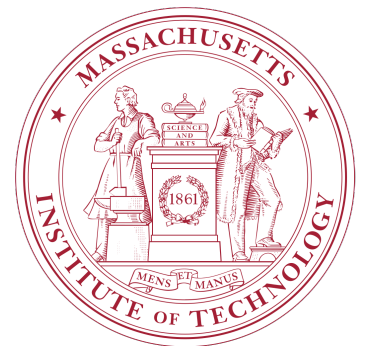




“Nuova” pedagogia

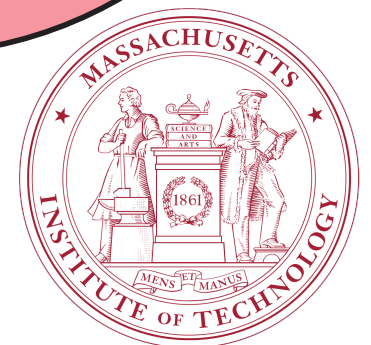
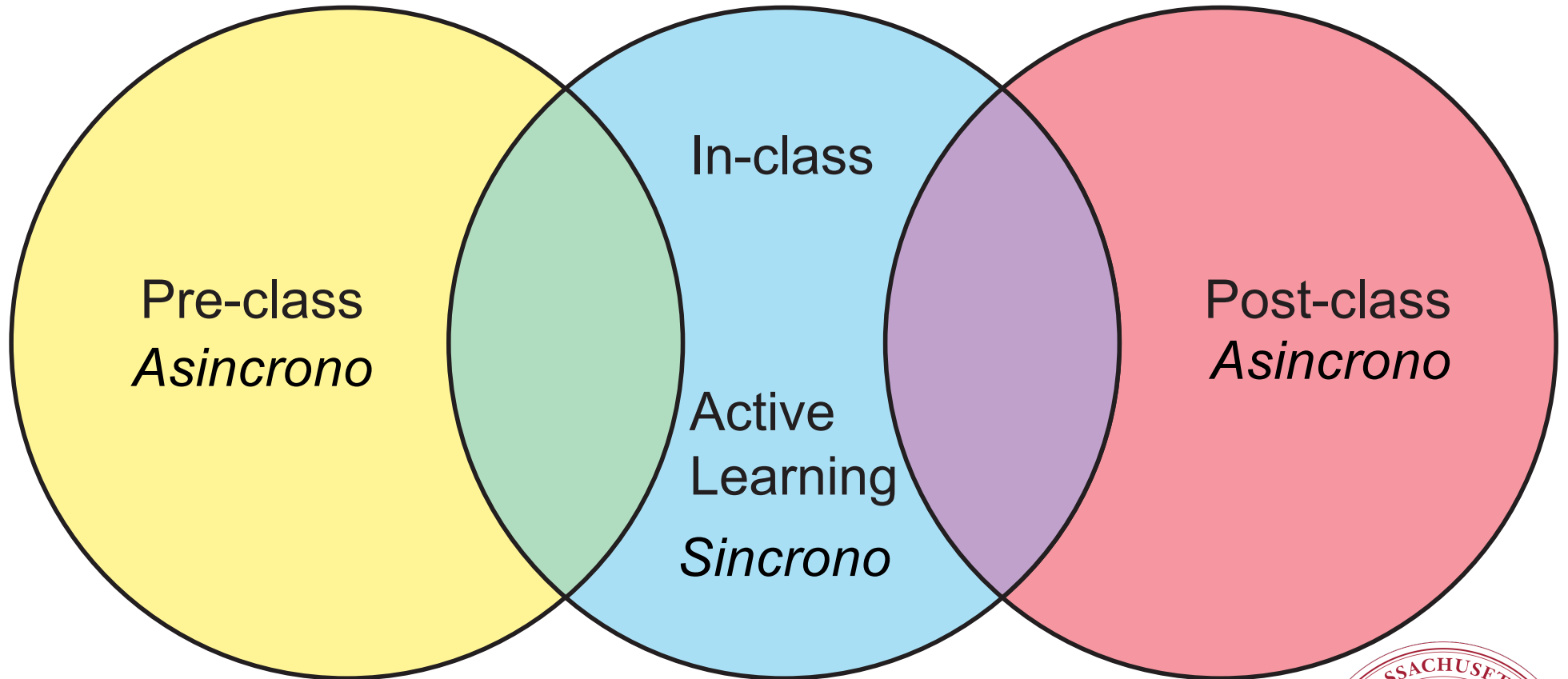
- Active learning – apprendimento attivo
- Hands-on learning - imparare facendo (?)
- Project enhanced learning – apprendimento potenziato da progetti

- **Flipped classroom – lezione capovolta**





Struttura tipica di un corso

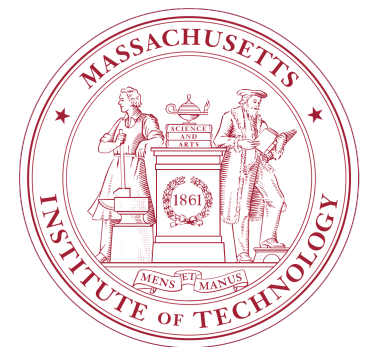




“Nuova” pedagogia

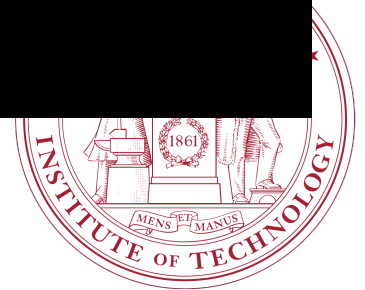
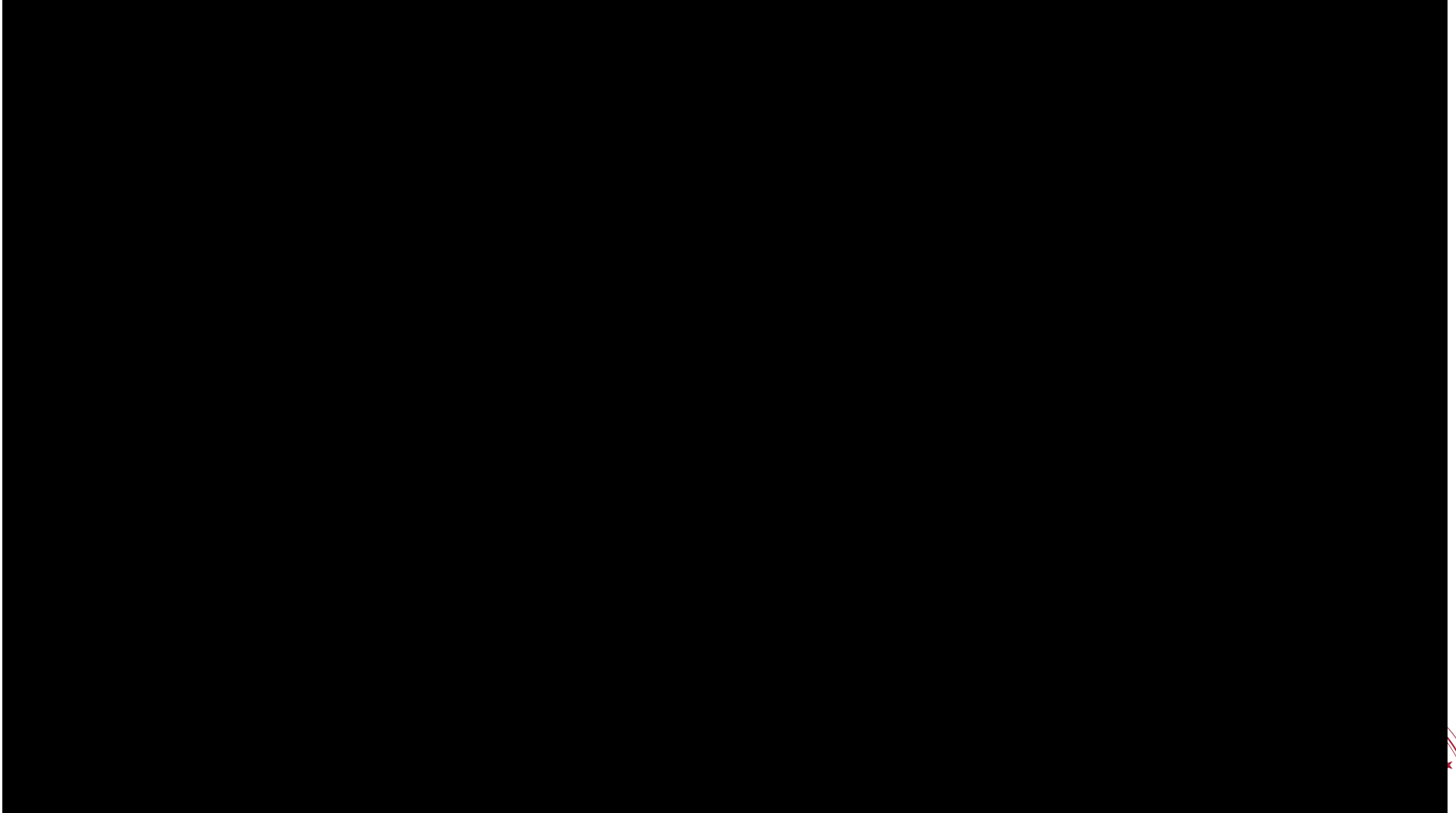
- Active learning – apprendimento attivo
- Hands-on learning - imparare facendo (?)
- Project based learning – apprendimento basato sul progetto
- Flipped classroom – lezione capovolta

- **Peer teaching – educazione tra pari**





Peer teaching

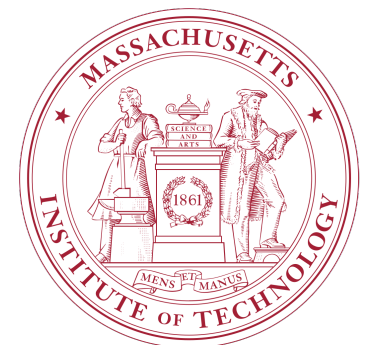




“Nuova” pedagogia

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- Hands-on learning - imparare facendo (?)
- Project based learning – apprendimento basato sul progetto
- Flipped classroom – lezione capovolta
- Peer teaching – educazione tra pari

- **Interdisciplinary experiments – esperimenti interdisciplinari**





I seminari di ESG

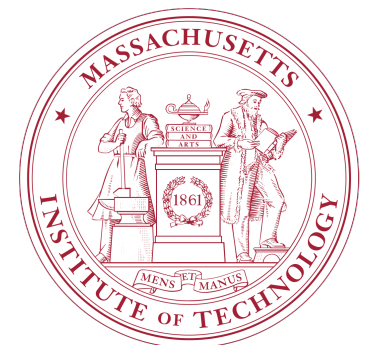
Tipicamente 6 unità, 2 ore a settimana

Chemistry of Sports; The Math of Toys and Games;

Speak Italian...with your mouth full; Kitchen Chemistry;

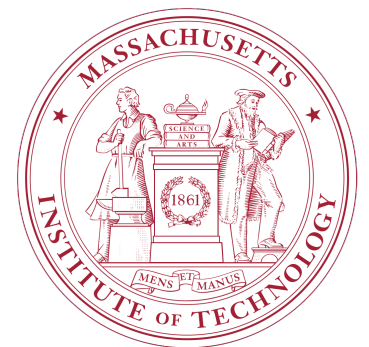
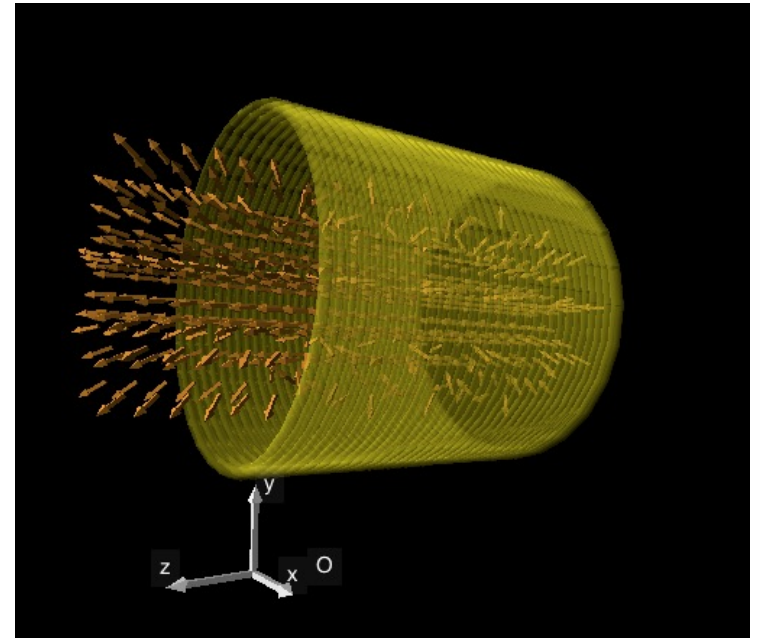
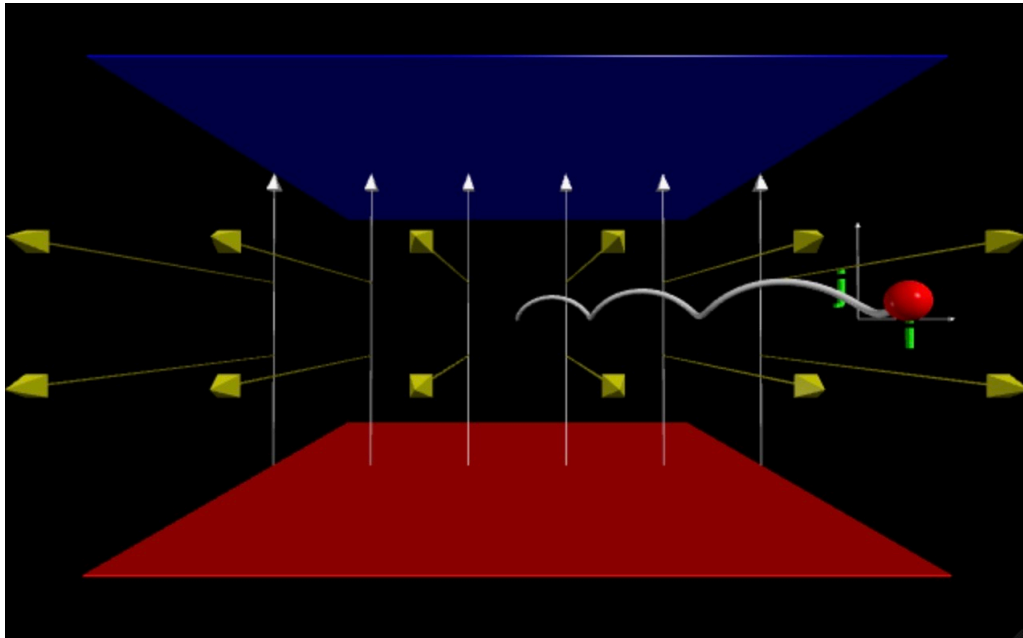
*American Photography and its Influence; **E&M and***

mechanics with Python





Un ponte tra fisica e informatica

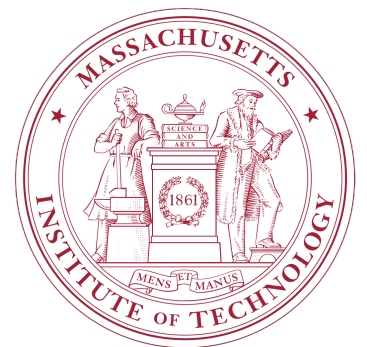




“Nuova” pedagogia

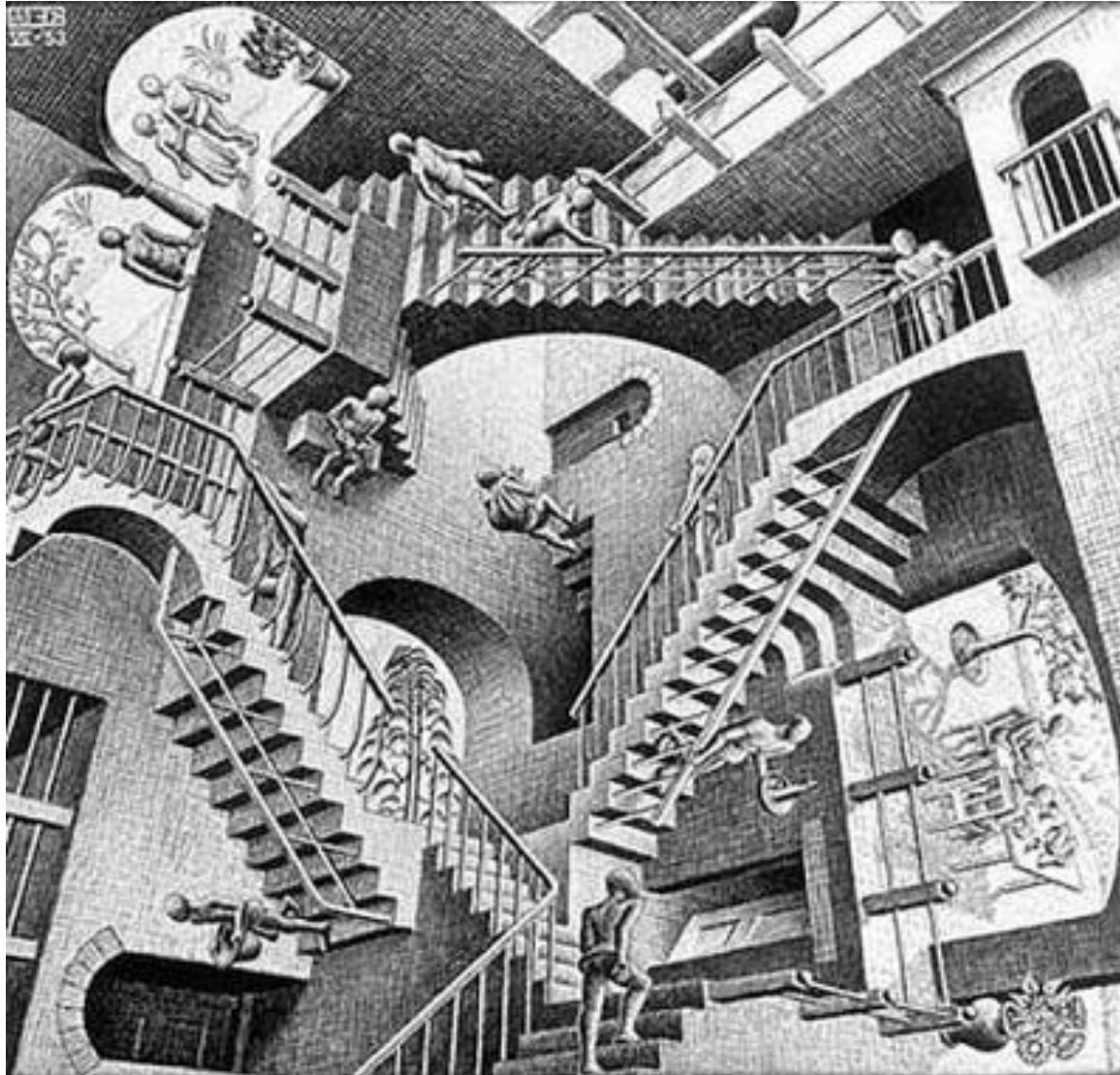
- Active learning – apprendimento attivo
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- Project enhanced learning – apprendimento potenziato da progetti
- Flipped classroom – lezione capovolta
- Peer teaching – educazione tra pari
- Interdisciplinary experiments – esperimenti interdisciplinari

COME APPLICARLA SU LARGA SCALA (~
900 alunni per volta) ???

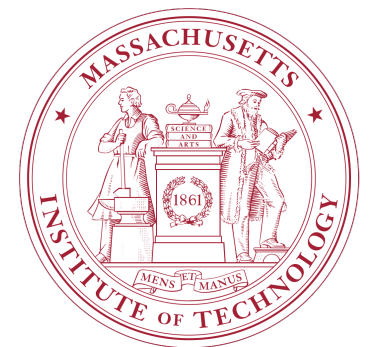




Dal piccolo al grande



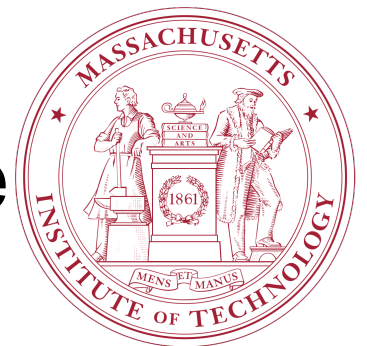
"Scale" di M.C. Escher





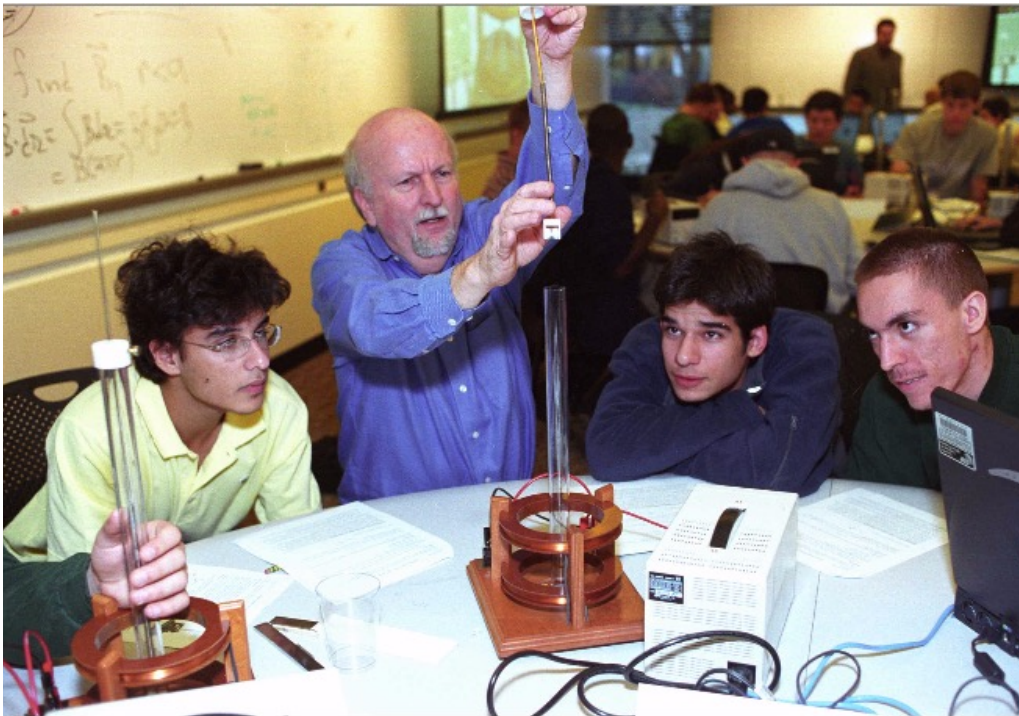
Verso un apprendimento attivo per tutti...

- Prof. Eric Mazur “Peer Instruction” (Harvard, 1991): lettura di materiale prima delle lezioni, approfondimento in classe, domande concettuali con discussioni tra pari
- MIT’s Integrated Studies Program (1995 – imparare facendo: la relazione tra tecnologia e cultura)
- SCALE UP alla North Carolina State University (Prof. Bob Beichner)





Technology Enabled Active Learning (TEAL) Studio (2001)

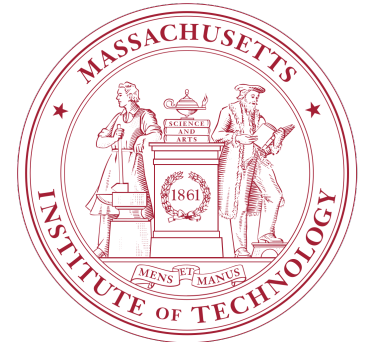


Prof. John Belcher



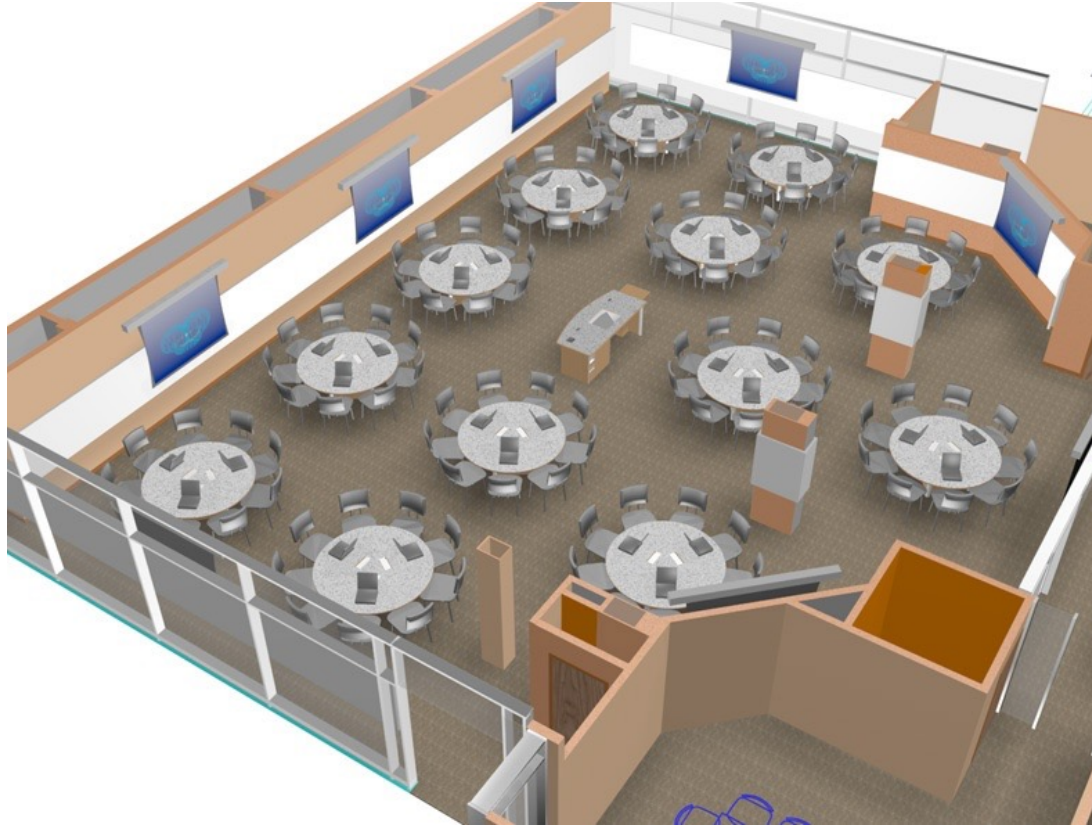
Dr Peter Dourmashkin

MIT Physics Department





Nuovi ambienti: l'aula TEAL



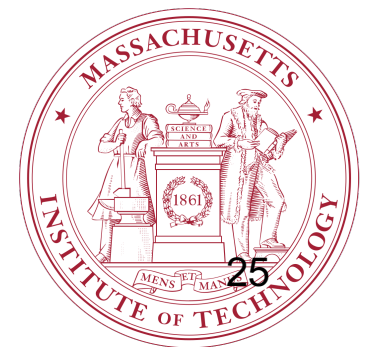
Fondatori:

Prof. John
Belcher

Dr. Peter
Dourmashkin

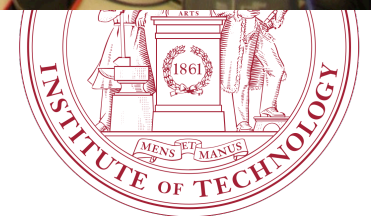
Prof. David Lister

Apprendimento collaborativo (aula ispirata dall'NCSU's Scale-Up): nove studenti per tavolo in gruppi di tre





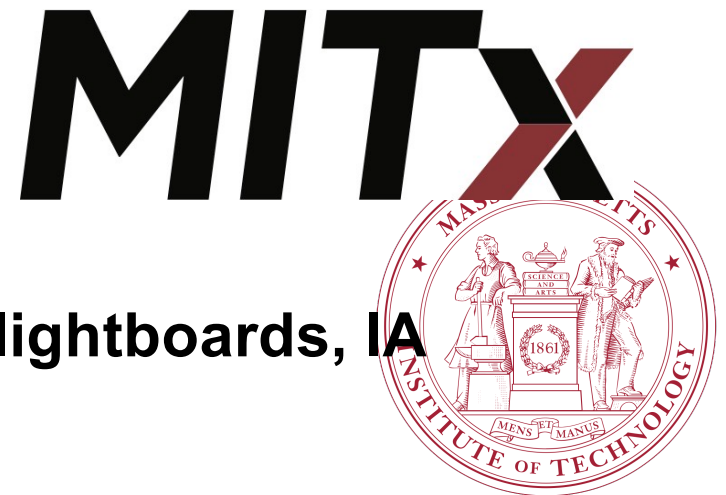
TEAL in azione



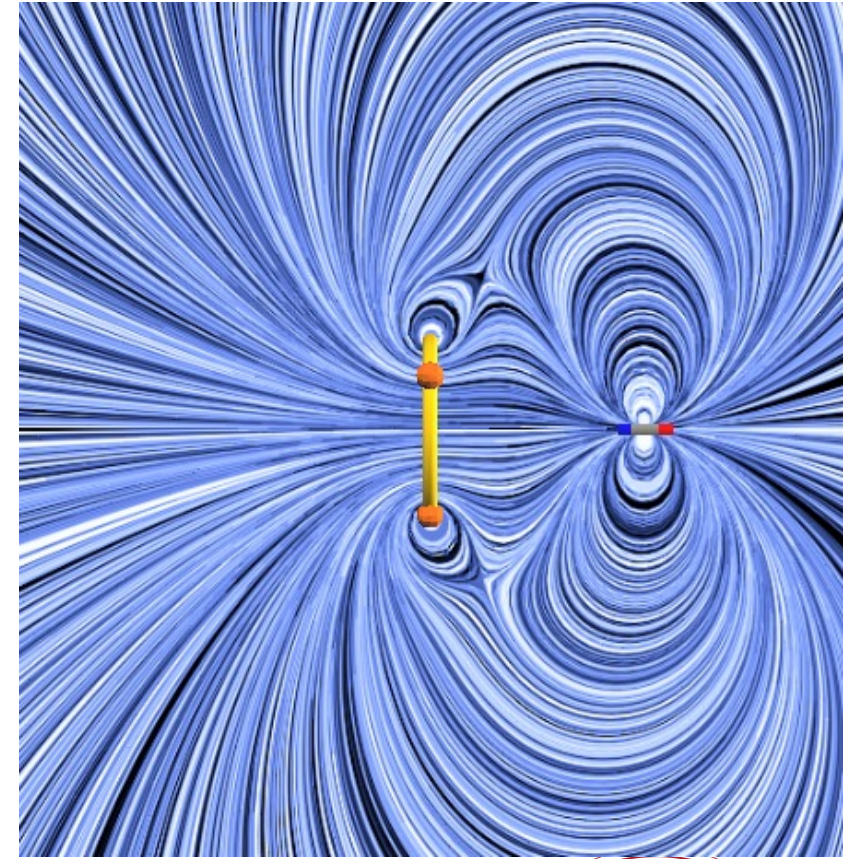
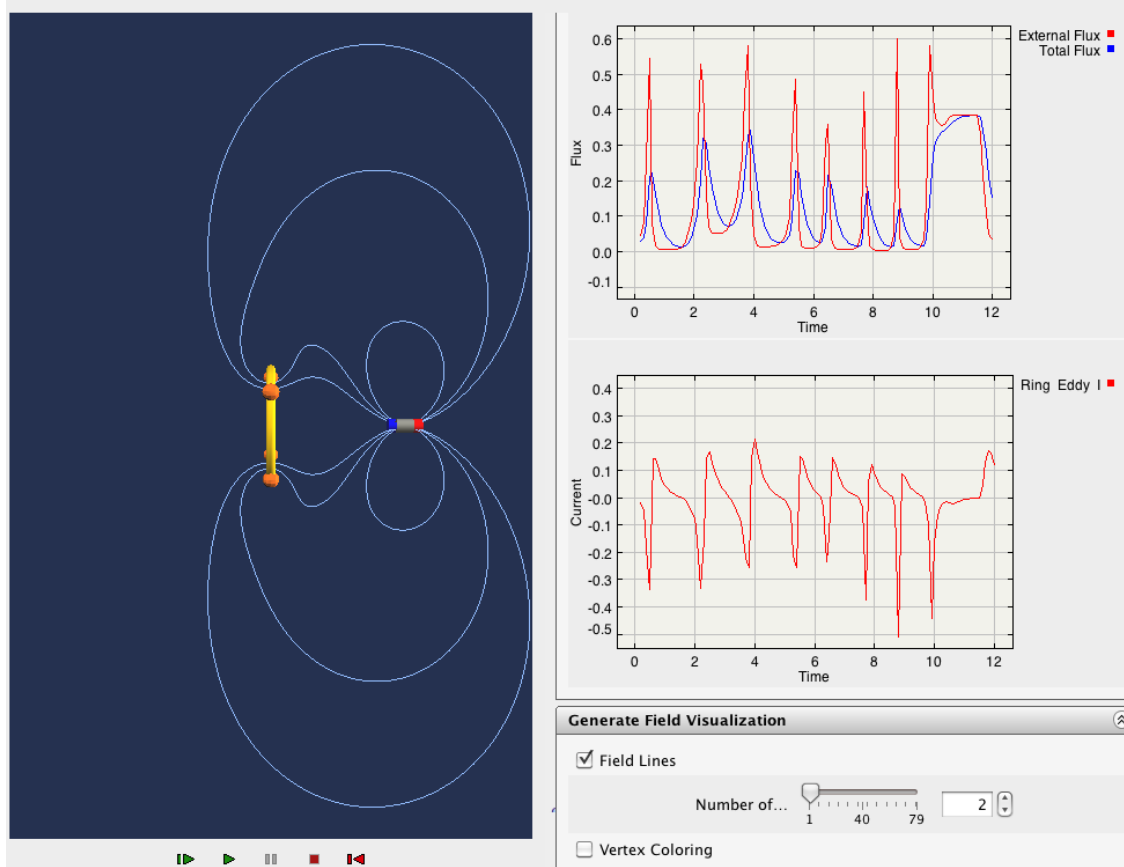


“Nuova” pedagogia

- Active learning – apprendimento attivo
- Hands-on learning - imparare facendo (?)
- Project enhanced learning – apprendimento potenziato da progetti
- Flipped classroom – lezione capovolta
- Peer teaching – educazione tra pari
- Interdisciplinary experiments – esperimenti interdisciplinari
- **Technology Enabled Active Learning**– apprendimento attivo grazie alla tecnologia
- ***Blended learning*: MITx, simulazioni, e lightboards, IA**

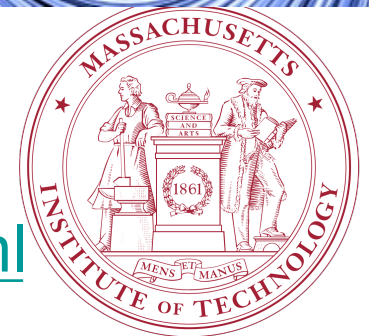


Simulazioni on-line

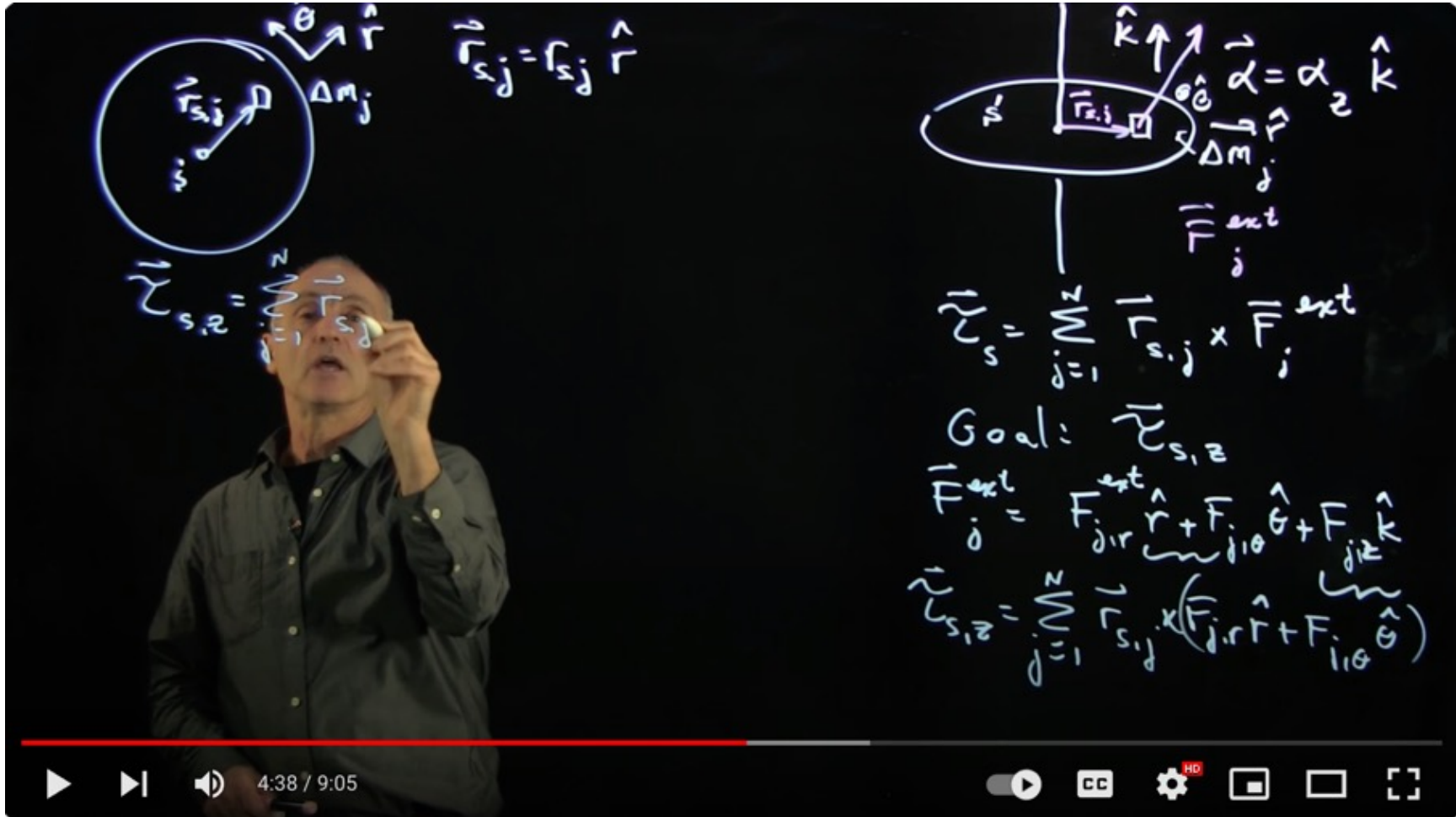


La legge di Lenz...resistenza al cambiamento

<http://public.mitx.mit.edu/gwt-teal/FaradaysLaw2.html>



Video fatti con Lightboards

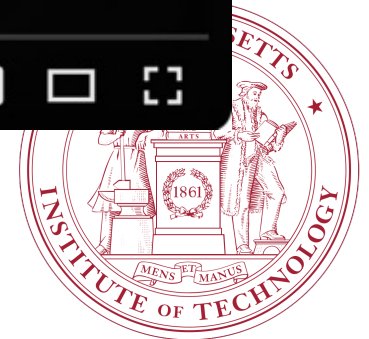


The video frame shows a lecturer writing on a lightboard. The board contains several diagrams and equations:

- Top left: A circular diagram with a vector $\vec{r}_{s,j}$ pointing from a center s to a point j . An angle θ is shown between $\vec{r}_{s,j}$ and a vertical axis \hat{r} . A mass difference Δm_j is noted.
- Top right: A diagram showing a vector $\vec{r}_{s,j}$ and an angle $\alpha = \alpha_2$ relative to a vertical axis \hat{k} . A vector $\vec{F}_{s,j}^{ext}$ is shown.
- Bottom left: A summation equation:
$$\vec{L}_{s,2} = \sum_{j=1}^n \vec{r}_{s,j} \times \vec{p}_j$$
- Bottom right: A goal statement:
$$\text{Goal: } \vec{L}_{s,2}$$
- Below the goal: A vector equation for external force:
$$\vec{F}_j^{ext} = F_{j,r} \hat{r} + F_{j,\theta} \hat{\theta} + F_{j,k} \hat{k}$$
- Bottom right: A summation equation for angular momentum:
$$\vec{L}_{s,2} = \sum_{j=1}^n \vec{r}_{s,j} \times (F_{j,r} \hat{r} + F_{j,\theta} \hat{\theta})$$

The video player interface at the bottom shows a progress bar at 4:38 / 9:05 and various control icons.

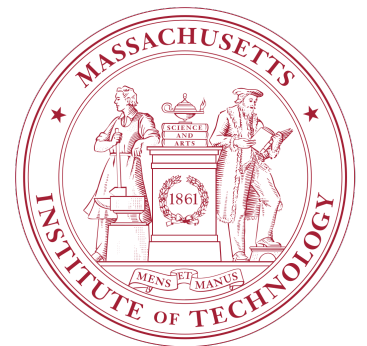
Dr Peter Dourmashkin – Senior Lecturer





Utilizzo di Intelligenza Artificiale

- per riassumere gli errori degli alunni prima della classe
- per offrire uno strumento in più di discussione





Per gli studenti...



Physics Today, Marzo 2017 ->

Commentary

How to teach me physics: Tradition is not always a virtue

Physics is the most exciting endeavor I can imagine. That is why I want to become a physicist and join what Richard Feynman called “the greatest adventure that the human mind has ever begun.”¹ Now, after my second year of undergraduate studies in astrophysics at University College London (UCL), I want to comment on some of the vicissitudes I have experienced while being taught physics.

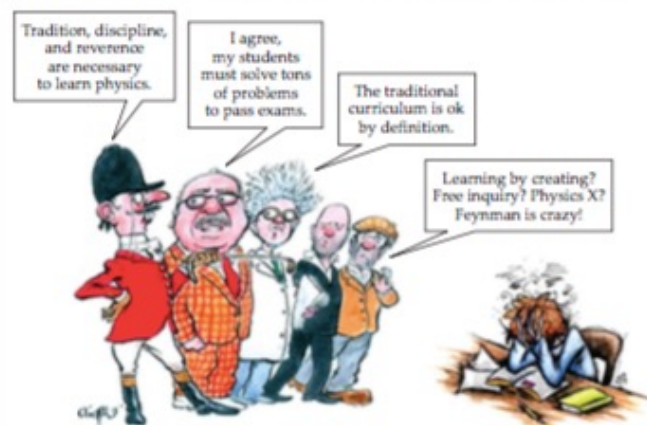
The basic courses of my first two years were disappointing. They didn’t really give me the opportunity to join that greatest adventure. Most of my lecturers followed traditional teaching approaches based heavily on solving standard problems and learning by rote, with no hint of free inquiry or discussion. They seemed to be convinced that we would understand physics through that method. I was not enthusiastic.

Traditional teaching

My fellow students and I spent a lot of time and effort solving textbook-style problems. But we didn’t really understand physics by doing that. In practice, we were mostly trained to use problem-solving techniques. Feynman touched on that failing when he said, “I don’t know what’s the matter with people: they don’t learn by understanding; they learn by some other way—by rote or something. Their knowledge is so fragile!”²

I felt that fragility. The time crunch of a heavy course load forced me to memorize a lot of equations and mathematical procedures in order to pass my physics exams.

As time passed, I forgot many of the things I had studied. Noam Chomsky, interviewed in 2012 for the Learning Without Frontiers Conference, put it best when he said,



TRADITIONAL PHYSICS TEACHERS teach us to swim on the surface but not in the deep, where, as Steven Weinberg says, “the unclear, uncharted areas of science can lead to creative work” (*Nature* **426**, 389, 2003).

Passing tests doesn’t begin to compare with inquiring, searching, pursuing topics that engage us and excite us. In fact, you will remember what you discover—if you pursue this kind of learning.

The aspects of physics I have understood best so far are those I have studied for pleasure. I understood special relativity better when I derived the Lorentz transformations in a different form.³ This task was much more exciting than the usual assignment of calculating the length contraction of a rod. I understood Maxwell’s equations better when I reviewed the Helmholtz theorem⁴ and this task was far more thrilling than calculating the electric field of a charged sphere.

Traditional teaching methods urge us to perform standard calculations that

The idea that solving such problems is not the best way to understand physics was succinctly expressed by Dieter Nachtigall:

Pupils can often solve what textbook authors call “problems” without understanding the physics concepts involved in them. Such “problem solving” often exhibits nothing else than the ability to find some appropriate equations, put them together, manipulate them algebraically, fill in figures and finally come out with the “correct answer.” A student can be good with the formulae but may have understood nothing about the physics behind them.⁵

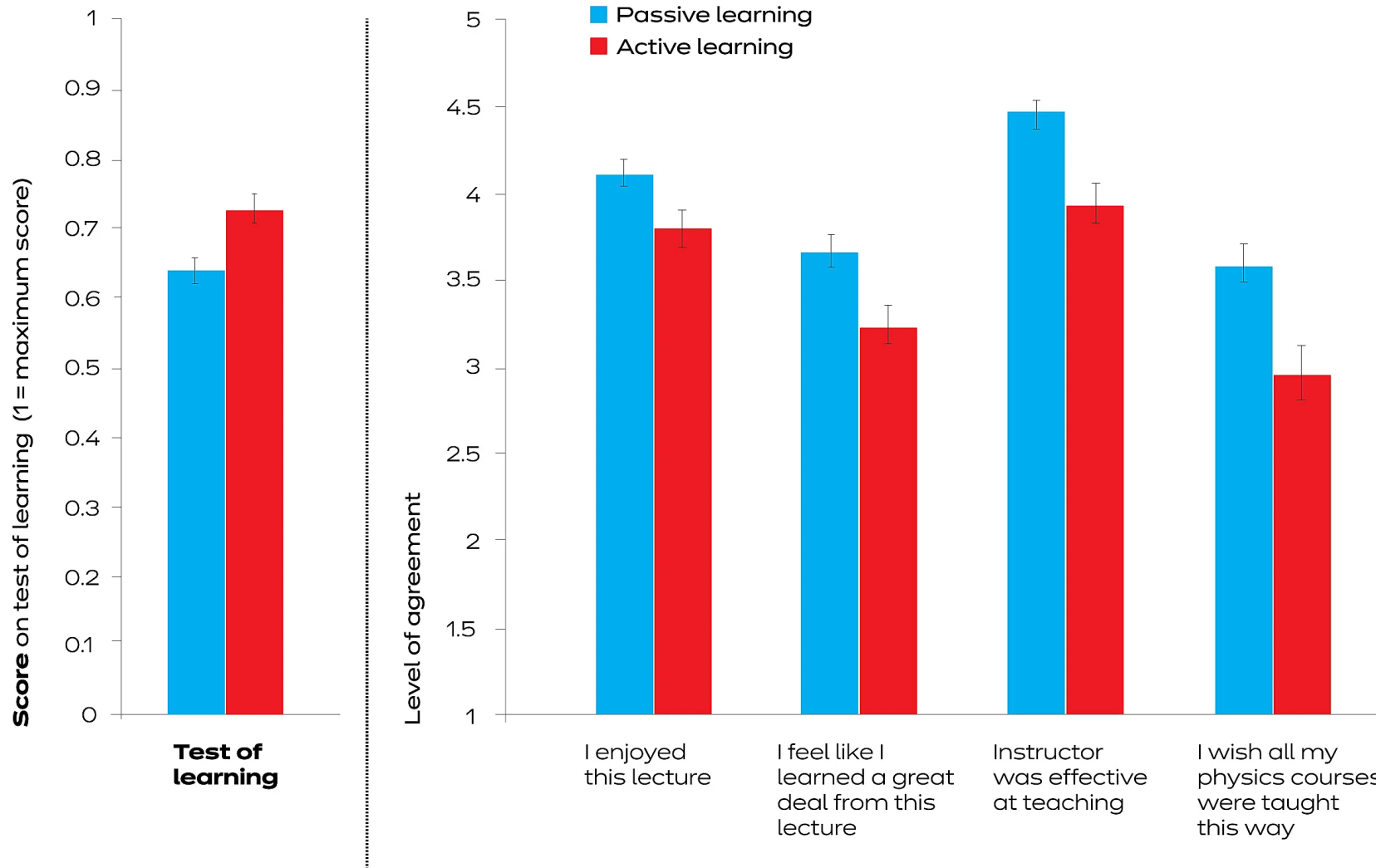
Learning by creating

A robust alternative to traditional

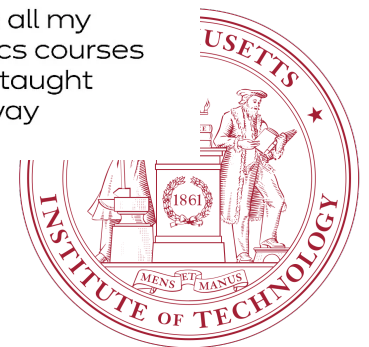




Performance vs. perception

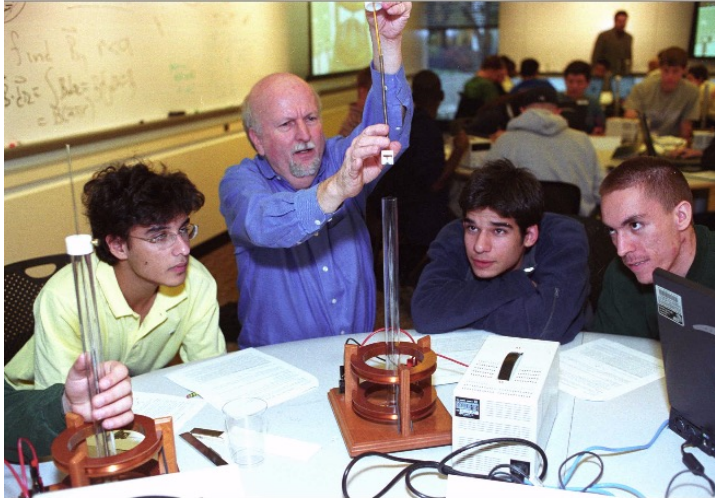


“Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom,” Louis Deslauriers, Logan S. McCarty, Kelly Miller, Kristina Callaghan, and Greg Kestin

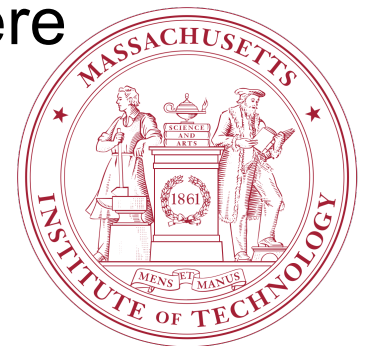




Per gli istruttori...



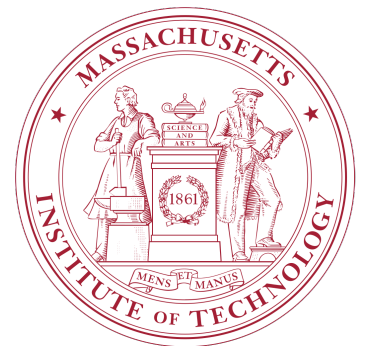
- Opinioni divergenti
- Ci vuole più tempo a organizzare e preparare il materiale
- Aiuta fare parte di un gruppo più che lavorare individualmente
- Non sempre è facile condurre la discussione
- In classe bisogna essere pronti a rispondere ...





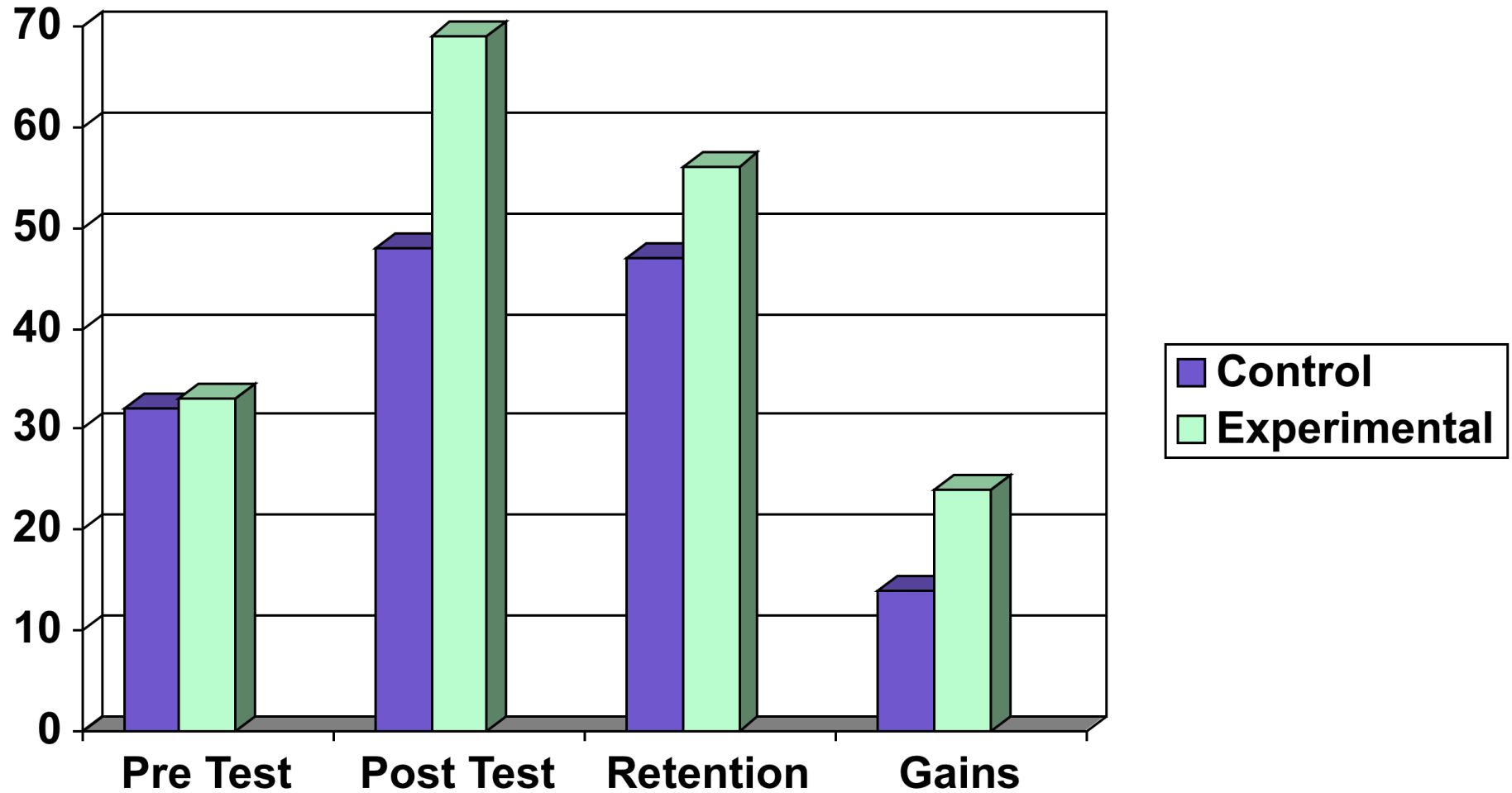
Formazione

- Formazione di assistenti undeegraduates (ESG teaching seminar, UTI)
- Formazione degli studenti di dottorato
- Formazione dei nuovi membri del dipartimento

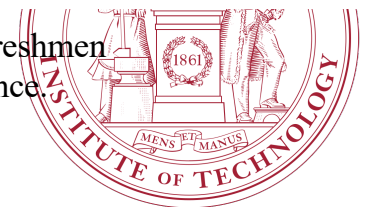




Effetto a lungo termine...



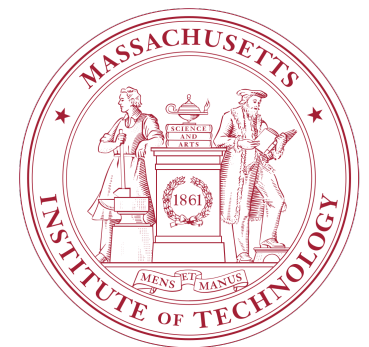
- Source: Dori, Y.J., E. Hult, L. Breslow, & J. W. Belcher (2005). "The Retention of Concepts from a Freshmen Electromagnetism Course by MIT Upperclass Students," paper delivered at the NARST annual conference.





Come "esportare" la filosofia dell' ESG?

- Sostegno a livello istituzionale
- Costruire nuovi spazi o riadattarne di vecchi
- Tecnologia (budget, personale)
- "Allenare" professori, lecturers, assistenti, studenti
- Rendere gli studenti partecipi alle decisioni
- Adattarsi alla cultura locale





GRAZIE!!!

Il sito dell'ESG: <http://esg.mit.edu>

Mini-documentario sull' ESG:
<http://tinyurl.com/y8kkmmle>

Relazione sulla didattica al MIT: <https://future.mit.edu>

