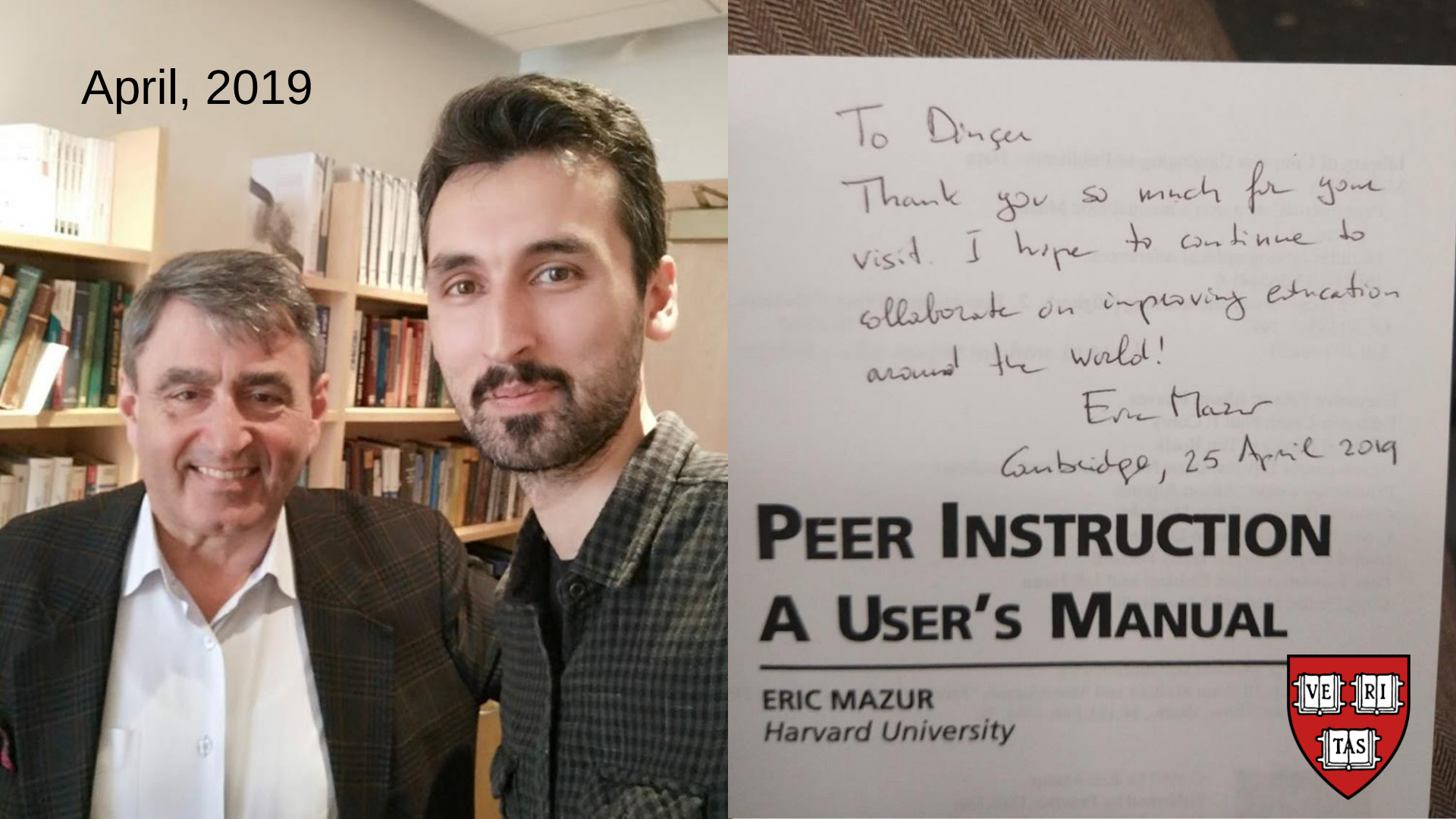
Flipped Learning and Peer Instruction at Harvard:

Observations on Eric Mazur's Physics Course

Dinçer Özoran, 30 May 2019

April, 2019


To Dinçer
Thank you so much for your visit. I hope to continue to collaborate on improving education around the world!
Eric Mazur
Cambridge, 25 April 2019
PEER INSTRUCTION
A USER'S MANUAL
ERIC MAZUR
Harvard University
VE RI TAS

Leading Questions

1. A **Flipped** course at **Harvard**, what does it **look like**?
2. How grading works in this course? What is team-based assessment? Is team-based assessment cheating?
3. What do Harvard **students like in this course**? What are their **challenges**?
4. What were/are the **challenges for Eric Mazur**?

The Context *(Long Story Short)*

Rich ?

Main Goal and Design of the Course

Main goal : Promote **intrinsic motivation** to learn

Design : Projects and team-based learning

in a "**flipped classroom**" framework.

Projects: Students take **ownership** of their learning.

Teams : Social **responsibility**, "do not let the team down!"

Flipped : Information **transfer OUT**

Cognitively **engaging tasks IN** class

AP50

~~lectures~~ group work ~~exams~~ projects

Context of the Course

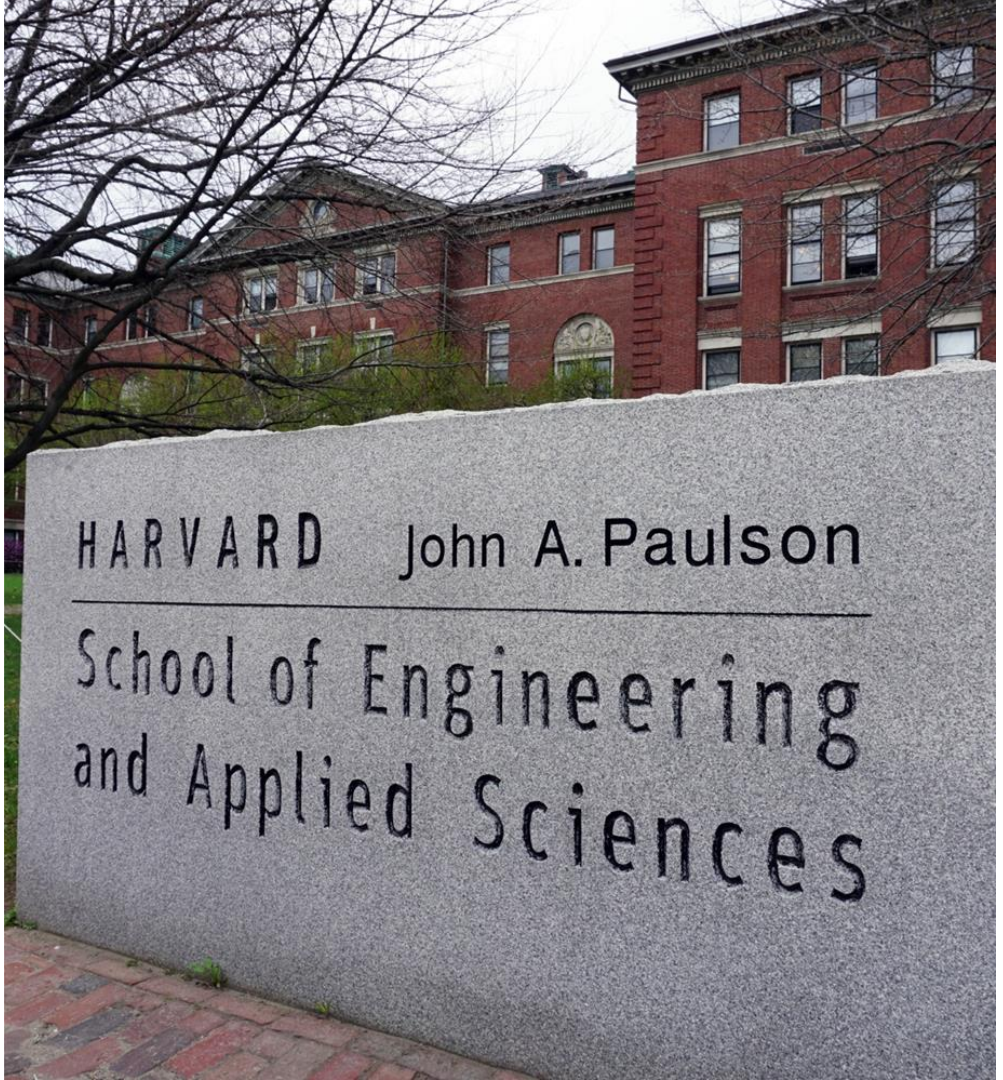
Title : AP 50 - Applied Physics

Offered at: School of Engineering and Applied Sciences (SEAS)

Sciences: Applied Math., Computer Sc.

Engineering: Environmental, Mechanical, Electrical, Bio

SEAS : Students decide departments at the end of 1st year.



Who take AP 50 Course

Before graduation, SEAS students need to take 1 course from *Intro to Physics* Track Options: **AP 50** + other **two traditional courses**

Students from 1st year (**Freshman**) to 4th year (**Senior**) are enrolled.

The capacity of the course is limited to 75 Ss.

Workforce: Team-teach

2 Instructors co-teach:

In total they have **120+ patents.**

TQ researchers!

Prof. **Eric Mazur**

Prof. **Federico Capasso**

Workforce: Team-teaching

10 TAs: Grads and PostDocs

Teaching staff meetings:

2 hours per week

75 students, 12 teaching staff:

1 staff per 6 students!

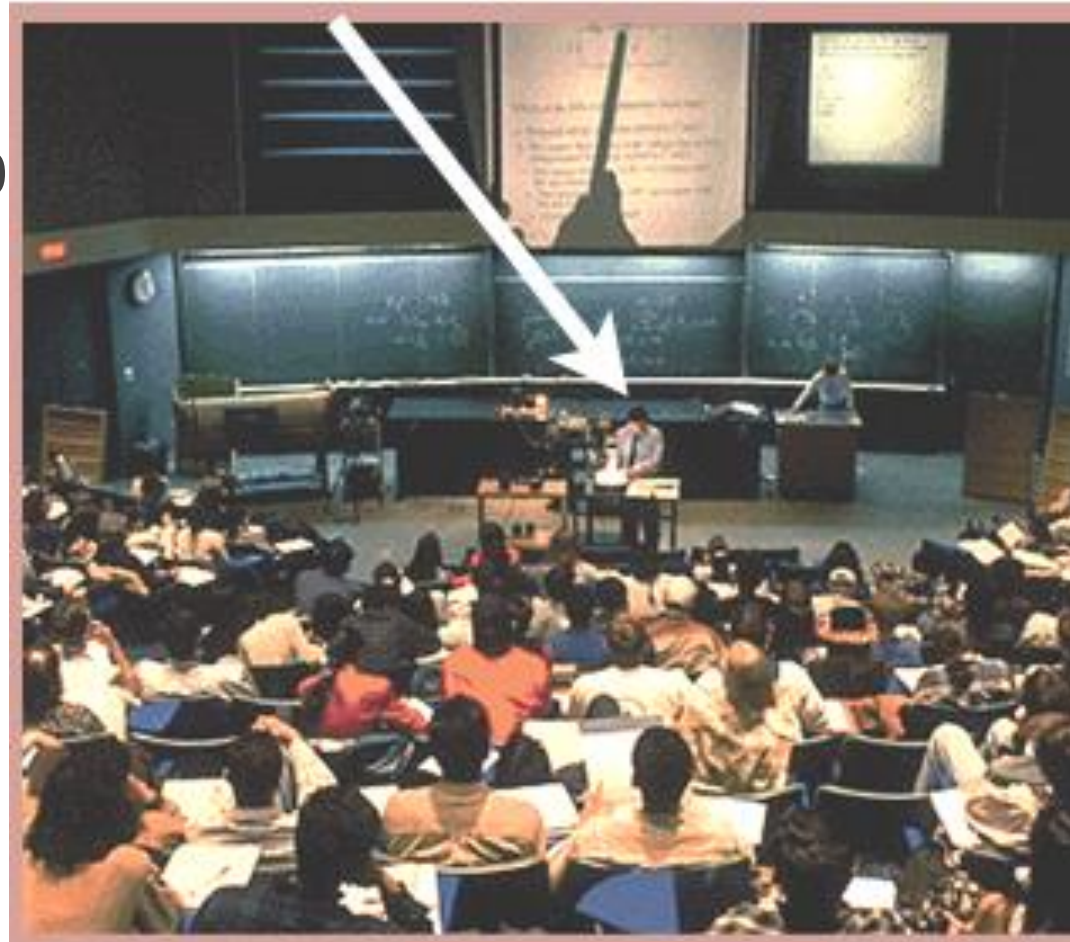
What is the course ab

– – –

Introduction to Physics:

Topics:

- mechanics,
- waves,
- electricity and magnetism,
- circuits,
- optics



1990s

What is the course ab

– – –

1 year course:

- PART I in **Fall**
- PART II in **Spring**

6 hours class time per week.

No Labs.

No Lecture.

No Exams.

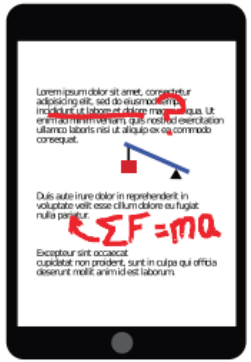
2010s

Before Class

Perusall: Reading

see schedule

Perusall



Read and annotate text BEFORE class

Respond to others' annotations

Annotations guide the class

need device

Course Organizer – NAFYS... | Atoms_Radiation_and_Ra...

https://app.perusall.com/courses/nafys05e-2016-2017-1b/atoms_radiation_and_radiati

Zoeken

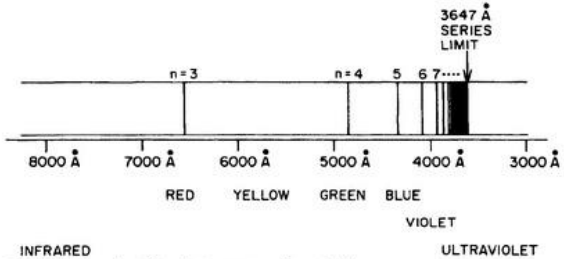


Fig. 2.1 Balmer series of lines in the spectrum of atomic hydrogen.

observed wavelengths, λ, in the hydrogen spectrum. His formula is equivalent to the following:

$$\frac{1}{\lambda} = R_\infty\left(\frac{1}{2^2} - \frac{1}{n^2}\right); \tag{2.1}$$

where $R_\infty = 1.09737 \times 10^7\ \mathrm{m}^{-1}$ is called the Rydberg constant and $n = 3, 4, 5, \ldots$ represents any integer greater than 2. When $n = 3$, the formula gives $\lambda = 6562$ Å; when $n = 4$, $\lambda = 4861$ Å; and so on. The series of lines, which continue to get closer together as n increases, converges to the limit $\lambda = 3647$ Å in the ultraviolet as $n \to \infty$. Balmer correctly speculated that other series might exist for hydrogen, which could be described by replacing the 2^2 in Eq. (2.1) by the square of other integers. These other series, however, lie entirely in the ultraviolet or infrared portions of the electromagnetic spectrum. We shall see in Section 2.3 how the Balmer formula (2.1) was derived theoretically by Bohr in 1913.

As mentioned in Section 1.3, J. J. Thomson in 1897 measured the charge-to-mass ratio of cathode rays, which marked the experimental "discovery" of the electron as a particle of matter. The value he found for the ratio was about 1700 times that associated with the hydrogen atom in electrolysis. One concluded that the electron was less massive than the hydrogen atom by this factor. Thomson pictured atoms as containing a large number of the negatively charged electrons in a positively charged matrix filling the volume of the electrically neutral atom. When a gas was ionized by radiation, some electrons were knocked out of the atoms in the gas molecules, leaving behind positive ions of much greater mass. Thomson's concept of the structure of the atom is sometimes referred to as the "plum pudding" model.

AB

KW

Current thread

AH: When I calculate this for n = 3 I'll get a different value. $\lambda = 1/(1.09737 \times 10^7 \times (0.25 - \frac{1}{9})) \approx 6.561$ instead of 6562. What did I do wrong?

Nov 14 12:09 pm

AH: Nevermind, I just found out that angstrom is a unit of length equal to 10^(-10)

Nov 14 12:17 pm

SH: This can also be found at the bottom of page 22 and at the top of page 24 in another example :) +1

Nov 14 12:18 pm

MA: what is the unit with A and dot on top?

Nov 14 8:15 pm

MK: That unit is called Angstrom and it is equal to 10^-10 meters.

Nov 14 8:20 pm

More information on angstrom https://en.wikipedia.org

In-class

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

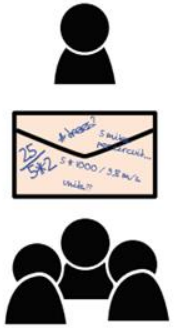
Explore concepts

Discuss with staff

In-class

apply

EA: Estimation Activity 30 min



Estimate quantities

Develop individual strategy

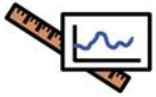
Discuss and solve as team

EDA: Experimental Design Activity 90 min

Conduct experiment with team

Take measurements

Analyze data



Carry out simulations

bring device

In-class

evaluate

Problem Set & Reflection 90 min

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

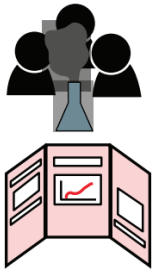
RAA: Readiness Assurance Activity 90 min

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

bring device

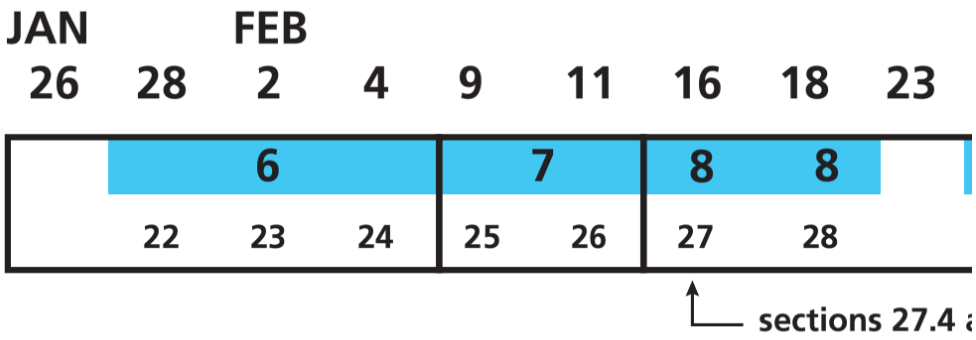
Post-class (Throughout)

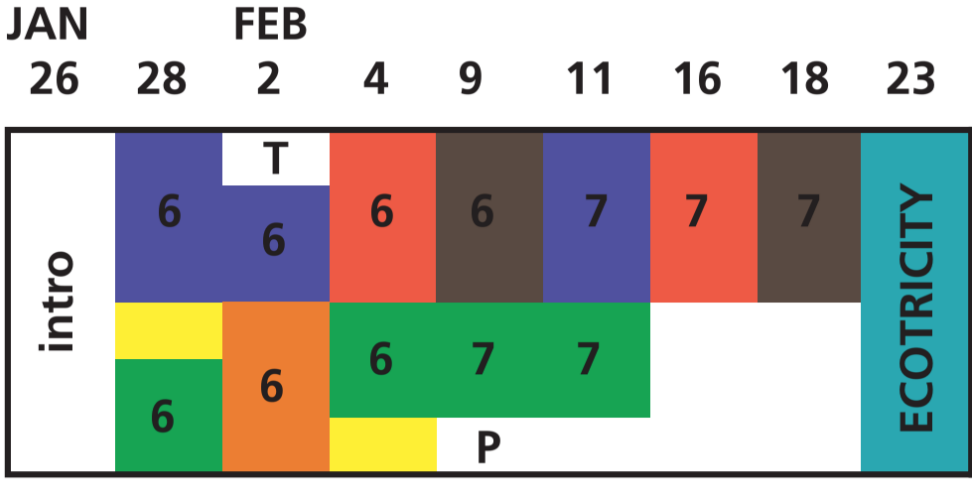
Projects **one/month**

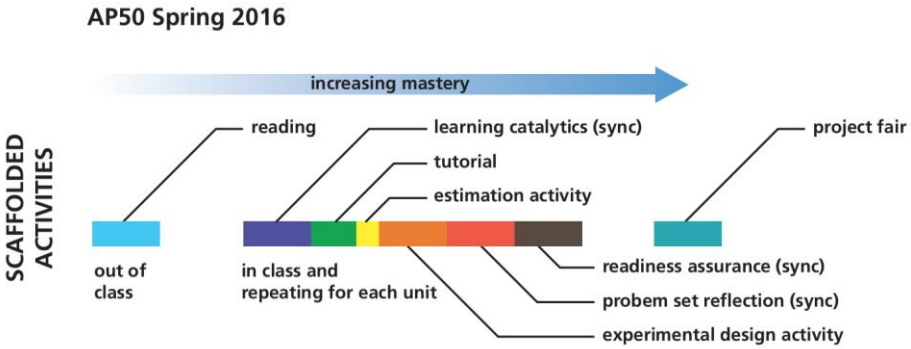


- Read and understand project brief
- Prepare model, build project with team
- Present project at Project Fair
- Hand in and revise report
- Complete team, peer, and self-evaluation

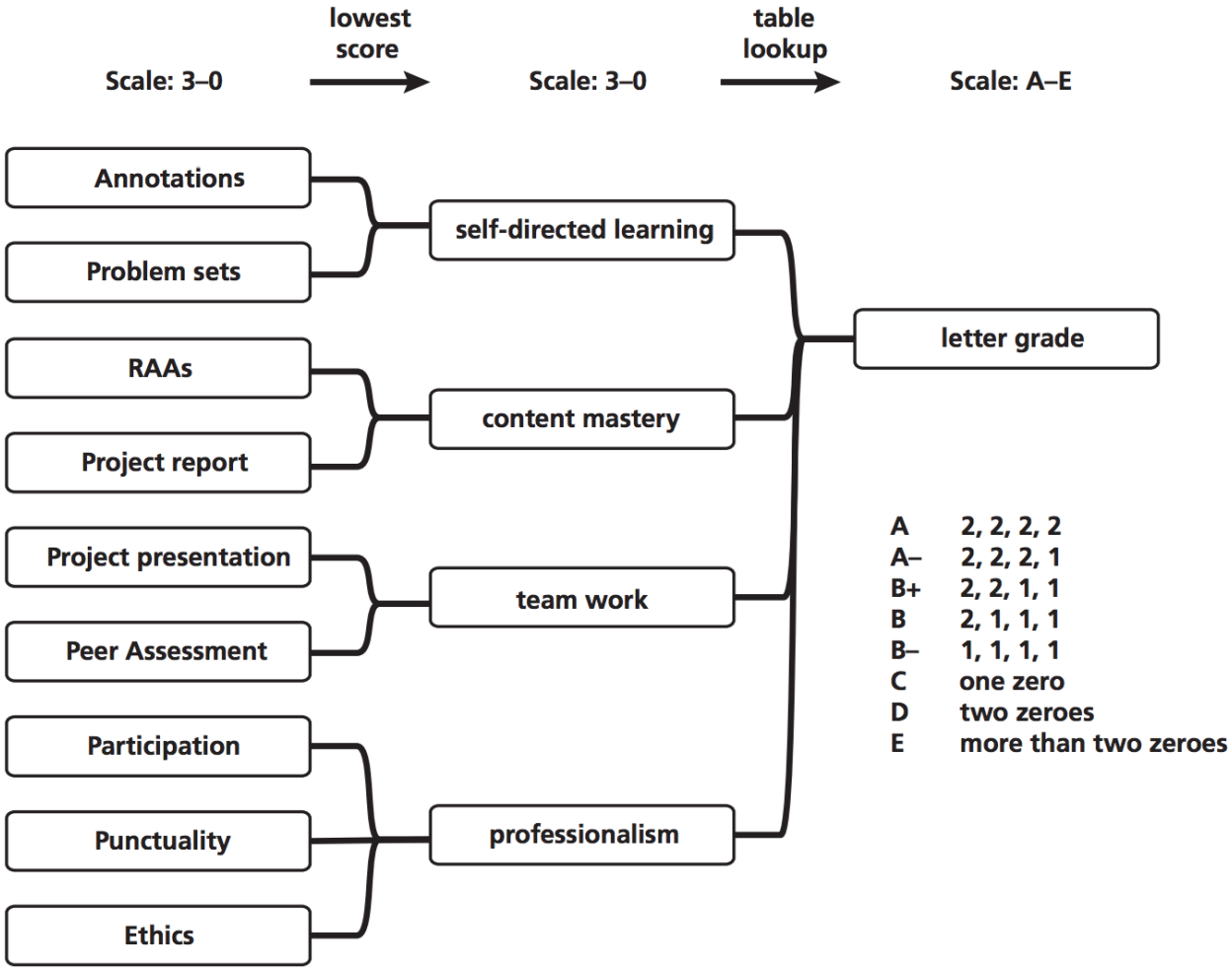
3 cycle per Semester







Grading


Scale: 3–0
lowest score
Scale: 3–0
table lookup
Scale: A–E
Annotations
Problem sets
RAAs
Project report
Project presentation
Peer Assessment
Participation
Punctuality
Ethics
self-directed learning
content mastery
team work
professionalism
letter grade
A 2, 2, 2, 2
A– 2, 2, 2, 1
B+ 2, 2, 1, 1
B 2, 1, 1, 1
B– 1, 1, 1, 1
C one zero
D two zeroes
E more than two zeroes

Any Questions so far?

Mazur's Challenges

1981: started at Harvard as Postdoc

1984: started Teaching at Harvard

End of 80s: Begin experimenting Peer Instruction

1990-2000s: Resistance, struggle, discouragement, insult, resistance, discouragement, struggle, insult, resistance, praise, resistance, etc..

"A Nobel Laureate Professor attacked me on how I teach, I could not reply (I was in my 30s)"

Students said: "*You are not teaching!*"

1996: Published Peer Instruction Book

2012: Moving from amphitheater to "flipped" classroom.

2014: Begin to think of new ways for assessment.

Eric Mazur on testing, assessment

Team-Based Assessment (TBA)

Lasry, N., Miller, K., & Mazur, E. (2017)

Jang, H.,

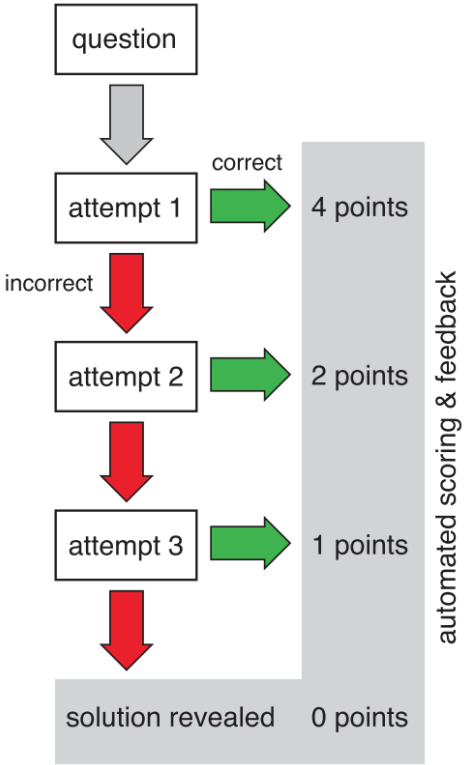
Perceived problems for TBA:

- lack of individual accountability
- help weaker students, not stronger students

Procedure:

- Two round open-ended questions
- 1st round individual, 2nd round team-based
- Individual and team scores are combined.

2nd round, team-based



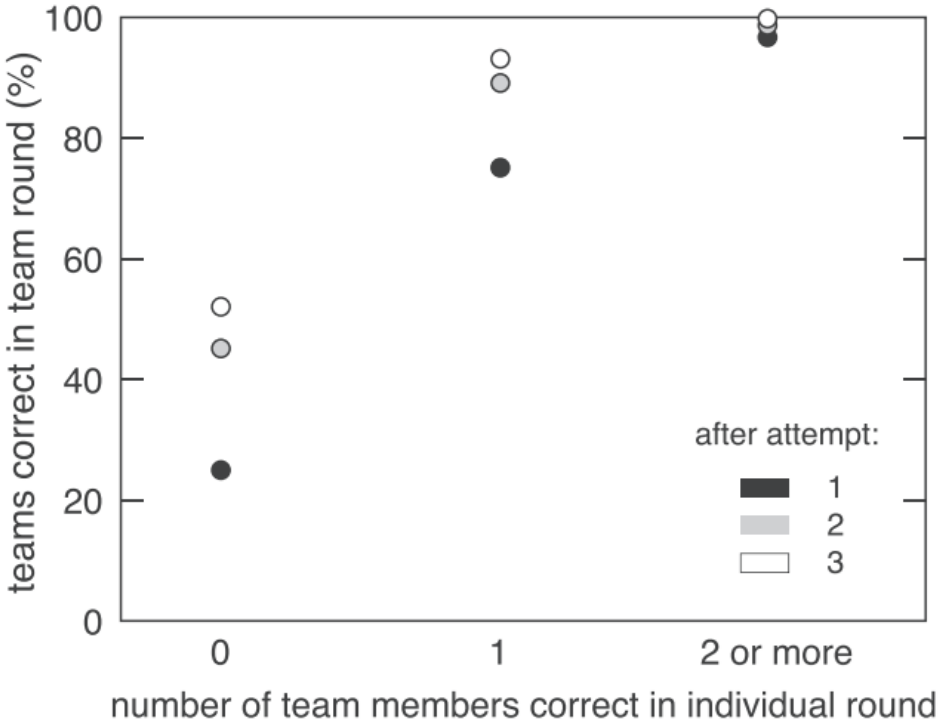
Team-Based Assessment (TBA)

Jang, H.,

Lasry, N., Miller, K., & Mazur, E. (2017)

The research results (Mazur Group):

- Half of the teams with no correct answers in ind. Round manage to get the correct answer.



Team-Based Assessment (TBA)

Jang, H.,

Lasry, N., Miller, K., & Mazur, E. (2017)

- Both weak and strong students have gained

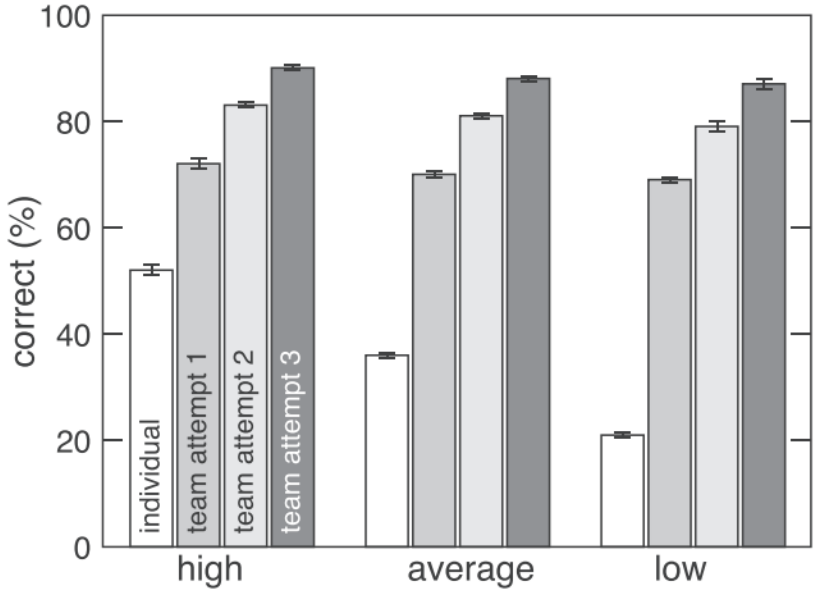


Fig. 4. Average individual (white) and team (gray) scores after each of three attempts. Students' ability levels are determined by the average individual score on five exams (low: bottom quartile; high: top quartile, average: the remainder). Error bars represent the standard error of the mean.

Student Interviews

My General Questions:

- **Why did you take this course?**
- **What is different about this course? (compared to other courses you take)**
- **What did you like about this course?**
- **What were the challenges you had during the semester?**

4 Students were Interviewed

1 Economy
1 Freshman
1 Electrical Engineering
1 Mechanical Engineering

4th year, 1st year,
2nd year (x2)

GPAs [3.6 - 3.8]

What they appreciate...

- **Course help me understand and talk about how things happen it our everyday life. I can connect what I've learned with what I experience in my life.**

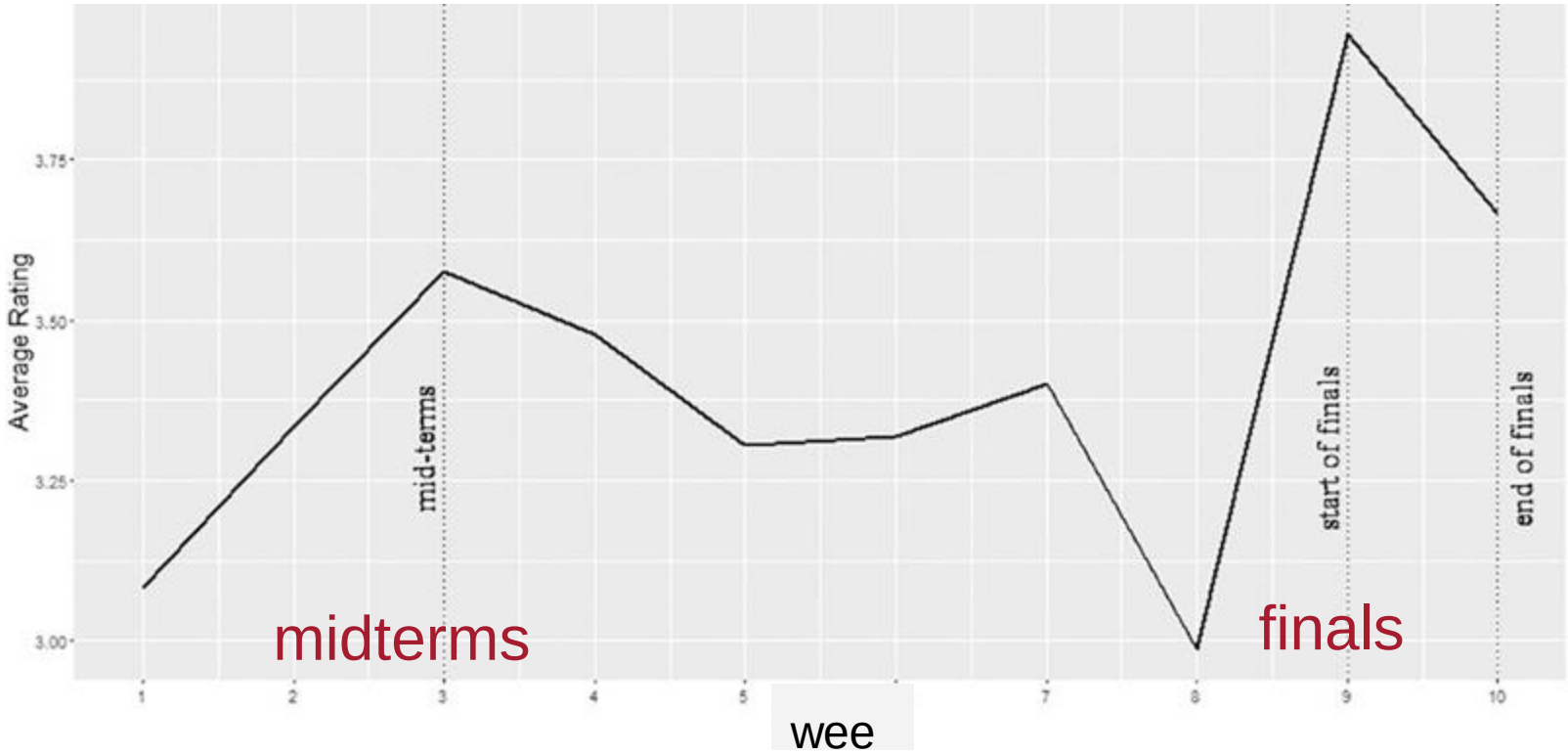
- **It is fun**

- **Most other courses are like a survival process, if you can hold on you survive otherwise you are eliminated (natural selection).**

- **The level of stress is balanced, spaced , *fluid learning experience* and it is never high like other courses where you have Midterm and Finals. (Thanks to the course designed)**

Stress for Freshman (200 students, 10 weeks)

Garett, R., Liu, S., & Young, S. D. (2017)



Their Challenges

- **When I do readings on my own, I cannot ask questions about thing that I could not understand. If I were in a classroom and listening to a lecture I could do that.**

- **Gradings are on effort not the results we have. Sometimes grading is very vague and not fair. I want to know exactly what I did, how I performed**

- Flipping Introduction to Physics ok, but **what about more complex/advanced courses** in Engineering ? Doing pre-class activities on such subjects… I'm not sure.

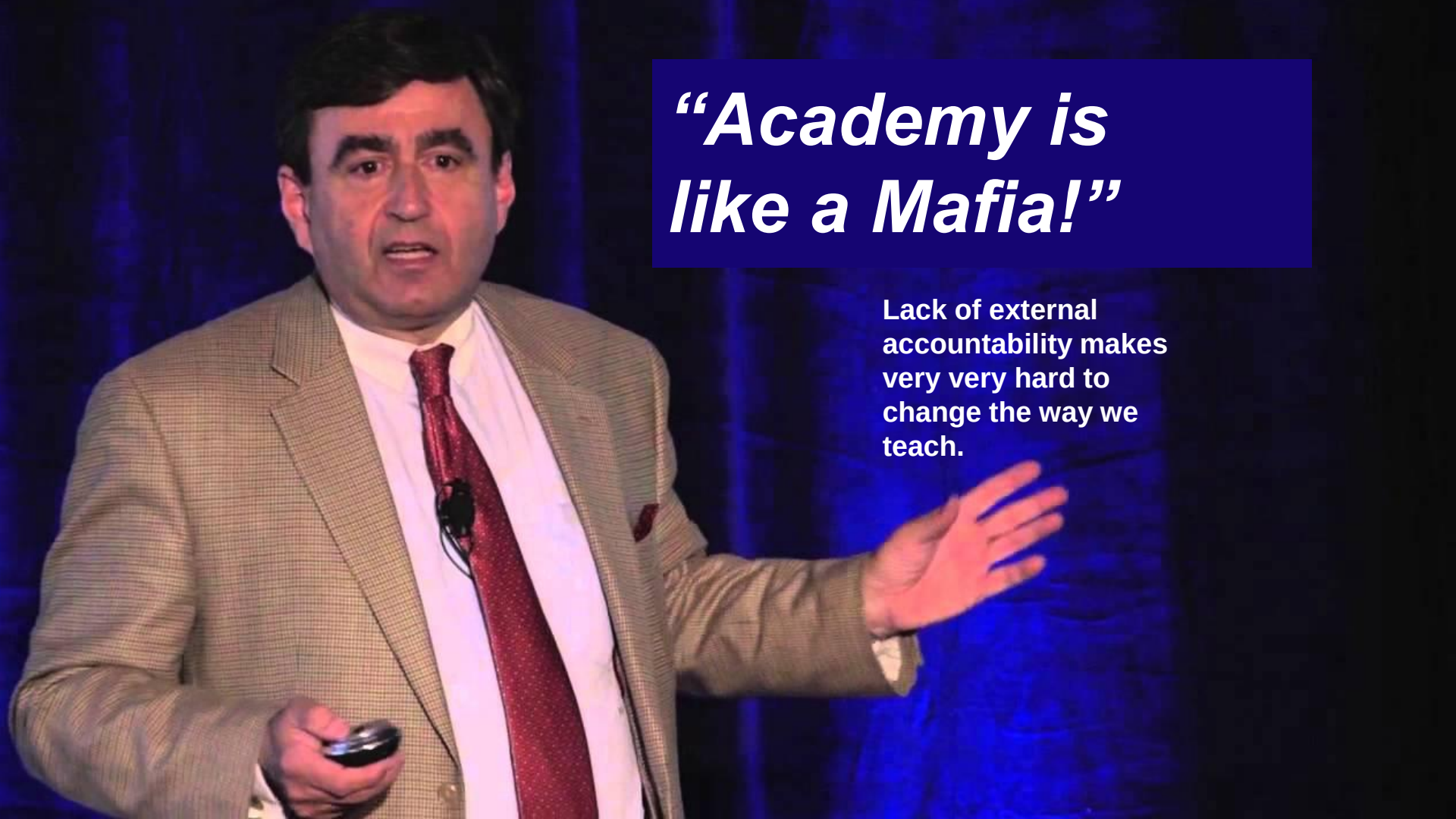
- Some **teams** are better than others...

My Observations

- **Eric Mazur cares a lot his students, how deep they learn, how effective they learn**
- **He collects every single data (since 1984) and analyzes, compares LOs.**
- **He is well organized (and passionate) so that his physics research and teaching goes together successfully.**
- **The course has a lot of details, dimensions, you can get lots of new ideas.**

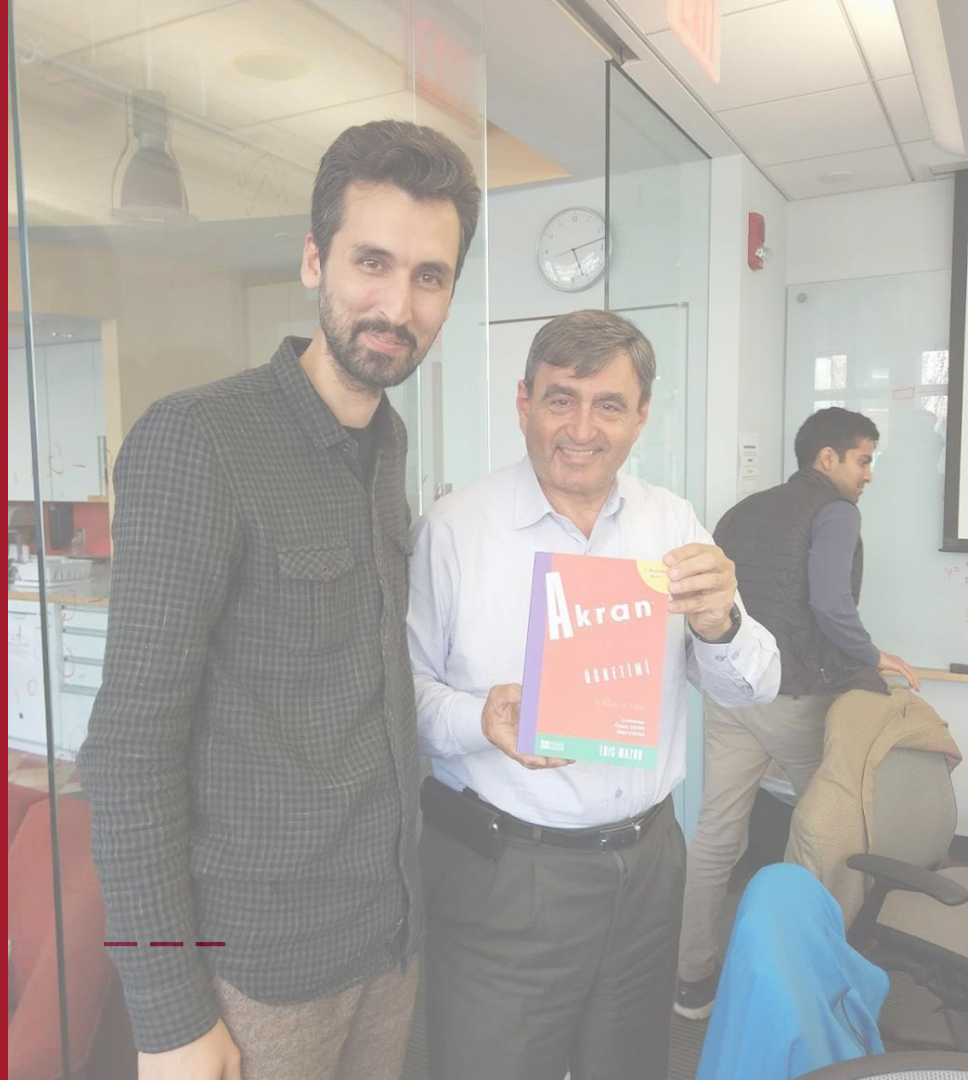
My Observations

- **There are a lot of workload on TAs, most of them were not very motivated to help the course, they were also stressed and overwhelmed.**
- **The course has a lot of details, dimensions. In case you want to replicate it, It would be hard to find the same workforce and manage it.**


“Academy is like a Mafia!”
Lack of external accountability makes very very hard to change the way we teach.

Thanks for your attention.

Any Questions?



References

Garett, R., Liu, S., & Young, S. D. (2017). A longitudinal analysis of **stress** among incoming college freshmen. Journal of American college health : J of ACH, 65(5), 331–338. doi:10.1080/07448481.2017.1312413

Jang, H., Lasry, N., Miller, K., & Mazur, E. (2017). Collaborative exams: Cheating? Or learning? American Journal of Physics. http://doi.org/10.1119/1.4974744

Bibliography for team-based learning: https://learnification.files.wordpress.com/2017/05/gilley-ives-two-stage-exam-workshop-ubco-learning-conference-2017-05-04.pdf

More Resources

http://www.teambasedlearning.org/

www.ericmazur.com

What is the most important part of Flipped Learning?

Pre-class ?

In-class?