Good practices for student instruction

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Experience & background

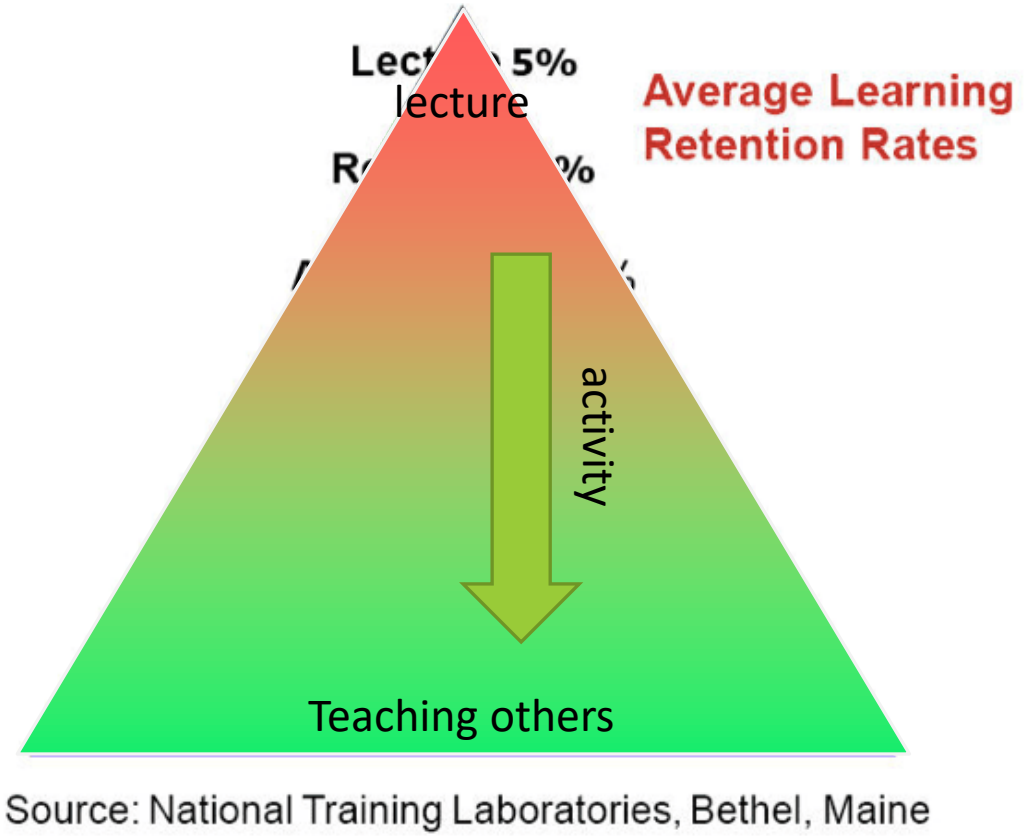
I am…

- theoretical physicist, interested in nuclear physics at very high energies
- university teacher, with experience in teaching (currently):
  Intro to calculus, Statistical physics, Quantum and nuclear physics (Matej Bel University)
  General Relativity (Czech Technical University)
- trained as both theoretical physicist and physics teacher at secondary level
- science communicator, organiser of outreach activities
- … and mainly: interested in how to make my teaching better, more interesting, useful and effective

The learning pyramid (actually wrong)

Active learning methods are more effective than the passive ones.

Include more active learning.



Flipped classroom

Standard approach:

Classroom time is devoted to passive *information transfer* (lecture) and the difficult *information assimilation* happens often individually at home (homework).
(Of course I've simplified this, as there are seminars, recitations, labs, field trips, etc…)

Idea (flipping the classroom):

Move knowledge transfer out of classroom and spend the classroom time with problems, applications, …

History:

- 1984 Militsa Nechina (USSR): reading texbook and discussion at school
- 1993 Alison King: "From Sage on the Stage to Guide on the Side" – use classroom for construcion of meaning
- 1997 Eric Mazur: Peer instruction

Flipped classroom: at home assignment

- Reading – requires textbook, introduced in the original (ancient ☺) version of FC
- Videolecture from ouside resource
  - Many available videos online, just pick one that suits your needs
  - Easy to use
  - Not made completely under intructor's control – may not be completely suitable/adjusted
- Videolecture prepared by the instructor
  - Fully adapted to the actual course
  - A **LOT** of work
- Slides – rather support to oral lecture, not really study material
- Video footage, movies
- Other…

Flipped classroom: in class

- Solve problems
- Work on small projects, possibility to work in teams
- Discuss, based on the knowledge acquired during the at-home preparation
- Instructor may repeat the material (You understand the lecture best if you know the content already)

Make sure that the students do the preparatory work at home before the class.

Explain the students, how they are supposed to work, what is expected from them and how they are going to be graded.
Plan the grading.
Stick strictly to the rules and introduced system of work.

Flipped classroom: pros and cons

Advantages:

- Students proceed in individual pace – home assignement in time and duration suitable for them
- Collaboration and instruction during the active part – enhances the most effective part of learning
- Individual approach - improved approach for more conciencious, industrious, organised students

Disadvantages:

- Need for the resources (textbook, videos, …)
- More work from the instructor required (at least for the first time)
- Students may be reluctant to collaborate
  - No improvement for students lagging behind (reported at secondary level; should they be at the university?)
  - Stimulate with pre-class tests

Learning Management System (LMS)

- Computer/web supported learning; e.g. Moodle (open source)
- Allows to:
  post and/or link materials for self study; post announcements and instructions; administer assignments; organise and administer tests and quizzes (may be randomized, individualised); get feedback; include topics-oriented chat; send messages to course participants; grade (only seen by individual student); evaluate; …
- Saves time with course organisation
- Needs log-in to chat
- Available for browser, android, iOS (moodle)

Producing videos

- Different to taking records of a lecture
  (even if you like to watch recorded lectures – but they are communication with live audience, importance of non-verbal communication)
- Lot of time in live communication instructor-students is spent in vain
  (but it is necessary for the actual communication and understanding)
- Videos can be stopped and replayed
  (one of motivations for Salman Khan – Khan Academy)

Producing videos: examples

- Slow writing: student can follow the audio and writing, but it may be toooo lengthy and boring

- Fast writing:
  - can be quickly viewed for overview
  - On problematic places – stop, replay, think
  - Uses the opportunities of working with videos
  - Instruct the students how to work with videos

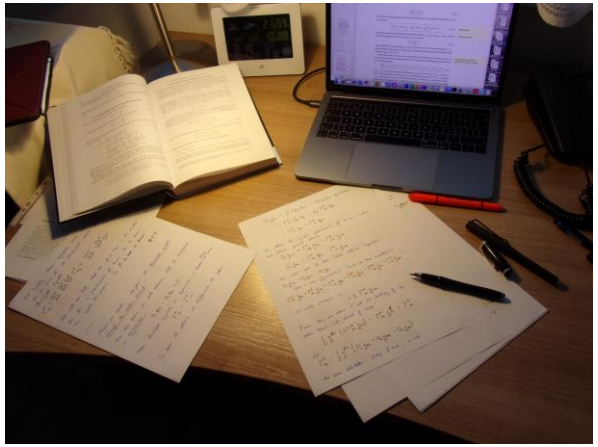
Producing videos: technical comments

- Do you want that the instructor is seen?
  - More natural but can be distractive
  - Harder to produce – much more work needed (camera, tripod, light, setup, assistance, editing)
- Length of the video – shorter than lecture (quoted ideal 12 min)
- Prepare! Screenplay saves time

Example: (shooting on paper)

- Fixing construction for the camera (or smartphone)
- Taking audio and video together
- No editing

Recording tablet screen



Just in Time Teaching

- Adjust the class to what the students actually need
- Stimulate students to do the pre-class work - warm-up pre-test
- Significant cognitive gain reported

Weekly time plan

- Day 0: Announce next topic (reading, video, audio…) and open **warm-up pre-test** (LMS, Moodle, MS Teams…)
- Day 1-6: Students work on the assignment and answer warm-up pre-test; deadline 4-24 hours before the class
- Day 6-7: Review and evaluate the warm-up pre-test – **embed the corrections/responses into the in-person class** (JiTT feature)

Just in Time Teaching: warm-up pre-test

Goal

- Shows instructor, which topics/concepts are well understood and which need to be discussed in the lecture.
- Stimulates students to do pre-class reading/watching

Questions:

- Conceptual, so that they can uncover misunderstandings/misconceptions
- Cannot be looked-up easily
- Ideally open; the student needs to formulate the answer with own words
- Always include:
  Which part was the most difficult? What would you like to discuss in the lecture?

Just in Time Teaching: instructor warm-up

- Organise the warm-up pre-test so that it is reviewed and evaluated before the lecture
- Studets inputs make up an important part of the lecture
- Try to include as many students questions as possible (each student must be included at least once per semester) – all students must be engaged
- Evaulate in an encouraging way – important is the thinking, not correct answers (motivates students to think; reveals the misunderstandings)
  - Example: I give 1 point for almost every answer, 0.9 points for completely wrong answers (sometimes), 0 points for no or wrong and not substantiated answers
  - Total for warm-up pre-tests ~10% of final grade

Just in Time Teaching: examples of questions

(from Statistical physics course..)

In 2007 there were 684 862 children born in Germany. The ratio of boys to girls was 1.054. Based on these data, is it possible to state that genetics prefers boys over girls? Explain your answer.

How the conductivity of semiconductor is changed, if the temperature increases? Is it the same for a conductor? Explain your answers.

Explain, what is the entropy.

A comment on Zoom/Covid fatigue

My JiTT course on General Relativity was developed during first year of pandemic as on-line only.

- Pre-class assignment: videos, identified chapter in Book
- Made lecture based on addressing student questions and comments - students inteersted in connecting
- Recitation session made online – problem solving and discussions – teaching assistant

Evaluation (anonymous):

Positive responses by students (4th year)
“The best physics course I’ve had at this faculty. Hope that some of this teaching strategy can also be used after Covid.”

Lot of work! (2 days a week to produce a videolecture).

Peer instruction

A method to have students in class teach each other

- Teaching others is most effective learning technique
- Instruction by fellow students may cover also instructor blind spot

Designed by Eric Mazur (Harvard, Physics) in 1990's

[book: Eric Mazur, Peer Instruction: A User Manual]

Peer instruction: strategy

Divide the classs into blocks (7-10 min), devoted to individual topics/concepts
One block:

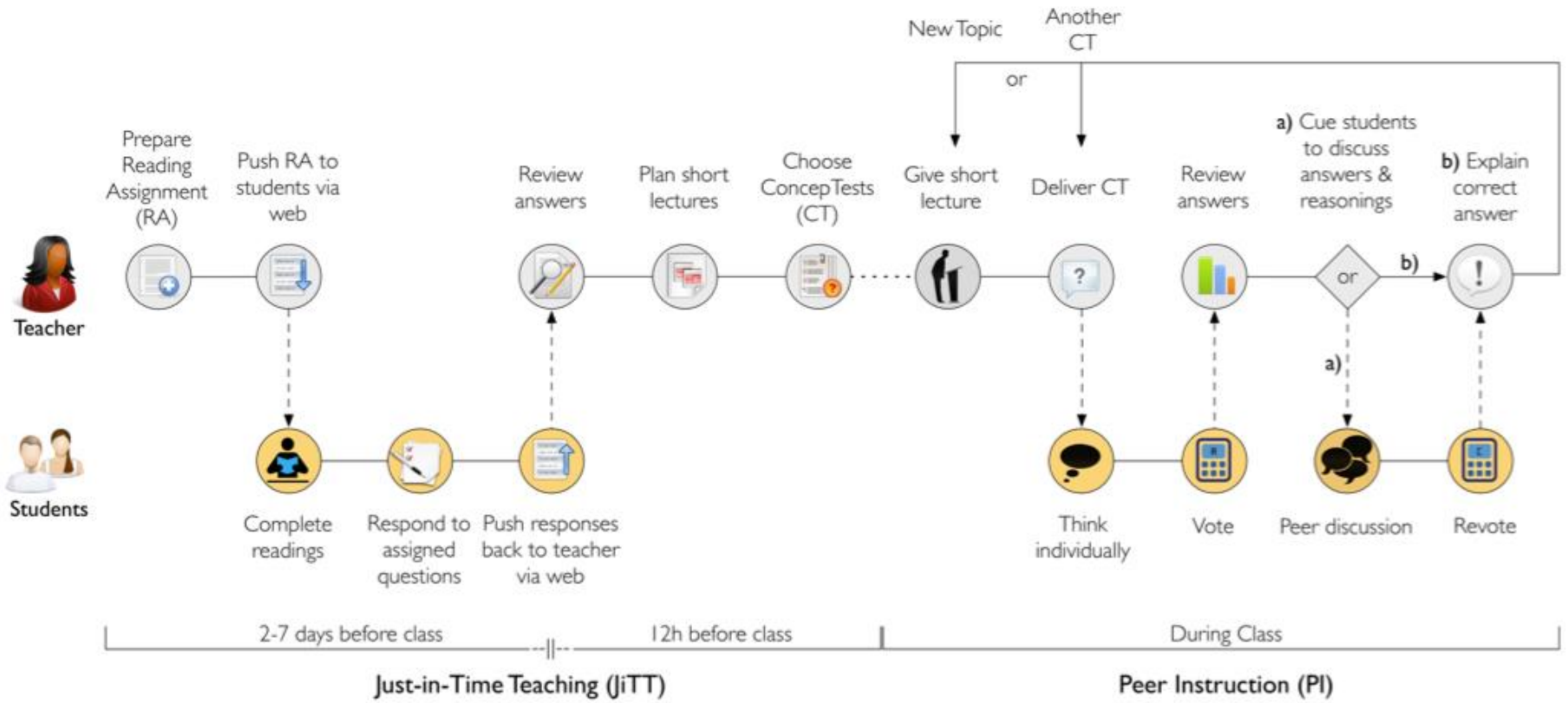
1. Introduce the block
2. Formulate conceptual question (1 min)
3. Students think and vote on the question (1-2 mins) – Classroom Response System (CRS, clickers or bring-your-own-device (BYOD)), alternatively flashcards
4. Review answers
5. Divide class into groups with 3 – 4 students and let them discuss (peer instruction) (2-4 mins)
   - All students must participate in the discussion
   - Meaningful if correct answer rate in the first test is 30-85%
6. Vote again (2 min)
7. Correct and/or summarise

An example of conceptual question

A locomotive pulls a series of wagons. Which is the correct analysis of the situation?

1. The train moves forward because the locomitive pulls forward slightly harder on the wagons than the wagons pull backwards on the locomotive.
2. Because action always equals reaction, the locomotive cannot pull the wagons—the wagons pull backwards just as hard as the locomotive pulls forward, so there is no motion.
3. The locomotive gets the wagons to move by giving them a tug during which the force on the wagons is momentarily greater than the force extended by the wagons on the locomotive.
4. The locomotive's force on the wagons is as strong as the force of the wagons on the locomotive, but the frictional force of the locomotive is forward and large while the backward frictional force is small.
5. The locomotive can pull the wagons only if it weights more than the wagons.

FC with JiTT and PI ☺



Conclusions

Some good practices…

- Flipped classroom
- Just in Time Teaching
- Peer Instruction

What you choose in individual and should be adjusted to your students and you.

- Be organised – this helps you and your students (even more during pandemic)
- I strongly recommend using LMS
- Producing videos: think about how to make them, get a tutorial