THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center
Making Cancer History®

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Making the Most of a One-hour Lecture with Alternative Teaching Methodologies

Implementing Project-based and Flipped Learning

Problem 1:
If only there was more time….

MEDICAL PHYSICIST

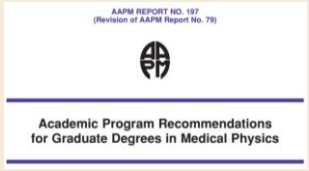
What do Medical Physicists Do?

Medical physicists are concerned with three areas of activity: clinical service and consultation, research and development, and teaching. On the average their time is distributed equally among these three areas.

- **On average, their time is distributed equally among these…..**
  - **A standard appointment at my "academic" institution is 80% clinical and 20% academic (which includes both research and teaching activities)…..**

Problem 2:
Courses cover a substantial amount of material...

- **For a graduate program in medical physics: minimum coursework requirements for CAMPEP Accreditation include the topics listed in AAPM Report 197.**



- **What topics must be covered?**
- **And in what detail?**

Core Topics - Example

Topic	Course #	Comments
8.1 Radiological physics and dosimetry		
8.1.1 Atomic and nuclear structure		
8.1.2 Classification of radiation		
8.1.3 Quantities and units - radiation fields		
8.1.4 Quantities and units - radiation interactions		
8.1.5 Indirectly ionizing radiation: photons		
8.1.5.1 Exponential attenuation		
8.1.5.2 Photon interactions		
8.1.6 Indirectly ionizing radiation: neutrons		
8.1.6.1 Neutron interactions		
8.1.7 Directly ionizing radiation		
8.1.7.1 Directly ionizing radiation interactions		
8.1.8 Radioactive decay		
8.1.9 Charged particle equilibrium		
8.1.10 Radiation dosimetry – general		
8.1.11 Radiation dosimetry – calorimetry		
8.1.12 Radiation dosimetry – chemical		
8.1.13 Cavity theory		
8.1.14 Ionization chambers		
8.1.14.1 Calibration of photon and electron beams with ionization chambers		
8.1.15 Dosimetry and phantoms for special beams		
8.1.16 In vivo dosimetry (TLD, OSL)		
8.1.17 Relative dosimetry methods		
8.1.18 Neutron dosimetry		
8.1.19 Pulse mode detectors		

At my institution, we cover these topics in one course, *Radiation Detection*

Breadth and depth?

- **In a course that meets two or three times per week for one hour….**
- **How is it possible to thoroughly cover all of the topics, including both theory and practical clinical applications?**
- **We have implemented two alternative teaching techniques in our course.**

Alternative Teaching Techniques

We use:

- **Flipped learning to engage the students in radiation detection theory** — **Implemented for ~ 80% of "lecture" content"**
- **Project-based learning to expose students to clinical applications of detectors** — **Assigned at beginning of course, due at the end**

Project-Based Learning

- Students are assigned classroom projects relevant to real-life applications.
- Creates opportunities for groups of students to investigate meaningful questions that require them to gather information and think critically.

Components of Project-Based Learning

1. Organized around an open-ended question or challenge
2. Creates need-to-know essential content and skills
3. Requires inquiry to learn or create something new
4. Requires critical thinking, problem solving, collaboration, and various forms of communication
5. Allows some degree of student voice and choice
6. Incorporates feedback and revision
7. Results in a publicly presented product or performance

Radiation Detection Project

You have been recruited as the director of physics for a cancer center. As part of your contract, you are expected to provide the cancer center administrator with a list of QA equipment (along with justification for each item) that you consider essential.

- Divided into teams:
  - Each team chooses a cancer center type, e.g., comprehensive, proton center, prostate radiotherapy, imaging facility, etc.
  - Each student selects a particular imaging or treatment modality for their "QA" focus within the team defined cancer center.
- Submit individual report and gives 10-minute oral presentation

Collectively, students learn about many different detectors for many different clinical applications.

Shared Knowledge

- Each team member is required to read the other members' reports.

How is this enforced?

- Each student includes two exam questions related to the detectors described in their report.
- Final exam includes one question from each student's report.

Flipped Learning

Basic Principle

- Classroom is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

Four Pillars of F-L-I-P

- **F** Flexible Environment
- **L** Learning Culture
- **I** Intentional Content
- **P** Professional Educator

Our Implementation of FLIP Learning

Prior to Class:

- Students listen to prerecorded lecture that focuses on theory.

In Class:

- Students presented with concept questions that focus on applications and clinical issues but that are rooted in understanding underlying theory.

Concept Question Procedure

- Professor presents a multiple choice question
  - Generally, six questions per "lecture hour"
- Students individually vote on an answer
  - Generally, no consensus among answers

Flip the Classroom: Students break into teams to discuss and convince others of the right answer. → They apply knowledge from prerecorded lecture to teach themselves and others.

- Revote
  - Consensus on right answer

Example Concept Question

For a dosimeter (detector measuring dose), what is meant by the expression "energy independent"?

a. Incident particles of all energies are equally likely to be absorbed in the detector
b. Incident particles of all energies deposit the same signal in the detector
c. Incident particles of different energies produce signal in the detector with the same energy dependence as in water

FLIP Learning Implementation Challenges

- Time consuming to record lectures
  - True for the first year, but less time consuming in subsequent years
- Difficult to develop concept questions
  - Takes effort, but payoff is substantial
- Where to start?
  - For each "lecture", identify the key concepts you want the students to know

Practical Tips
Writing Concept Questions

- Don't be afraid to repeat important concepts
  - Ask the same question twice in different ways, students never bored
- No concept is too easy
  - Some concepts are easy for some students, but rarely easy for all
  - Even questions explicitly covered in the lecture are answered incorrectly on the initial "vote"
- Don't try to get too fancy
  - Stick to the basics!
  - Don't need five answers for each question
  - After the group discussion, ask for a volunteer to explain a concept to the class (follow-up with commentary if needed)

Pros and Cons
FLIP and Project-based Learning

FLIP Learning

Con: Substantial effort to implement

Pros:
- Less effort once established
- Students take responsibility for their education
- More time available to discuss important concepts
- Students learn better/more efficiently

Project-based Learning

Con: None

Pros:
- Minimal effort to implement
- Students take responsibility for their education
- Students "see" theory applied to clinical applications

Overall Experience
FLIP and Project-based Learning

- Once established, less effort for faculty

Addresses Problem 1:
Limited time for education

- More material covered in 3-credit course

Addresses Problem 2:
Courses must cover a lot of material that requires depth/breadth

- Positive student feedback
- Improved student performance

Added bonuses make us

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End

Thank You