Stop Lecturing Me! New Methods for Teaching Medical Physics

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Making Cancer History®

Learning Objectives

After taking this course, the participant will:

- Identify novel teaching methodologies such as Peer Instruction and Project-Based Learning.
- Be able to incorporate these teaching methodologies into their classes.
- Identify various tools to aid in teaching such as Facebook and SurveyMonkey

What is the Problem?

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.

From the AAPM website

Two Questions

1. How are your present medical physics practice methodologies different from those you used 5 years ago?

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2. How are your present teaching methodologies different from those you used 5 years ago?

How Did We Learn to Teach?

- We often patterned our behavior after effective teachers we had in college or grad school.
- We didn't have the opportunity to learn theory, so we learned by example.

Standard Teaching Methodology

- Present information in a 45- to 60-minute lecture
- "I don't teach, I lecture"

Problems with Lectures

- One way, instructor-focused
  - Instructor is center of attention
- One size fits all
- Little, if any, real-time feedback
- Lose train of thought (i.e., fall asleep) and lecture is lost

Problems with Lectures

- Inefficient use of lecturer's time
  - Why not use last year's lecture?
    - This year's lecture likely to be same as last year's lecture
  - Why not use canned lecture?
- "Lecturing is delivery of information. Teaching is delivery of knowledge."

"In the digital world, there is no longer any reason to use class time to transfer the notes of the instructor to the notes of the student (without passing through the brain of either)."

H. Lewis, "Reinventing the Classroom," *Harvard Magazine*, Sept-Oct 2012

Today's Presentation

- We're going to give you some examples of focusing classroom activity away from lecturing.
- These methodologies are working for us, and we want to share these experiences with you.

Today's Presentation

- Take away from this presentation what seems to make sense for you.

Order of Business

- Peer Instruction (Starkschall, Kry)
- Project-based learning (Howell)
- Conclusions (Starkschall)
- Panel Discussion (all)

Peer Instruction – 1

George Starkschall, PhD

Peer Instruction

- Developed by E. Mazur (Harvard Univ) to teach introductory physics
- Focuses class attention on concepts rather than information or problem solving
- Based on the idea that students who have recently acquired understanding of a concept have better ideas about impediments to understanding than faculty do

Peer Instruction

http://americanradioworks.publicradio.org/features/tomorrows-college/lectures/

Aired on KUHF (Houston)
Oct. 9, 2011

Peer Instruction

- YouTube video of seminar presented by Mazur: http://www.youtube.com/watch?v=WwslBPj8GgI

Prior to Class

- Students expected to complete reading assignment
- Students expected to download and listen to lecture (at their convenience)
- Rationale for this:
  - Lecture content does not vary from year to year
  - Instructor's time better spent clarifying concepts than presenting information

Prior to Class

- Verify that students have prepared for class
  - Students given short online quiz prior to class
- Use SurveyMonkey to generate pre-test

Pre-test

*1. Name:

2. Why is a small detector desired for narrow-beam geometry?

- Larger detectors are not necessary.
- Larger detectors are difficult to make.
- To limit the number of photons of all types it receives.
- To only detect photons that have not interacted with the target.

3. For narrow beam geometry, we want all of the following except

- A large distance between detector and attenuator
- A thick attenuator
- A narrow beam
- A small detector

Prior to Class

- Free-form question:
  "Are there any issues that are not clear to you at this time?"
- Start class by answering questions
- Use questions to modify lectures for classes in subsequent years

Principles of Peer Instruction

- Before class:
  - Identify 6-8 concepts to be presented in class
  - Develop "ConcepTest" questions

ConcepTest questions

- Focus on concept and applications of the concept, not the recall of facts
- Not solvable by relying on equations – Avoid plug 'n' chug
- Have adequate multiple-choice answers
- Use unambiguous wording – no trick questions
- Be neither too hard nor too easy

Radioactive nuclei that decay via electron capture are particularly desirable for implant radiation therapy because

A. The short half-lives of these nuclides result in short periods when the patient must be isolated.
B. The x-rays produced in the decay are typically attenuated within the patient.
C. These materials are relatively easy to produce.

Concept to be Presented

- Electron capture results in the emission of low-energy characteristic x-rays that are attenuated near the point of production.

The mass attenuation coefficient for Compton scatter in soft tissue (Z_{eff}=7.4) is approximately 0.02 cm^2/g. Estimate the mass attenuation coefficient for Compton scatter in lead (Z=82).

A. 0.0002 cm^2/g
B. 0.02 cm^2/g
C. 2.0 cm^2/g
D. 20.0 cm^2/g

Concept to be Presented

- The mass attenuation coefficient for Compton scatter is essentially independent of the nature of the absorbing material

Concept vs Information

- In both cases, the ConcepTest question does not necessarily test recall of information but rather understanding of how that information is used

Principles of Peer Instruction

- Ask ConcepTest question
- Students have ~1 minute to respond
  - Insufficient time to do extensive calculations
  - Students display response without seeing others' responses
  - Can use flash cards or ARS devices to display responses

Principles of Peer Instruction

- Students gather into groups of 3 or 4
- Students have several minutes to convince others in their group that their answers are correct

Principles of Peer Instruction

- Generally, students who understand the concept provide a more convincing argument why their answer is correct than do students who do not understand the concept
- Generally, students who have recently achieved understanding of the concept have a better idea of the barriers to understanding than does the faculty member

Principles of Peer Instruction

- Students are asked the ConcepTest question again
- Typically, almost all students get the right answer
- Short discussion of answer
- Go on to next concept

Some Observations

- Students are more engaged in the learning process
  - Large amounts of class discussion
  - Almost all students participate in discussion
  - Students are not allowed to be passive listeners
  - Many classes end with students still discussing material

Continuing the Dialogue

- Students asked to identify points that were not made clear in class
- Questions then posted on Facebook
- Students have 24 hours to respond to Facebook questions and receive extra in-class credit

Evaluations

- Positive student reviews (quoted from class evaluations)
  - "The online lectures/conceptest question procedure was very helpful"
  - "The style of lecture chosen was, in my opinion, very instructive"
  - "I like the conceptest question style"
  - "I found Dr S method of teaching to be very effective and I would most likely gain much more from the other faculty if they utilized the same style"
- No negative reviews
- Received commendation from UT Graduate School of Biomedical Sciences

Peer Instruction – 2

Stephen Kry, PhD

Impetus

- Primary instructor for Radiation Detection course
- I had didactic lectures completed (4 years)
  - Change was hard

1) More effective method
2) Some students struggled with exam
   - ABR type questions. Hard but realistic
   - Many good grades, too many poor grades

My procedure:

- Record the lecture for the students
  - Focus on theory
  - They listen to this before class
- Prepare concept questions (~6/class)
  - Focus on applications/clinical issues
  - Students vote on answer (paper vote)
  - Let students discuss, convince each other, and get to the right answer
  - Revote to find consensus

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

Steps to implement flipped learning:

- You have lectures, just record yourself giving them
- Come up with concept questions

Challenges and suggestions (1)

- Time consuming to record lectures
- True for the first year, but it is definitely better subsequent years.

Challenges and suggestions (2)

- Hard to edit lectures once they're recorded
- Yes, but consider this a last resort.
- More practically: a new paper can be introduced along with a concept question during the class period, additional reading material
- Some instructor leading, but it's a realistic solution

Challenges and suggestions (3)

- Hard to come up with concept questions
- This took the most effort
  - Identify the concepts you want the students to know
- Accept feedback from students
- Must be prepared to revise between years

Practical tips on concept questions

- Don't be afraid to repeat important concepts
  - Ask the same question twice in different ways, students never bored
- Some concepts are easy for some students, but rarely easy for all
  - "this was explicitly covered in the lecture", yet half the class had the wrong answer
- Don't try to get too fancy
  - Don't need to have hard questions, just stick to the basics!
  - Don't need 5 answers for each question
  - I have a question where I just ask for a volunteer to explain a concept

Compare the ion chamber signal from a measurement in air (in cobalt) with a buildup cap versus without:

A) Higher because you're measuring dose to acrylic instead of dose to air
B) Higher because of buildup of electrons in the cap
C) Very similar because air and acrylic have similar atomic numbers and stopping powers
D) Lower because acrylic is more attenuating than air

My experience:

- The students spend more time on the material
- Cover in logical progression:
  - Basic theory of detector operation
  - Clinical issues/applications
- Student feedback has been positive
- Student performance has improved

My results

- Exam grades from past 6 years.
  - 4 years of traditional lecturing
  - 2 years of peer-based learning
  - Average 14 students per year
- Historically a high spread with high grades but too many low grades
- Lost low tail with flipped learning

	Didactic lecturing	Flipped learning
Average grade	68	72
Standard deviation	16	8
Grades <50%	48, 45, 44, 42, 40, 34, 33, 31, 29, 27	-

Summary

Pros
- Less effort once program is established
- Students have more responsibility for their education
- More time available to discuss important concepts
- Students learn better and more efficiently

Cons
- Substantial effort to get program up and running

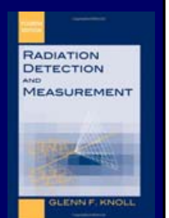
Project-Based Learning

Rebecca Howell, PhD

Starting Point for Changing our Course

<u>"Traditional" Radiation Detection Course:</u>

- Semester-long course, 2 instructor-taught lectures per week, labs, midterm and final exams
- Course content was consistent with AAPM Report 197 requirements
- Used standard textbook: Glenn Knoll, *Radiation Detection and Measurement*



Purpose and Motivation for Redesigning our Course

- Purpose: To revise and improve our Radiation Detection course.
- Motivation:
  - Negative student feedback
  - Desire to keep core content
  - Desire to add more clinical applications

How to Make Our Course More Clinically Relevant While Keeping Core Curriculum?

- Faced with the limited amount of time, we considered:

  Did we want to continue with traditional instructor-led lectures or implement student-initiated learning?

Considered 2 types of student-initiated learning:
Problem-based learning **Project-based learning**

Types of Student-Initiated Learning

Problem-Based Learning	Project-Based Learning
• Students use "triggers" from the problem case or scenario to define their own learning objectives. • They conduct an independent, self-directed study before returning to the group to discuss and refine their acquired knowledge. • No instructor-taught lectures.	• 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. • Keep instructor-taught lectures.

Project-Based Learning

- We chose to implement project-based learning rather than problem-based learning because keeping the instructor-led lectures for a core course that is fundamental to training of medical physics graduate students was very important.

Our "Real World" Project

You have been recruited as the director of physics for a comprehensive cancer center. The facility is still under construction, but as part of your contract, you are expected to provide the cancer center administrator with a list of quality assurance equipment (along with justification for each item) that you consider essential to your new department. The cancer center administrators have already committed to the following equipment:

- External Beam RT
  - A multi-energy linac equipped with MLC, EPID, CBCT, VMAT, and SBRT.
  - Treatment-planning system:
    - CRT, IMRT, VMAT.
- Imaging Equipment
  - PET/CT simulator
  - CT simulator
  - RT-dedicated MRI
- Tomotherapy
- Brachytherapy Equipment
  - HDR remote afterloading HDR TPS
  - Applicator system for LDR seed prostate Implants
  - LDR TPS
  - Ultrasound

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

Written Reports

- Each team submits a single report summary that includes a list of all equipment being requested for their hypothetical department.
- Each individual also submits an separate report (on selected topic) that includes:
  - List of routine QA (and frequency) that's required
  - Description of the various detectors that can be used to carry out this QA and which ones they recommend
  - Two exam questions related to the detectors described in the report

What Do I Do with the Exam Questions?

- Select 1 question from each student for final exam:
  - Students must answer ALL of the questions from their team.
  - Students can answer questions from the other team for extra credit.

Keeps each student engaged in the "class" project and ensures more comprehensive learning.

Learn how to/how not to write exam questions

Class Presentations

- Each team is required to give a PowerPoint presentation that includes:
  - Brief introductions describing how the group divided the "department."
  - 10-minute presentations from each team member; points are deducted for every minute over the time limit.
    - Learn to present the most relevant information in a short time slot (e.g., an AAPM oral presentation).

Successes?

- Students have met and exceeded expectations every year.
- Course instructors have more time to focus on fundamental concepts.
- Positive long-term feedback from former students.

Positive Student Feedback

"I just wanted to let you know that as a newly minted medical physicist just arriving at my new base (Keesler Air Force Base, Biloxi MS), one of my immediate responsibilities is to basically perform the detection final project for both the radiation oncology and diagnostic imaging departments. Apparently, before Hurricane Katrina wiped out operations, we had all of the equipment we needed. Currently, nearly everything is being contracted out on the imaging side to the extent that we don't even have a CTDI phantom or pencil ionization chamber (yikes). Further, we're bringing LDR, SBRT, and HDR online, and I'm responsible for figuring out exactly what we need to meet QA requirements. I suppose what I'm trying to say is that the Detection final project is not as far-fetched as some of the students may think and really proved to be a valuable learning experience for me. Keep up the good work!"

Jonathon W. Mueller, MS
Diagnostic Imaging Flight Commander
Keesler Air Force Base, Biloxi MS

Positive Student Feedback

"To foot stomp the e-mail I sent you in September about the reality of the Detection project, I once again find myself engaged in a similar project in the "real world." I am working on standing up a new imaging physicist position at an Air Force base in Florida, and these efforts include making a shopping list of all the equipment this new physicist will require. Therefore, twice in my first year as a physicist, your Detection final project proved realistic. Thanks for the mentoring!"

Jonathon W . Mueller, MS
Diagnostic Imaging Flight Commander
Keesler Air Force Base, Biloxi MS

Project-Based Learning Summary of Our Experience

- **We maintained our instructor-led lecture format to teach core course content.**
- **Added a comprehensive class project that combines detector fundamentals with practical applications for imaging and therapy.**
- **The project requires critical thinking, problem solving, and collaboration among the students in each group.**
- **We continually seek feedback from the students on the course and specifically on the project.**

Thank You

Conclusions

Take-Home Message

- We can enhance our roles as teachers by providing our students with insight and understanding as well as guidance as to how to process the information that is accessible to them.
- We must leave ourselves open to learning new ways to do this.

Take-Home Message

- Implementation of the techniques we have shown are likely to take you out of your comfort zone

- BUT -

- The way we learn is by extending the boundaries of our comfort zones.

Closing Thought

- Our role as medical physics teachers is not to teach our students medical physics

Closing Thought

- Our role as medical physics teachers is not to teach our students medical physics
- Our role as medical physics teachers is to teach our students to learn medical physics

Panel Discussion