Innovations in teaching an introductory medical physics class

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THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center
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Purpose of Presentation

1. Share experiences in teaching introductory medical physics course to 1st year graduate students
2. Present some (at least for me) innovative techniques for teaching course

Course Description

GS020093 Introduction to Medical Physics I: Basic Interactions

Starkschall, George. Three semester hours. Fall annually. Prerequisite: consent of instructor

This semester covers the basic interactions of ionizing and non-ionizing radiation important in medicine. Topics include photon, electron, and neutron interactions, high LET radiation, radioactivity, ultrasound interactions, and laser interactions.

- **15-week semester**
- **2 meetings per week to introduce new material**
- **1 meeting per week in smaller groups to work out problem sets**

Use of Website

GS02-0093 - Introduction to Medical Physics I
Basic Interactions

Schedule - Fall 2010

last revised 11/17/2009

Objectives:

The purpose of this course is to provide the medical physics student with an introduction to ionizing radiation and its use in medicine. Topics covered include production of radiation, interactions of radiation with matter, and measurement of radiation. This course is a prerequisite for subsequent courses in medical physics.

Lectures:

Mondays, Wednesdays, and occasional Fridays 2:45 - 3:45 pm (Fridays primarily reserved for quizzes)
GSBS Small Classroom (BSRB3.8367)

Problem Sessions:

Thursday 4:00 - 5:00 pm
Group 1 - Radiation Physics Classroom (B2.4526)
Group 2 - Imaging Physics Classroom (CPB5.3312)

Faculty:

Dr George Starkschall, course coordinator
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Dr Jason Stafford
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Dr Sastry Vedam
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Information on Website

Date	Topic	Instructor
Monday, 8/30	**Part 0 - Introduction to the course**	Starkschall
Wednesday, 9/1	**Part 1 - Introductory Material** 1.1 - Basic quantities and units reading assignment: Johns & Cunningham, ch 1, pp 1-10 [link to notes] [link to lecture] [link to lecture transcript] [link to ConcepTest questions] [link to Problem Set 1.1]	Starkschall
Thursday, 9/2	No class	
Friday, 9/3	1.2 - Radiation quantities and units reading assignment: Johns & Cunningham, ch 1, pp 10-12 [link to notes] [link to lecture] [link to lecture transcript] [link to video] [link to ConcepTest questions] [link to Problem Set 1.2]	Starkschall
Monday, 9/6	No class - Labor Day	
Wednesday, 9/8	1.3 - Atomic and nuclear structure reading assignment: Johns & Cunningham, ch 1, pp 12-21 [link to notes] [link to lecture] [link to lecture transcript] [link to ConcepTest questions] [link to Problem Set 1.3] Problem Set 1.1 due @ 5 pm [link to Problem Set 1.1 Solutions]	Starkschall
Thursday, 9/9	No class - Lab safety instruction	

Information on Website

- Reading assignment – Johns & Cunningham
- Link to notes
  - PowerPoint presentations, 3 slides/page
- Link to lecture
  - All lectures pre-recorded using Camtasia
  - Adds sound track to PowerPoint
- Link to transcript
  - Transcript of lecture

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

Peer instruction

- Teaching technique developed for physics class by Mazur (Harvard U)
- Focus class attention on concepts, rather than information or problem solving
- Based on idea that students who have recently acquired understanding of concept have better idea of impediments to understanding than faculty

Principles of peer instruction

- **Before class:**
  - **Identify 4-6 concepts to be presented in class**
  - **Develop “ConcepTest” questions**

ConceptTest questions

- Focus on concept, not the recall of facts
- Not solvable by relying on equations – avoid plug ‘n’ chug
- Have adequate multiple-choice answers
- Be unambiguously worded
- 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 test recall of information, but rather understanding of how that information is used

Principles of peer instruction

- Spend about 7-10 minutes on each concept
- Ask ConceptTest question
- Students have ~1 minute to respond
  - Insufficient time to do calculations
  - Students display response without seeing others' responses
  - Can use flash cards or ARS devices to display response

Principles of peer instruction

- Students gather into groups of 3-4
- Students have 3-4 min to convince others in their group their answer is correct

Principles of peer instruction

- **Generally, students who understand the concept provide a more convincing argument why their answer is correct than 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 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

Problem Sessions

- Assigned at end of lecture, due 1 week later
- Students split up into two groups in problem sessions
- Prior to working out problem solutions, students get “Guesstimation” problem
  - Develops skill in estimating answers to problems with essentially no knowledge of specifics
  - Focus is on strategy, not numbers

Guesstimation problems

How many piano tuners are there in Houston?

To solve this problem, let us start with estimating how many pianos there are in Houston.

The population of Houston is about 3,000,000. However, several people live in a household, so the number of households is about 1,000,000.

We can estimate that 5%-10% of households have pianos. Let's say 10%, as that would also include piano in public places such as schools, auditoriums, churches, etc. That would make the total number of pianos to be 100,000.

How often is a piano tuned? I would guess once every 2 years on the average. In that case, 50,000 pianos are tuned per year.

How long does it take to tune a piano? Probably around 2 hours. So 100,000 hours are spent tuning pianos each year.

One work year is 2000 hours. To tune the pianos in Houston in one year would take 50 workers.

So that's our estimate. There are around 50 piano tuners in Houston. That's probably not too far off from the exact answer.

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

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**

Thank you