“MAKE YOUR CLASSROOM A COMMUNITY THAT EQUIPS EACH INDIVIDUAL FOR SUCCESS”

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Adult Learning (Androgogy) Techniques for Medical Physics:
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First, a required disclosure slide:

Disclosure

- Employee of Accuray Incorporated

IN THIS TALK ARE IDEAS FROM PREVIOUS MENTORS:

➔I tried to combine all the best ideas from my past when I took over Medical Physics 501 from Rock Mackie at the University of Wisconsin – Madison.

-- Homework ideas are from Rock Mackie (Medical Physics Professor).

-- Term paper ideas are from Ray Fonck (Nuclear Engineering Professor).

-- Symposium ideas are from Robert Jeraj (Medical Physics Professor).

-- Lecture ideas are from Speech Instructor as an undergraduate at Penn State.

-- Exam ideas are from Rock Mackie and Mike Van Lysel (both Medical Physics Professors)

CONTENTS AND THEMES:

1. Make group problem solving tasks that are fun and accepting of risk taking. Have at least one social event to help teams to form. Laugh at your own mistakes, and make it easy for students to speak up. Encourage them to teach each other: peer-to-peer teaching is highly effective.

2. Spend some time with individual students and smaller groups, at their level. Do some homeworks with them, as one of them, to see what the roadblocks really are. Some students need some things done differently, so make that happen.

CONTENTS AND THEMES, CON'T:

3. <u>Make exams deep and varied with high quality,</u> time consuming grading. Students always appreciate more detail and care in grading, helps them up-their-game too. Make projects that directly train them for something practical as well as teach content.

4. <u>Make lectures a detailed story with frequent references</u> to key concepts, mixed with fun extras. It is 100% the teacher's job to make it an interesting lecture. Optimize total motivation = teacher motivation * student motivation.

5. A bit more … <u>some dos and don'ts</u>

1. THE WAY I ACCOMPLISH COMMUNITY FOR RESEARCH SKILLS:

a. Students do a group project, <u>learning useful writing and speaking skills</u> for graduate school:
   -- they write it up *as a journal article*:
   -- they write a typical AAPM style talk and present it like a small conference to each other.

b. I have them <u>form groups in a party</u>! I call it a 'donut mixer!'

My students learn to write in real world styles:

Comparison of AAPM TG-51 and AAPM TG-21 dosimetry protocols in low energy clinical electron beams

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(Dated: 15 December 2016)

A comparison of the determined absorbed dose in water with electron beams has been made following the AAPM's TG-21 and TG-51 dosimetry protocols. Absorbed dose to water was determined at electron beam energies of 4 and 6 MeV on a Varian Clinac™ 21EX using three different ionization chambers: a Farmer-type chamber, a scanning chamber and a plane-parallel chamber. Compared to TG-21 at 4 MeV, the doses at d_{max} were 3.4% larger using TG-51 for the Farmer-type chamber, 3.7% larger using TG-51 for the scanning chamber, and 0.4% larger using TG-51 for the plane-parallel chamber. At 6 MeV, these doses were 3.3% larger in TG-51, 0.6% larger in TG-51, and 1.2% smaller in TG-51, respectively. The measurements at 6 MeV for the Farmer-type chamber were within the margin of error of a previous comparison study performed by Huq et. al. in 2001, published in *Medical Physics*. This group's comparison for the plane-parallel chamber was just outside the uncertainty reported in TG-51, most likely attributed to the conservative estimate of uncertainties.[1] This study also investigated 4 MeV electron beams as no previous comparison studies have been published at this energy. Absorbed dose to water measurements follow the trends seen at higher energies; TG-51 measurements have a slightly higher calculated dose than the comparable measurement calculated using TG-21. These results show agreement with a previous comparison of the two protocols at 6 MeV and provide new insight for comparison of the protocols for a 4 MeV clinical electron beam.

I. INTRODUCTION

In order to increase the precision of dosimetric measurements in radiation therapy, the American Association of Physics in Medicine (AAPM) set up Task Group 21 (TG-21) in 1983 to create a protocol for the determination of absorbed dose from high-energy photon and electron beams.[2]

In 1999, the AAPM formed Task Group 51 (TG-51) to develop a second protocol for clinical reference dosimetry.[3] This second protocol differs from TG-21 in that TG-21 calibrations are based on an exposure ionization chamber calibration factor while TG-51 calibrations are based on absorbed dose to water. Both protocols require the use of ADCL-reported calibration coefficients obtained using a standard cobalt-60 beam. TG-51 utilizes the absorbed-dose-to-water calibration coefficient, $N_{D,w}$, directly, but TG-21 uses N_{gas}, which is calculated from the reported calibration coefficient, N_X, and various chamber-dependent correction factors.[1]

In TG-51, the quality conversion factor, k_Q, converts the absorbed-dose-to-water calibration factor for a ^{60}Co beam, $N_{D,w}^{^{60}Co}$ into the calibration factor for a beam of quality Q for either photon or electron beams, $N_{D,w}^{Q}$. The quality conversion factor is chamber specific. For photon beams, k_Q is provided in the protocol for most reference chambers.[3] However, for electron beams, the quality conversion factor is defined as follows:

$$k_Q = P_{gr}^{Q} k_{R_{50}} \quad (1)$$

where P_{gr}^{Q} is only applicable for cylindrical chambers in order to correct for gradient effects at the reference depth. $k_{R_{50}}$ is defined as a product of two factors:

$$k_{R_{50}} = k_{ecal} k'_{R_{50}}. \quad (2)$$

The photon-electron conversion factor, k_{ecal}, is fixed for a specific chamber model as the conversion from $N_{D,w}^{^{60}Co}$ to the absorbed-dose calibration factor in an electron beam of quality Q_{ecal}, $N_{D,w}^{Q_{ecal}}$. Then, $k'_{R_{50}}$, the electron beam quality conversion, which is beam dependent, converts $N_{D,w}^{Q_{ecal}}$ to $N_{D,w}^{Q}$. The introduction of k_{ecal} means that the chamber-to-chamber variation of $k'_{R_{50}}$ is much less than $k_{R_{50}}$, and it is a useful quantity because of its ease to directly measure and its natural role in cross-calibrating plane-parallel chambers against cylindrical chambers.[3]

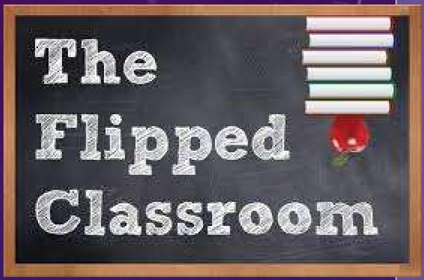
A comparison of the two protocols has been previously conducted for electron and photon beams in differing types of phantoms.[1,4] Information on the differences between protocols allows for consistency when calibrating and a better understanding of the impact of using each protocol. Cho et. al. (2001) compared the protocols at electron beam energies of 9 MeV and 16 MeV and found that the dose measurements taken with TG-51 were sligtly larger, but in general within 1% of the dose determined using TG-21. The estimated uncertainty of electron beam measurements was less than ±0.2%, excluding the inherent error associated with the calibration factors.[4]

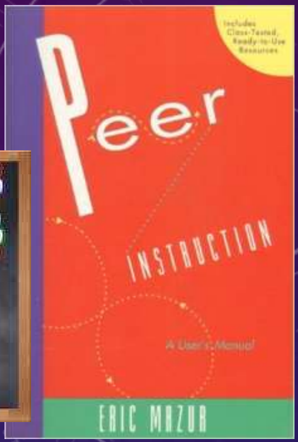
Huq et al. (2001) compared the protocols at electron beam energies of 6, 8, 10, 12, 15, and 18 MeV using Farmer type and plane-parallel chambers. It was found that in cylindrical chambers, the absorbed dose to water was 1% to 3.1% higher in TG-51 than in TG-21. For the plane parallel chambers, the TG-51/TG-21 ratios ranged from 1.007 to 1.029 for direct calibration technique. The authors noted that some error can be due to discrepancies

By the way, I teach TG-21 in my theoretically focused class to connect cavity theory to REAL protocols.

2. STUDENTS PLAY AN ACTIVE ROLE IN HOMEWORK REVIEW, ALSO CREATING COMMUNITY:

I am not doing a fad here, but there are elements of it!





a. They present a problem to the whole class: It develops public speaking skills, learning to solve a problem in front of others. I request all students be polite as they are critical.

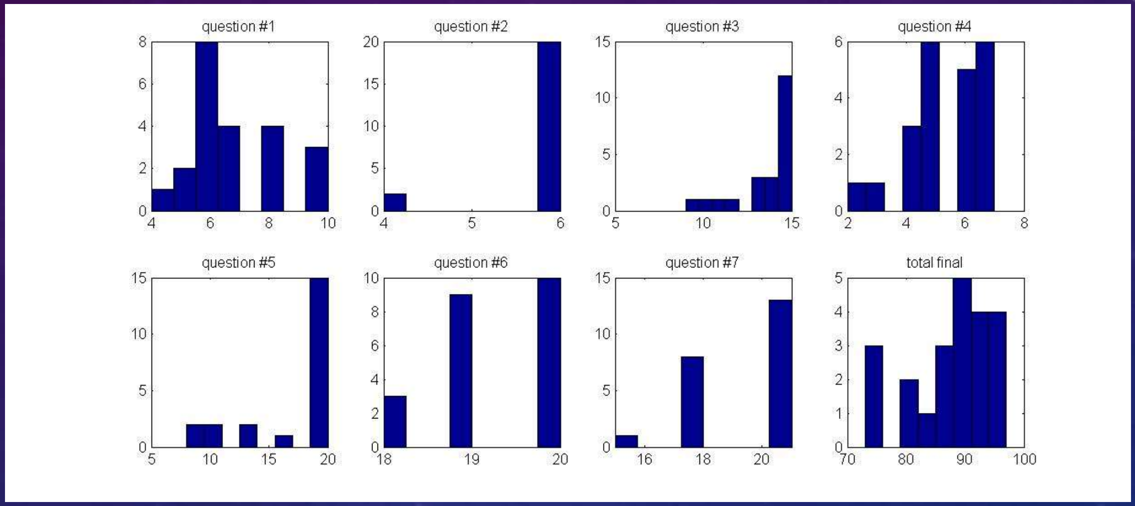
b. Then, they correct other students' homeworks! (not grading, just indicating what is right and wrong.

c. There are elements of this that connect to "flipped classrooms" or "peer learning" BUT, What I am doing with homework was inherited from Rock Mackie who got the idea from his old professor in Canada. So, not a new fashion, but actually an established technique!

3. MY EXAMS …

a. Stay away from multiple choice as a main part of the exam. Make the exam creative for a variety of people.

b. Hand back exams with histograms on the front:



c. I try not to curve the grade: I try to keep scale fixed and adjust the difficulty to get one or two 100%s but try not to get scores lower than 50%.

d. Take extra care in grading: students always welcome your careful effort in grading!

4. LECTURES

a. Provide details and examples. Using power point for lectures is not a good idea: often too thin on info.

b. Do examples frequently BUT they are time-consuming, so not too many.

c. Tell them a story! Make it entertaining.

d. Be very open to questions and student feedback: they are customers!

e. Make a coherent and organized set of notes that point to textbooks.

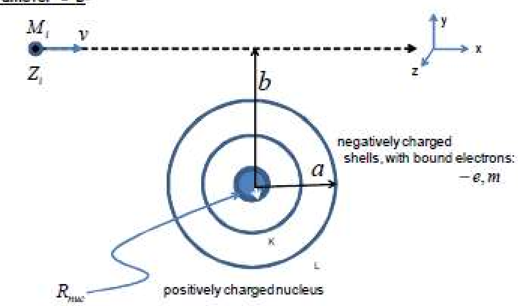
From my notes:

Charged Particle Interactions with Matter:

- We will switch gears now that we know about *transferring* energy to charged particles, let's find out what happens next – how do these charged particles then **deliver the energy to matter** as they slow down.

- We will start with an important derivation that will then be generalized to eventually work for electrons slowing down in condensed matter.

- At first though, let's start with a heavy charged particle with **kinetic energy** = T, **velocity=v** with a lot of inertia going very quickly by an atom with an **impact parameter = b**:



- The "heavy and fast" particle at the base of the arrow in the above figure has a charge, Z_1 and a mass, M_1, and a significant energy, $\gamma M_1 c^2$ such that $\gamma = 1/\sqrt{1-v^2/c^2} >> 1$ ("fast" = "Born approximation"). The bound electron on the other hand has only a charge, $-e$, a mass, m, and bound energy such that kinetic energy, T, roughly equals its potential energy. The velocity is v (not frequency here). In other words: $mv^2/2 \sim e^2/a_0$ where $a_0 \approx \hbar^2/me^2$ which gives $v^2/c^2 \sim e^4/\hbar^2c^2 \sim (1/137)^2$, the fine structure constant, α, squared. Therefore,

I send old & original papers:

14 Dr. N. Bohr: *Theory of Decrease of Velocity of*

of the orbits gives *

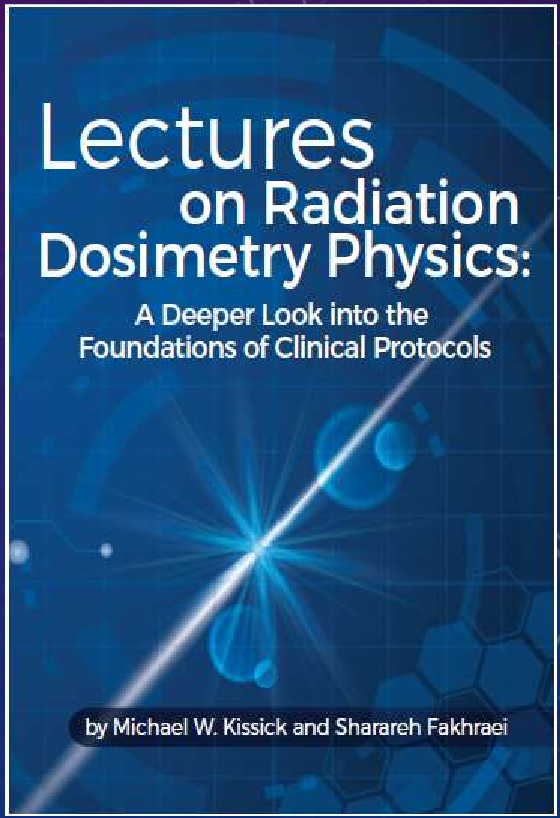
$$\sin^2 \vartheta = \frac{1}{1 + \frac{p^2 V^4}{e^2 E^2}\left(\frac{mM}{M+m}\right)^2},$$

where 2ϑ is the angle through which the direction of the relative motion is deflected by the collision. For the sake of brevity we shall in the following use the notation

$$\lambda = \frac{eE(M+m)}{V^2 mM}.$$

The velocity of the electron after the collision will make

IN FACT, I MADE MY LECTURES INTO A SMALL / CONDENSED BOOK FOR THOSE TOO BUSY TO TAKE A CLASS OR READ A HUGE TEXTBOOK:



A lot of people in your adult class may be just interested in practical knowledge, so

<u>make sure you get to the point quickly when you can, after that, go into theory and detail</u>

-- lots of summary charts
-- lots of good diagrams
-- some examples <u>with correct units and significant digits</u>

DOS AND DON'TS:

1. **Never publically embarrass a student: that is never really forgiven.**

2. **Never say you know something if you really don't: the bigger the class, the more it gets noticed, but**

3. **Always remember that students always forgive honest mistakes, if you are graceful about it.**

CONCLUSION:

INFORMATION IS RETAINED WHEN ATTACHED TO EMOTIONS OR SOMETHING UNEXPECTED/INTERESTING:

MAKE YOUR CLASS MEMORABLE !

People will forget what you said. People will forget what you did. But people will never forget how you made them feel.

-- Maya Angelou