

Innovations in Medical Physics Education

Joann I. Prisciandaro, Ph.D.
joannp@med.umich.edu



Disclosures

- Chair of AAPM Education Council

Learning Objective

- Describe methods to educate, train, and prepare students and trainees for the future of our profession



Innovations in Medical Physics Education

- Training and education of medical physicists
 - Preparation for the future of our profession
- Pedagogical techniques

Medical Physics Graduate Curriculum

- AAPM Report 197 – recommended curriculum for medical physics graduate programs (MS/PhD)
- AAPM Report 197S – recommended minimum didactic curriculum for alternative pathway candidates
 1. Radiological physics and dosimetry
 2. Radiation protection and radiation safety
 3. Fundamentals of imaging in medicine
 4. Radiobiology
 5. Anatomy and physiology
 6. Radiation therapy physics
- Per CAMPEP's graduate educational standards, graduate education programs shall, as a minimum, include the core topics defined by Report 197S plus professionalism and ethics



Training of Clinical MP Residents

- 2.5 Expected Areas of Competence for a Clinical Medical Physicist in Imaging.....
- 2.5.1 General Radiography
- 2.5.2 Hard-copy and Image Displays
- 2.5.3 Angiography and Fluoroscopy
- 2.5.4 Computed Tomography (CT)
- 2.5.5 Ultrasound (US)
- 2.5.6 Mammography
- 2.5.7 Magnetic Resonance Imaging (MRI)
- 2.5.8 Nuclear Medicine and Positron Emission Tomography (PET).....
- 2.5.9 Imaging Informatics.....
- 2.5.10 Safety

J.I. Prisciandaro *et al.*, AAPM Report No. 249, 2013.



Training of Clinical MP Residents

- 3.5 Expected Areas of Competence for a Clinical Medical Physicist in Nuclear Medicine
- 3.5.1 Gamma Camera with/without SPECT.....
- 3.5.2 Positron Emission Tomography (PET and PET/CT)
- 3.5.3 CT Scanner (with SPECT or PET)
- 3.5.4 Non-imaging equipment
- 3.5.5 Radiation Safety
- 3.5.6 Patient Dosimetry
- 3.5.7 Informatics
- 3.5.8 Radiopharmacy.....
- 3.5.9 Clinical Studies.....
- 3.5.10 Radionuclide Therapy

J.I. Prisciandaro *et al.*, AAPM Report No. 249, 2013.



Training of Clinical MP Residents

- 4.5 Expected Areas of Competence for a Clinical Medical Physicist in Radiation Oncology.....
- 4.5.1 Treatment Equipment.....
- 4.5.2 Patient Treatment.....
- 4.5.3 Patient Safety.....
- 4.5.4 Brachytherapy.....
- 4.5.5 Detectors and Dosimeters.....
- 4.5.6 Imaging.....
- 4.5.7 Radiation Safety.....
- 4.5.8 Informatics.....
- 4.5.9 Elective Rotations.....

J.I. Prisciandaro *et al.*, AAPM Report No. 249, 2013.



Challenge with Didactic and Training Curriculum

- Addition of new content
- Removal of older, less relevant content
- Expanding the diversity of the didactic and training curriculum
- Teaching soft skills (e.g., ethics, professionalism, communication, teamwork, leadership, patient interactions)



Challenge with Didactic and Training Curriculum

- How do we add content without taking out older, important material?
- When do you stop talking about older, less relevant topics (e.g., point A based brachytherapy treatment planning) and replace the content with new material (e.g., volume based brachytherapy treatment)?
- How do we expand the diversity of the didactic and training curriculum?
- How do we find room to teach soft skills (e.g., ethics, professionalism, communication, teamwork, leadership, patient interactions)?



How can we address these challenges?

- Ensure medical physics education is dynamic to keep up with the field
- Recruit faculty with diverse background – beneficial for students, clinic, and research and development
- Provide opportunities professional mentoring and potential internships

The Working Group on Medical Physics Graduate Education Program Curriculum and the Work Group on Periodic Review of Medical Physics Residency Training are in the process of updating AAPM Report 197 and 249, respectively.



How do we prepare our students and trainees for the future of MP?

- Medical Physics 3.0
 - Redefine and reinvigorate the role of physics in modern medicine
 - Position physicists to be “scientific agents of precision, innovation, and value in the development and practice of medicine”
- In line with the mission of AAPM Working Group FUTURE

<https://w3.aapm.org/medphys30/medphys.php>

E. Samei, What is Medical Physics 3.0?, AAPM Annual Meeting, 2017



How do we prepare our students and trainees for the future of MP?

- Ensure students have a strong, fundamental background in physics and medical physics
- Prepare students to be critical thinkers
- Include course offerings in other disciplines
 - Immunotherapy
 - Cancer & molecular biology
 - Big data and machine learning
 - Artificial intelligence
 - Leadership and management

<https://w3.aapm.org/medphys30/medphys.php>

E. Samei, What is Medical Physics 3.0?, AAPM Annual Meeting, 2017



How do we prepare our students and trainees for the future of MP?

- Communicate with other health care professionals and hospital administrators
- Lifelong learning
 - Medical physics
 - Contemporary sciences
- Develop relationships/collaborations with other professional

C. Fiorino *et al.*, *Radiotherapy and Oncology*, 153, 7 – 14 (2020).

C.H. Clark *et al.*, *Physics and Imaging in Radiation Oncology*, 11, 71-75 (2019).



“How are your present teaching methodologies different from those you used 5 years ago”?

G. Starkschall, Journal of Applied Clinical Medical Physics, 2009, 10(3), 1-2.



Innovative Pedagogical Techniques

- Traditional learning approaches
 - Lectures
 - Hands-on labs
 - On-the-job training
- Transition from passive, instructor centric (traditional) to active, student centric learning

<https://www.aapm.org/org/structure/committee/article.asp?id=13350>



Innovative Pedagogical Techniques – Just-in-Time Learning

- Combines modified lectures and group based problem solving
- Pre-class reading assignment
- Short quiz (~3 questions) on topic that has not been covered the class, but will be addressed in the class, including a question on what was most interesting or confusing about assigned material
- Responses are due a few hours before class
- Lecture and classroom activities are modified based on the quiz

Novak, Just-in-Time Teaching: Blending Active Learning with Web Technology, Addison Wesley, Copyright 1999

E.F. Redish, Teaching Physics with the Physics Suite, John Wiley & Sons, Copyright 2003

<https://www.aapm.org/education/VL/vl.asp?id=12051>



Innovative Pedagogical Techniques – Peer Instruction

- Interactions incorporated within the lecture
- Pre-class reading assignment
- Students are broken up into groups
- Series of short lectures delivered in short segments (5 – 7 minutes)
- Concept oriented multiple choice question presented to group
- Students respond to question
- Groups discuss problem with group for several minutes
- Question repeated and student asked to answer again
- If students still struggling, additional material is presented

E. Mazur, Peer Instruction, Pearson, Copyright 1997

E.F. Redish, Teaching Physics with the Physics Suite, John Wiley & Sons, Copyright 2003

<https://www.aapm.org/education/VL/vl.asp?id=12051>

Innovative Pedagogical Techniques – Flipped Classroom

- Plan lesson – determine objective
- Record lecture
- Distribute video to students
- Students are broken up into groups
- Groups given problems to work on together (e.g., concept based)
- Class comes back together as a whole to discuss work

J. Bergmann and A. Sams, Flip your classroom: Reach every student in every class every day, International Society for Technology in Education, Copyright 2012.



Innovative Pedagogical Techniques – Problem/Project-Based Learning

- Student presented with open-ended problem/project
- Students define their learning objective
 - What do they already know?
 - What do they need to learn?
 - Where they can acquire this information?
- Solve the problem
- Present on their findings

M.D. Merrill, Journal of Research on Technology in Education, 2007, 40(1), 5-22.
<https://www.bmj.com/content/326/7384/328>



Innovative Pedagogical Techniques

- Resources
 - AAPM Virtual library
 - 2018 AAPM Workshop – Improving the teaching and mentoring of medical physics
- Committee on Medical Physicists as Educators
 - MPESC Wiki:
<https://www.aapm.org/org/structure/committee/article.asp?id=13350>
- 2021 Education Council Symposium
 - Lessons learned during the COVID-19 pandemic – innovative approaches to didactic and clinical training

“Staying abreast of the subfield of medical physics in which one works is a challenge given the rapid advancements. However, such rapid advancements keeps one’s work interesting.”

<https://www.medphysics.wisc.edu/spotlight/edward-jackson/>



RADIATION ONCOLOGY