



It only took a pandemic: Engaging online students with active learning strategies

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Disclosures

• None



US Centers for Disease Control COVID-19 Case Surveillance Public Use Data



Challenges of Online Learning

Technical Challenges

- Computer access
- Internet connectivity
- Computer literacy

Lack of Structure

- Organization
- Self-discipline
- Time management

Social limitations

- Feelings of Isolation
- Lack of interaction
- Reduced motivation



Browning MH et al (2021) PLOS ONE; Ihm L, et al (2021) Int J Health Plan Mgmt; Li X, et al (2021) Int J Env Res Public Health

The Online Environment

- Reduced focus
- Home environment
- Distractions
- Zoom fatigue
- Few interactions
- Passive learning



The Online Environment

- Online learning is more tiring on concentration
- We cannot transfer online the same approaches used in face to face learning



Traditional Learning	Active Learning
Passive, lecture-heavy, one-way transmission of information	Student actively participates in the learning process
Instructor talks and students listen with few interruptions	Instructor talks with regular breaks for structured activities
Student concentration drops after 10 minutes	When student concentration begins to wane, a short in-class activity is assigned
The instructor is unaware of student comprehension during the lecture	Student comprehension is assessed directly during the lecture

Benefits of Active Learning



Activities promote high-order thinking skills, improving understanding and learning

Interaction improves human connection, engagement, motivation, and participation



Collaboration forces students to actively contextualize meaning among a group



Community supports collaborative learning and helps students feel comfortable and valued

Course Description

3-Credit Graduate Course Fall semester		Tw lect (1	vo 75-minute ures per week Tues/Thurs)	
R	adi Bio	ation logy		
Incoming Medical Physics Graduate Students		(R	Course size ange: 4 - 14 students	



Prepare Students for Success

- 1. Define measurable student learning objectives
- 2. Align educational content and assessments to meet them
- 3. Use a Learning Management System

Motivate students with Active Learning Strategies

- 4. Humanize course with interactions
- 5. Create engaging lectures & interactive activities
- 6. Promote a strong collaborative learning community

Define Learning Objectives Prepare Content & Assessments

Торіс	Student Learning Objectives	Bloom's Learning Level	Assessments	Activities	Text Readings	PowerPoint Slides
Radiation -induced damage to cells	1. Identify the 5 major types of radiation- induced chromosome aberrations	Remembering	Short answer	Teamwork in Jamboard		Radiation damage to DNA and Chromosomes
	2. Differentiate the 3 techniques for identifying DNA damage, quantifying chromosomal aberrations, and graphing cell survival curves	Analyzing	Essay	Padlet activity	Radiation biology for the radiologist	Evaluating chromosomal damage & cell survival
	3. Calculate cell survival fractions given an irradiation scenario	Applying	Solve	Homework		Cell survival curves
	4. Predict how modifying radiation type, dose rate, or oxygen concentration will affect cell killing to normal cells and tumor cells	Evaluating	Short answer	Discussion in breakout room	Chapters 1-3	Cell survival curves
	5. Recommend an irradiation treatment plan for a specific type of tumor	Creating	Discussion	Discussion board in Canvas		Factors that affect cell survival

Create a Structured Course in Canvas

- Each lecture had its own:
 - Linked page
 - Instructional materials
 - Activities & Assignments
- Frequently sent students messages, reminders, feedback
- Synchronous lectures in Zoom
 - Recorded for review

LECTURE 1 INTRODUCTION TO RADIATION BIOLOGY	LECTURE 2 RADIATION INTERACTIONS			
Hello everyone! In this first lecture we will review the importance of this class and why you should know this a medical physicist. We will explore the history of the discovery of radiation, how it led to some detrimental effect pioneers of the radiation protection era.	Hello everyone! In today's lecture, we will review some fundamental cor interactions. Radiation Interactions is actually such a complex topic, dedicated to it with Dr. Bolch this semester! Today, we verelevant portions that will help prepare you to learn about	you will out		
OBJECTIVES	B OBJECTIVES			
At the end of this lecture, students will be able to 1. Understand the course structure and instructor expectations 2. Be able to define what the topic of Radiation Biology entails 3. Appreciate the history of the discovery of radiation and its effects 4. Have an overheave of the immediate and long term effects of radiation	At the end of this lecture, students will be able to 1. Demonstrate understanding of photon and particle interactions 2. Compare and calculate Ranges and Linear Energy Transfer for different types of radiation			
*. Have an overview of the infineduate and long term enects of radiation	E READINGS			
E READINGS	There were two assigned readings for Lecture 2:			
There are no pre-assigned readings for Lecture 1.	1. The last 23 slides in the Lecture Powerpoint: <i>Electromagnetic Radiation</i> 2. The Essential Physics of Medical Imaging: Chapter 2: <i>Radiation and the Atom</i>			
• LECTURE	• LECTURE			
Course notes: <u>link here</u> *	Course notes: <u>link here</u> ±			
ACTIVITIES	ACTIVITIES			
We will access the following links together during the class lecture: 1. Pre-Course Quiz: <u>link here</u> 2. Jamboard: <u>link here</u> ø 3. Padlet: <u>link here</u> ø	We will access the following links together during the class lecture: 1. Socrative: <u>link here</u> ø 2. Electron binding energies: <u>link here</u> ø			
A HOMEWORK ASSIGNMENTS	A HOMEWORK ASSIGNMENTS			
Due Thursday, September 3rd: 1. Review the course <u>syllabus</u> 2. Dand the left 23 differences the left transmission Flatterment in Participa	 Homework Assignment #1 - due September 10th: link here Watch video reviewing lecture 2 and covering remaining slides on LET - due September 10th (Neys Byte Vescove) 			
 2. Read the last 23 slides in the Lecture Powerpoint: Electromagnetic Radiation 	1			

- 3. Read The Essential Physics of Medical Imaging: Chapter 2: Radiation and the
- Free e-book available for UF students through UF libraries here

How I taught a 75-minute Course





- Introductions, ice breakers, virtual backgrounds, show & tell, games
- Opportunities to discuss class material
 - Join class early or stay late
 - Provide a space outside class
- Scheduled social hours outside of class
- Instructor presence, enthusiasm, humor
- Campus announcements and resources



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Create Engaging Lectures & Interactive Activities

- Spark *intrinsic motivation* to drive learning
 - Real-word problems & clinical scenarios
- Formative feedback
 - Low-stakes quizzes, games, extra credit



Answer questions for candy







celebrates 100th birthday

Socrative Quizzes

b.socrative.com/teacher/#live-results/question/9 Education Medical Physics Personal Leadership Image: State of the state	RADBI02020	Izabella Barreto
Quiz - L'Iecture 4		FINISH
9 Which contains greater energy deposition?		
A Spur		25%
B Blob		75%
C Delta ray		0%
* SHOW EXPLANATION		

Jeopardy for extra credit before an exam



General	Radiation Interactions	DNA Damage & Repair	Chromosome Damage	Measurement methods
<u>1 point</u>	<u>1 point</u>	<u>1 point</u>	<u>1 point</u>	<u>1 point</u>
<u>2 points</u>	<u>2 points</u>	<u>2 points</u>	<u>2 points</u>	<u>2 points</u>
<u>3 points</u>	<u>3 points</u>	<u>3 points</u>	<u>3 points</u>	<u>3 points</u>

Promote Collaborative Learning



- Collaboration maximizes student learning
- Significant class time devoted to small group activities
 - Think-Pair-Share, "Jigsaw" Peer Teaching, Problem solving
- Exploit collaborative virtual tools
 - Chat and Discussion boards, Breakout rooms
 - Online apps like Google Doc, Padlet, Jamboard, etc

Without speaking, walk around the room and find the person holding the card that pairs with the cell on your card



Read, discuss in groups, teach the class



Group 1: Tattoos in MRI

Student A: https://www.livescience.com/32801-do-mri-machines-affect-tattoos.html Student B: https://blog.radiology.virginia.edu/mri-with-tattoos/

Reading Assignments (6 minutes)



Group 2: Blankets in MRI

Student A: https://www.prayfornoah.com/mri-burn.html Student B: https://www.radiologytoday.net/archive/rt0310p24.shtml

We Learned:

Tattoos in MRI can be dangerous and cause heating due to metallic particles (iron) present in the ink. The iron can interact with the magnetic and radio waves and conduct an electric current that heats up the tattoo.



(3 minutes, 1-3 sentences per student)



We Learned:

A boy wrapped in an anti-hypothermia blanket (containing aluminum) suffered a third-degree burn during an MRI scan. The company which makes the blankets issued an immediate recall. The punch line is that even non-ferromagnet metals are potential heat conductors.

Students read assigned sections from BEIR-VII, created summary slides, and taught the class

POPULATIONS EXPOSED FROM ATMOSPHERICTESTING, FALL

TABLE 9-2A Populations Exposed from Atmospheric Testing, Fallout, or Other Environmental Release of Radiation-Ecologic Studies

Reference	Incidence/ Mortality	Population Studied	Type of Exposure	Dates of Accrual	Type of Dosimetry	Outcomes Studied	Number of Cases	Summary of Results
Darby and others (1992)	Incidence	Children under age 15 in Nordic countries	Fallout from nuclear weapons tests	Denmark (1948), Finland, Norway, Iceland (1958), Sweden (1961– 1987)	Estimates of bone marrow dose to fetus, 1-year-old, testes, received during fallout period: low, medium, high	Leukemia	Not given	Little increase in high-fallout years; slightly elevated in high vs. medium group
Gilbert (1998)	Incidence and mortality	United States	Fallout from nuclear weapons tests in Nevada	Deaths: 1957– 1994; incident cases: 1973– 1994	Mean thyroid dose by county, derived from measurements and environmental modeling	Thyroid cancer	4602 deaths; 12,657 incident cases	No increased risk with cumulative dose or dose received at ages 1–15; suggested increase for those exposed under age 1 and those in 1950–1959 birth cohort

Not quantitative; nature of exposure not known

- Utilize population-based exposure, rather than specific doses to individuals
- Looked for incidence of leukemia and thyroid cancer

Results

NO INCREASE OF DISEASE RATES*

- 1. No difference in nodularity, hormone levels, but slight increase in frequency of unstable chromosome aberrations
- 2. No increase in high-background areas except in cervix
- 3. No association of leukemia with indoor/outdoor gamma levels
- No evidence of higher rates of cancer in areas with higher background gamma radiation

Populations exposed from the Chernobyl Accident

April 26, 1986 – Explosion at the Chernobyl Power Station
Exposures: Iodine (I-131) & Cesium (Cs-137)





ENVIROMENTAL EXPOSURE

Hanford site

- nuclear production complex
- first full-scale plutonium production reactor in the world
- Marshal Islands

 United States detonated 67 nuclear bombs
- Enewetak and Bikini Atoll
- Groom Lake
 Fall out in Utah
- Chernobyl and Fukushima Daiichi
- Two worst nuclear disasters in history
- 5.6 roentgens per second estimated activity



THE RESULTS ARE IN!!!

 Most facilities showed no significant increase in cancer development from just living near the nuclear facility

- 3MI showed an actual increase in cancer development which is expected
- Dounreay, Scotland did show an increase over the expected amount in the zone nearest the nuclear reprocessing plant* (also expected)
- Children in England and Wales showed a significant increase in linear risk in two regions

 The PM theory in France resulted in a positive trend in leukemia development as the mixing index increased, therefore a higher risk of all cancers in children 1-6

 NONE of these studies provided " individual estimates of radiation dose and have therefore not provided an estimate of disease risk."

BEIR VII – Environmental Radiation Studies: Children of Adults Exposed to Radiation

Megan Glassell

Brainstorm what you think may be a possible radiation-induced health effect



Meet your partner in a breakout room and create 4 Q&A's related to today's lecture

Doug and Jared Questions

1. LET is considered,

- a. An absolute quantity
 b. An average quantity
- c. A minimum quantity
- d. A maximum quantity

2. The units of the alpha/beta ratio are

- a. 1/Gy
- b. Gy
- c. Gy/cm
- d. cm/Gy

3. Draw a survival curve labeling the axis D1, Do, and D4 and describe what they represent



In your own words, describe radiation damage resulting in DNA single strand breaks and double strand breaks.

Ex: Single strand breaks are a common result of low doses of radiation. A single strand break occurs when one strand of a DNA is broken or when both strands have breaks but are separated by several base pairs. However, when both strands are broken nearly adjacent to one another, directly across or separated by only a few base pairs, it is considered a double strand break. Single strand breaks are considered inconsequential since they are easily and quickly repaired. While double strand breaks frequently can cause death to cells.

Q: Given the relation

$LET \sim \frac{Q^2}{E_F} \sim$

how can it be possible for an uncharged heavy particle (e.g. a neutron) to have a higher LET than a charged particle (e.g. an electron)?

A: This relation applies only to charged particles. A neutron can have a higher LET than an electron despite being electrically neutral since it does not rely on coulombic field interactions to transfer energy to the target medium, but rather direct interactions with other nuclei. Neutrons have a relatively high LET since they are slow-moving and can produce secondary recoil particles such as protons.

<u>Q</u>: Given a photon beam of intensity I_0 incident on a lead slab ($\rho = 11.4 \text{ g/cm}^3$), at what depth in the slab would the measured beam intensity I = 0? Assume the photons have an average range of 2 cm.

<u>A:</u> The process is stochastic, and any single photon has some probability of never interacting with the target medium. Thus the measured beam intensity can never actually be zero (or equivalently, zero beam intensity can be achieved only at infinite slab depth).

 $\underline{Q};$ Why is it so much more lethal for a cell to experience two DSBs on homologous chromosomes near the same locus (single-hit) as compared to two DSBs, also on homologous chromosomes, but at different loci (double-hit)?

<u>A:</u> In the former case, homologous recombination cannot be used to repair damage and the cell must resort to NEHJ, which has lower repair fidelity.

Q: Why is it especially dangerous to expose germ line cells to radiation, as compared to somatic cells?

A: Many germ line cells are undergoing or are the product of meiosis, which ultimately produces haploid daughter cells lacking chromosomes with sister chromatids. As a result, homologous recombination is not possible to repair DNA damage due to irradiation.

<u>Q:</u> In a group of asynchronous cells, how can we determine the relative amount of time each cell spends in each phase of the cell cycle?

<u>A:</u> Assuming the cells are asynchronous, the relative proportion of cells in each phase of the cell cycle should correspond to the relative amount of time spent in each phase (e.g. half of a population of cells being in G₁ implies that approximately half of a given cell's life is spent in the G₁ phase).

 Q_2 Why is the hydroxyl radical the dominant species in terms of cell killing, despite hydrogen peroxide being both more damaging and longer-lived *m* vho? <u>A</u>: Even though hydrogen peroxide is more damaging to DNA and can exist for longer in solution, the hydroxyl radical is responsible for a majority (65%) of cell killing for two main reasons: it is simply produced in larger quantities (which makes sense, given that it is the chemical precursor to H₂O₂), and it also is not subject to being picked up by cellular radical scavengers as is hydrogen peroxide. (The cell naturally produces a lot of H₂O₂ and therefore has mechanisms in place to decrease levels of this molecule in the cytoplasm.)

Literature review, risk calculations, presentations, discussion



Number of Assessments Increased

		Fall 2019	Fall 2020
	Extra Credit	2	2
	Exams	3	3
During	Graded Quizzes	1	2
class	Ungraded Socrative Quizzes	0	5
	Team work	0	5
	Peer instruction	0	2
Outside of Class	Projects	2	2
	Homework Assignments	8	10
	Reading Assignments	2	5
	Team work	0	1

Results

- All students demonstrated:
 - ✓ Strong participation and enthusiasm
 - ✓ Great team work and support
 - ✓ High grades (above B+)
 - ✓ Positive instructor feedback



Questions	Response	Instructor	College
	Rate	Mean	Mean
The instructor was enthusiastic about the course.	100%	5.00	4.51
The instructor explained material clearly and in a way that enhanced my understanding.	100%	5.00	4.38
The instructor maintained clear standards for response and availability	100%	5.00	4.41
The instructor fostered a positive learning environment that engaged students.	100%	5.00	4.44
The instructor provided prompt and meaningful feedback on my performance in the course.	100%	5.00	4.28
The instructor was instrumental to my learning in the course.	100%	5.00	4.36
Course content was relevant & useful.	100%	5.00	4.32
The course fostered regular interaction between student and instructor.	100%	5.00	4.01
Course activities improved my ability to analyze, solve problems, and think critically.	100%	5.00	4.22
Overall, this course was a valuable educational experience.	100%	5.00	4.37

- Dr. Barreto did a great job keeping the class involved in the lecture. It's easy to space off during zoom sessions and I feel she did a great job interacting with students.
- The class breaks were a welcome relief and made the information intensive lectures easier to pay attention to.
- Dr. Barreto provided good PowerPoints and created many interactive activities for us to do with our classmates.
- I felt like I had an instructor who didn't expect perfection but expected 100% effort. I respect that - It makes you want to give it your all.

Challenges of Active Learning



- It takes more class time
- Planning takes more prep work



- Instructors lack institutional support
- Large class sizes complicate implementation

- Instructors may believe students are engaged
- Students may resist new approaches

Final Thoughts



- The pandemic has opened the door to new teaching opportunities
 - Give students a role in actively participating
 - Emphasize community and collaboration
 - Use technology to enhance the learning experience

Thank you!

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