Improving Students' Critical Thinking Skills - A Multi-faceted Approach

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The nature of human mind

- It is not natural for the human mind to continuously re-think its systems, its routines, its habits—in fact, it is downright threatening (Richard Paul, 1995).
The world we live in is a world of continuous changes and continuous advancements that require minds that can expect, accept and adapt to these changes.

http://drupal.oneworldsingers.org/TurnTheWorldAround
Importance of critical thinking skills

- We need citizens with problem solving and critical thinking skills to adapt to these constant changes and improve the world we live in.

- Students are not born with these skills. We need to create a nurturing learning environment for our students in which they get exposed to opportunities to think, inquire, discover, learn, and apply.

But how?

What is critical thinking and how should I teach it?
I am teaching the way I was thought. I don’t know any other way…
This is the way I have been teaching forever and it works just fine. Why changes?
I have never been taught on how to incorporate critical thinking to my teaching.
I don’t have extra time to allocate for critical thinking activities in the classroom.

http://chasingamiracle.com/2013/01/how-do-you/
The University of Texas MD Anderson Cancer Center-Houston, Texas
9 Undergraduate Programs:

4 Programs in Radiologic sciences

5 Programs in Clinical Lab Sciences
Accreditation

- Quality Enhancement Plan (QEP) is required by SACS
Theme of our QEP
Moving forward toward our goal

School-wide efforts have been started to improve students’ critical thinking skills in various areas:

- Evaluating and interpreting data
- Applying existing knowledge to solve problems in new situations
- Demonstrating creativity in learning and problem solving
- Communicating data effectively and persuasively
Moving forward toward our goal

- Many activities were identified and designed to achieve our QEP goal including:
  - Professional development sessions for faculty to teach them about critical thinking strategies and how to incorporate them in their teachings.
  - Interdisciplinary seminars

http://icrhps.tuftsmedicalcenter.org/research/cevr/seminars.asp
Lessons Learned

Active Learning
Active learning: a motivation to learn

- Research supports the effectiveness of active learning in improving student outcomes.
- Providing opportunities for students’ engagement motivates them to learn, retain, and transfer knowledge.
- Technology provides educators with creative instructional tools encouraging students to inquire, communicate, discover, and apply knowledge in an interesting and participatory environment.
My tool box

1. Ask questions, provide wait time
2. Conduct Small and large Group Discussions
3. Use Student Response System
4. Provide Entrance and Exit Tickets
5. Use Graphic Organizes
6. Conduct Interdisciplinary Learning
7. Construct Critical Thinking Site (Wiki)
8. Offer Camtasia Recording of Presentations
9. Use Electronic Course Management System
10. Flip the classroom

http://nolimitstolearning.blogspot.com/2013/02/at-tools-for-everyones-toolbox-part-one.html
As simple as asking questions

- Asking questions stimulates students’ thinking.

- When you ask a question, what percent of the class usually respond?
  - So be creative:
    - Let them work as a group
      - Small and large group discussions
    - Provide appropriate wait time
    - Use student response system
    - Use entrance and exit tickets to measure their pre and post knowledge
Technology will make the learning fun

• Use technology to increase students’ participation in their own learning
  • Student response system
  • Electronic Course Management System
    • Electronic discussion board
    • Critical Thinking Site (Wiki)
  • Camtasia Relay
  • Graphic Organizes
  • Flip the classroom

http://phoenixrising.me/living-i-the-basics/tools
Critical Thinking Oriented Lesson Plans

Revisit your old lesson plans
Use your tools

1. Ask questions

2. Small and large group activities

Patient Thickness Versus Dose Uniformity

- Uniformity depends on patient thickness, beam energy, and beam flatness

Examine this graph in small groups. Explain the relationship Between the beam energy, patient thickness and uniformity.
Call it critical thinking question

1. Ask questions

2. Small and large group activities
Ask more questions

1. Ask questions

2. Small and large group activities

Critical Thinking:
Which curve is related to a sample with greatest $\lambda$?
Which curve is related to a sample that decays faster?
Small and large group discussions

- Encourage communication and interaction among the peers, which would improve their thinking
- Motivate students to participate in their own learning
- Encourage active learning
- Help relate new information to existing knowledge

Applicable to many educational settings

http://topschoolsinindia.com/top-10-tips-to-crack-group-discussion-you-must-know/
Provide appropriate wait time

- Results in more
  - Time to analyze the question and think
  - Student responses
  - Thoughtful responses
  - Student follow-up questions
Let them think and inquire

- Let them think about how to apply their knowledge to solve a new problem.
- Provide feedback and clarification.
- Provide more problem solving opportunities through homework and class exercises.

http://pcsc180daysoflearning.wordpress.com/2012/12/03/keep-calm-and-inquire/
Student response system

- Some students are not comfortable sharing their responses:
  - Too shy to speak in public
  - Are uncertain about their responses
  - Fear of being embarrassed
- Student Response System would increase students’ participation in class activities

http://historytech.wordpress.com/2012/03/13/socratic-very-cool-mobile-student-response-system/
Student response system

• Encourages all students’ participation because their responses are anonymous
• Provides the ability to collect and display data instantly
• Informs instructors of the knowledge and understanding of the class immediately

http://www.wilmu.edu/avsupport/clickers.aspx

http://regisdtclab.wikispaces.com/Student+Response+System+Tips
Student response system-example

1. What do you think would happen to the dose at mid-diameter if the block is left out?

- 1. Increases
- 2. Decreases
- 3. Not affected

3

Tool #
To assess students’ prior knowledge before building upon them.

You may be surprised how much they don’t remember.

- Provide a review before teaching the new knowledge.
To assess students’ understanding after the instruction.

**EXIT TICKET #1**

**Student Name:**

**Brachytherapy chapter 1:**

1. What is the SI unit for activity?
2. What is the activity of 1 gram of Radium in curie?
3. What are the three ways to control the shape of isodose distributions in brachytherapy?
4. What is the stable element at the end of the decay series for radium?
5. 1 Curie = _______ Becquerel

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- Focus on major points and keep it short

Number 4 from: http://adf.ly/1726888/banner/http://3.bp.blogspot.com/-tGGNJiUQeKo/UF7FAARI8bI/AAAAAAAAC50/CPTlwRaAig/s1600/neli.jpg
Exit Ticket

- Exit tickets will inform the instructor:
  - of the extent of students’ learning
  - if additional instruction or teaching resources are needed
- A review of the questions at the beginning of the next class will initiate discussion and reinforce learning

EXIT TICKET #2

Student Name: [Name]

Brachytherapy chapter 1:

1. What are the two sources commonly used in permanent implants? (Gold, Iodine)

2. Isotopes with greater decay constant vanish in a (faster/slower) rate.

3. What is the half life of radium? 1622 years

4. What isotope is commonly used for low dose rate GYN Intracavitary and interstitial brachytherapy? $^{137}\text{Cs}$

5. What are the energies of the two gamma rays emitted from Co-60? 1.17 MeV, 1.33 MeV
Students are often bombarded with new terms, concepts, definitions, variables, and relations in the classroom.

One useful teaching strategy is to require students to construct a concept map.

Teach what a concept map is and how to make it using a simple concept.

Make the construction of a concept map a required part of the class and count it toward the course grade in order to encourage student participation.
Building a concept map

Topic: Pizza

Identify major concepts:
Building a concept map

Building a concept map

Pizza

- is made of
  - sauce
  - toppings
  - crust

Building a concept map
(partially completed example)

Pizza

- sauce
  - spices
  - tomato
- toppings
  - cheese
  - meat
  - vegetables
  - Such as
    - sausage
    - pepperoni
- crust
  - Such as
  - including

And you can add more to complete this concept map...

Concept map example

http://ecrp.uiuc.edu/v8n2/birbili.html

http://library.usu.edu/instruct/tutorials/cm/CMinstruction2.htm
Concept map

- Concept mapping helps students
  - organize different concepts and link them together while identifying their relations
  - build upon their prior knowledge and understand and recognize the relations between concepts
  - increase their conceptual understanding of the topic of study
  - organize their minds, which would facilitate their learning
Concept mapping tools

- Paper and pencil
- Sticky notes
- Electronic concept mapping tools:
  - Bubbl.us
  - Prezi
  - iMindMap
  - Inspiration
    - And many more

http://griefandmourning.com/tools
Interdisciplinary learning

- Improve students knowledge, respect, and appreciation of other health care professionals
- Enhance communications among students
- Encourage students learning through active participation
- Increase students critical thinking skills

http://www.svsu.edu/academicaffairs/curriculumcommittees/graduatecommittee
Our annual interdisciplinary seminar: the school-wide effort

- Students are divided in groups, a representative from each discipline is assigned to each group.
- They enter the virtual clinic and collaboratively follow the fictional patient case from diagnose and treatment.
Our annual interdisciplinary seminar: the school-wide effort

- One group is randomly selected to present the role of each healthcare professional in diagnosis or treatment of this fictional patient.
Our Critical Thinking Site

A work in progress
Critical Thinking Site

- Medical Dosimetry faculty at UT MD Anderson Cancer Center constructed a “Critical Thinking” site using:
  - Sakai Course Management System
    - Wiki
    - Drop Box
  - Camtasia Relay Software
Critical Thinking Site: Objectives

- The goal is to teach them radiation physics concepts in an inquiry-based learning environment.
- The interacting activities designed for students in this site would motivate them to learn and stimulate their thinking and problem solving skills.
It is part of our curriculum and student participation is required.
Supplemental instructional videos of mini-lectures

Critical Thinking Assignment about Wedges (Required)
Please watch the video about wedges and answer to ALL the questions the instructor asked you in this video. Please submit section until the instructor makes an announcement about your participation in the group discussion.

Discussion on Wedges

http://inside3.mdanderson.org/streams/FullVideoPlayer.cfm?xml=cfg%2FSHP_Critical_Thinking_Ops_20131219_2

Assigned Research Projects for Students' Presentations (Required)

Presentation Topics for Spring Intro to Tx Planning II 2014.pdf

Critical Thinking Assignment about FIF and Energy Choice (Required)
Please watch the following video concerning energy choice and FIF. Consider the questions posed by the instructor dur deadline as indicated in your syllabus.


Critical Thinking Assignment about Parallel Opposed Beams (Required)

http://inside3.mdanderson.org/streams/FullVideoPlayer.cfm?xml=cfg%2FSHP_Critical_Thinking_Parallel_20131219

Parallel Opposed Beams Discussion
Thank you all for participating in the critical thinking activity concerning the parallel opposed beams. You can

Faculty's Recorded Mini-lectures Guide Students Toward Their Inquiry-based Learning in a Simulated Clinical Environment
Students’ individual responses call for further collaborative activities

- Students conduct critical thinking hands-on activities in a simulated environment using the Pinnacle Treatment Planning software.
- They submit their responses to their drop box on Sakai.
- The instructor evaluates the responses. Add a thought provoking response to the site for students’ comments. (This emulate large group discussion)
Students’ on-line discussion

Students post their response to the discussion board
Students’ comments lead to further discussion

3. How would you define physical penumbra and would that be different in a hetero vs. homo trial?

 Hide Comments (55) Add Comment


I somewhat agree and disagree with the response first. Homogenous calculation bases assume all tissue density is water equivalent, there are tissues in the beam path. It's just that we ignore the differences in tissues type and treat everything as water equivalent, we could possibly undertreat. In heterogenous calculation, all the tissue densities' factors are accounted for, so the MU is more precise.


I agree that the homogenous calculation will have a uniform smooth isodose distribution, as well. But as Khoa said, there are densities that are still there. When we observed the differences between the trials, it seemed that the reference depth and effective depth were the same for both. I was told that we see the same numbers for both calculations, but only the reference depth would be used for homogenous because it is assumed to be water equivalent; we still have different tissues. They are just treated as water equivalent for a homogenous calculation. For the heterogenous calculation, I agree that bone and tissue materials will affect the beam quite differently; an isodose distribution wouldn't go as deep in bone as it would in tissue. The heterogenous calculation also uses the effective depth, as we have seen in practice.


I agree with homogenous calculations having smooth lines because everything is treated as though it is the same density as water. The homogenous lung plan displayed a conformal dose distribution because it assumes no densities, but as Khoa said, the patient could be under treated because of the lack of MUs reaching the treatment area. In the heterogenous calculation, all densities are a factor in the isodose distribution. To add on to the stated answer, the beams go further into this patient because the lung has less density than water, creating deeper coverage.


I agree with Khoa. But I want to add that the patients could be also possibly overtreated as well as undertreated. Since homogenous calculations assuming all different tissues have same density as water, the beam passes through low density tissue, like lung, will over-treat its target, but the beam passes high density tissue, like bone, will undertreat its target. With the help of CT simulation and the use of computer, we can do heterogeneous calculation which considers the different tissues' densities. This method provides a much more accurate calculation of MUs.


Lung has a lower density than water phantom. Homogeneous calculation doesn't consider this factor, it show the how the isodose lines distribute through the water phantom, so the isodose line penetrates less than it actually penetrates. Bone has a higher density than water phantom, so the homogeneous calculated isodose line penetrates more than it actually does. But the
Students' presentation of critical thinking activities

- Students were given presentation topics that required them to think and perform activities in a simulated clinical environment.
- Not only this activity has improved their understanding of content knowledge, but also it improved their written and oral communication skills.
iThink: A Path to Enhance Students’ Critical Thinking Skills in Medical Dosimetry

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Introduction

Medical Dosimetrists are vital members of the radiation oncology team, working closely with radiation oncologists, medical physicists, and radiation therapists to provide customized radiation treatment plans designed to target cancer while sparing normal tissues.

The University of Texas MD Anderson Cancer Center School of Health Professions houses an educational program in Medical Dosimetry. Graduates earn bachelor’s or science degrees in Medical Dosimetry and have a wide range of career options that include patient care, education, management, medical sales and technical training positions.

Today’s society needs individuals who think critically and solve real-world problems. This is especially important in today’s world, where technology is an integral part of a student’s life and information is readily accessible. Therefore, the traditional teaching strategies with the teacher as the dispenser of knowledge and students as passive receivers are no longer sufficient.

Medical dosimetry faculty used the online course management system, Blackboard, to develop a “Critical Thinking Site (CTS)” where they taught students complex concepts in an interactive manner. The CTS presented students with challenging questions and required them to perform hands-on or blended exercises in online discussions, and complete assessments to evaluate subject comprehension.

Method and Materials

- Pineapple Treatment Planning Software
- Geen Course Management System
- Wiki
- Drop box
- On-line Assessment
- Centara Relay Software
- Microsoft Office

Conclusion and Future Plans

Medical Dosimetry Faculty believes that developing the ‘Critical Thinking Site’ for students, as well as incorporating numerous critical thinking strategies in the curriculum, has resulted in improving students’ critical thinking skills as measured by the CTS pre and post-tests. Increased student’s creativity and learning in the virtual setting, developed student’s understanding of the radiation physics principles rather than memorization of facts, improved student’s communication skills, and enhanced their motivation to learn.

- Students’ Improvement in Critical Thinking Skills (Measured by CTS Pre and Post Tests)
  - Cohort 1: 31.8% Increase
  - Cohort 2: 18.4% Increase
  - Cohort 3: 27.6% Increase

Future plans include the continuation of a “Critical Thinking Site” for additional courses in the Medical Dosimetry Program, conduct a comparison study to measure the effects of this intervention on student learning, and incorporating modules of this project in other Medical Dosimetry programs in the nation and the world.
Flip the classroom

- Used when there is not enough time in the classroom for active learning.
- Technology is used to provide the information to the students so that they learn the subject ahead of time at their own pace.
  - Camtasia recording of the lectures
  - Activities on the critical thinking site
- The class time is used for collaborative work and concept mastery exercises.

http://www.guide2digitallearning.com/blog_art_titzel/get_flipped
Measure of success

Medical Dosimetry Program’s Results:

- Students’ Improvement in Critical Thinking Skills measured by CAT Pre-and Post Exam
  - Cohort 1: 31.8% Increase
  - Cohort 2: 18.4% Increase
  - Cohort 3: 21.68% Increase
Future plans

• Continue to attend faculty professional development opportunities to learn the latest instructional strategies.

• Continue to revisit the existing lesson plans for incorporation of critical thinking strategies.

• Continue to develop cases for our annual interdisciplinary seminar.

• Construct a “Critical Thinking Site” for additional courses in the Medical Dosimetry Program.
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http://vktraining.wordpress.com/2011/06/21/from-the-post-bag-give-me-a-question-that-cant-be-answered-with-a-yes-or-no/