Flipped Physics Courses within a Radiologic Technologist Program: Video Production and Long Term Outcomes

AAPM Innovation in Education

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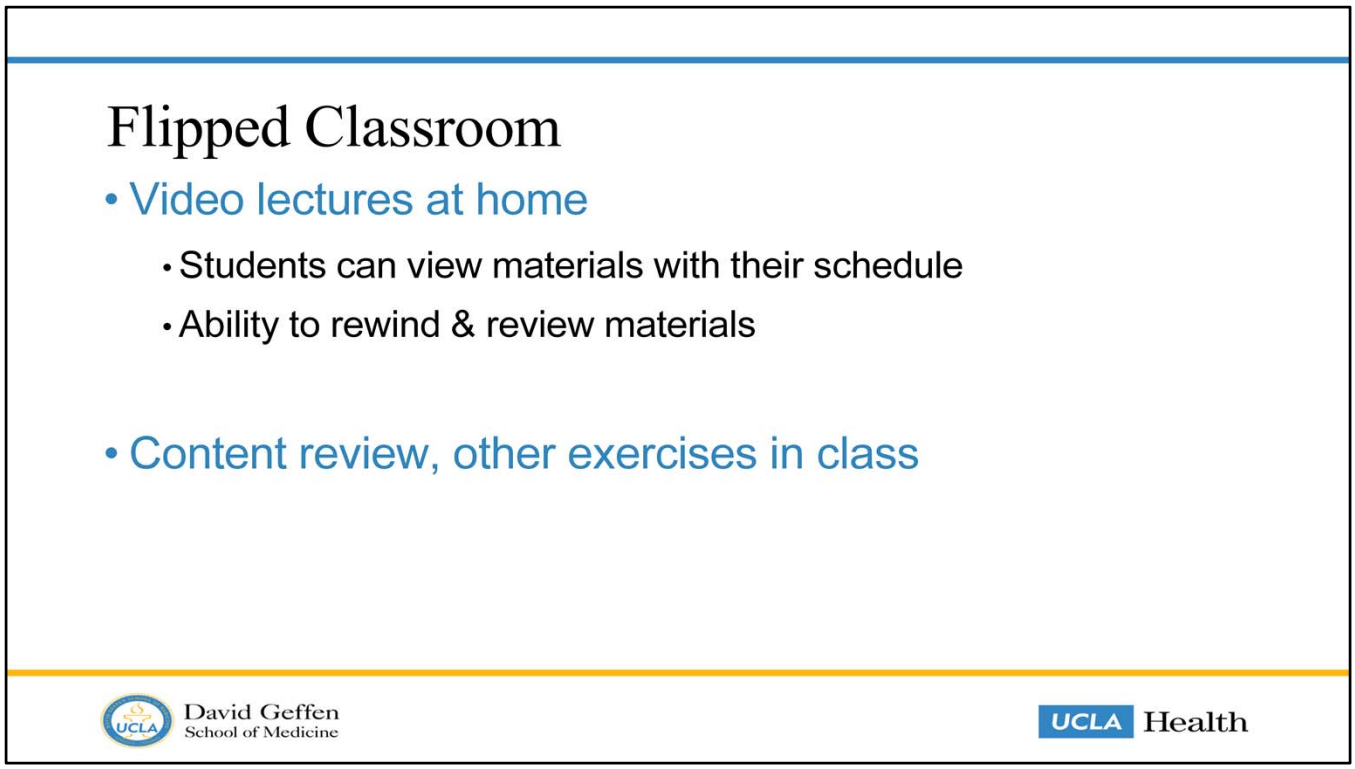
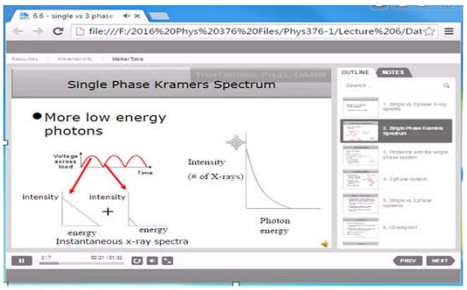
This was a retrospective analysis on what happened when two classes in a rad tech program were flipped.



The 'flip' means that traditional lectures have been converted to video lectures for students to absorb at home. This gives them flexibility in reviewing the materials. In most flips, students still meet in class, but these sessions are usually reserved for discussion and other exercises.

Flipped Classroom

- CSU Northridge Radiologic Technology Program
- UCLA Affiliation (instructors, clinical rotations)
- 2 Flipped Classes:
  - 2005+ Radiologic Physics (imaging)
    - "Video Lectures"
  - 2006+ Quality Control (testing, regulations)
    - "Video Lectures", "QC Videos"



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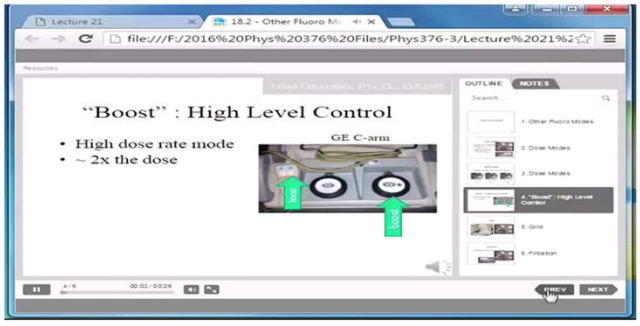
The flip was done in the RT program at California State University, Northridge. (UCLA has an affiliation with this program)

Starting in 2005 and 2006, two classes were flipped:
A radiologic physics class (fundamentals of x-ray imaging)
A quality control class (regulatory standards and testing guidelines)

The QC class had additional videos demonstrating test setups and some results which were used instead of actual hands-on QC testing.

Content Production: "Video Lectures"

- PowerPoint® presentations
- Audio voiceover: Audacity®
  - Cleaned
  - Audio file imported into PPT
- Video / web conversion (iSpring Converter®)
  - HTML5 (browser)
  - Easy navigation



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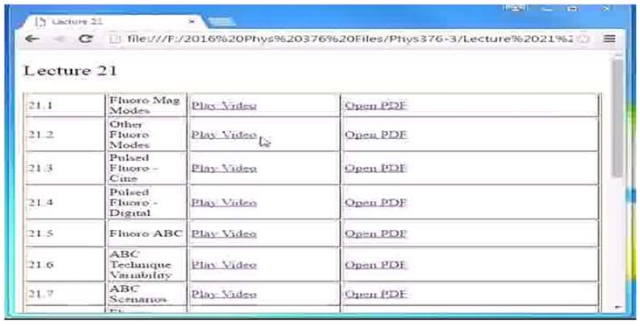
Currently, to make our video lectures, PowerPoint presentations were created and a voiceover track for each slide was recorded and edited using using Audacity software. http://www.audacityteam.org/ (free)

With Audacity, the 'ums', pauses and other voiceover problems could be removed. This cleaner audio track was imported into PowerPoint.

iSpring Converter was used to convert these into HTML5 format that could be played with an internet browser. This allows students to jump through or replay specific slide content. http://www.ispringsolutions.com/ispring-converter (approx $300 USD as of 8/1/16, education discounts available, trial software is available)

Content Production: "Video Lectures"

- 40 hours of "video lecture" content (2 classes)
  - 28 hrs (Radiologic Physics)
  - 12 hrs (Quality Control Class)
  - Lecture Video Total: ~350 (5-7 minute)
    - Navigation & replay



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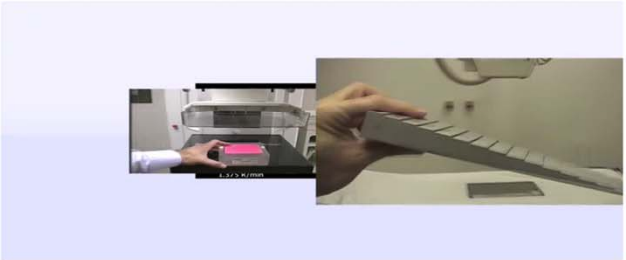
40 hours of video lecture content was produced, 28 for the radiologic physics class and 12 for the QC class. Content was broken down into much smaller segments that were "topic based" and were about 5 to 7 minutes in length. This made it easier for the student to navigate to the topics.

Content Production: "QC Videos"

- Video cameras & edited with Final Cut Pro®
  - Voiceover, lower 3rds titles, & soundtrack
- 65 demonstration & setup videos
  - 1-3 minutes in duration



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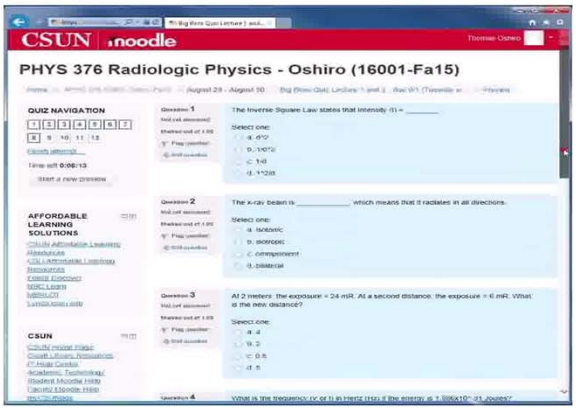
QC videos were recorded with an in-room or over the shoulder shot the step by step test setups. Within Final Cut Pro, a voiceover track, lower 3rds titles and a soundtrack was added. http://www.apple.com/final-cut-pro/ (~ 300 USD as of 8/1/16)

In total 65 QC and demonstration videos were produced, each ranging from 1-3 minutes and covering radiographic, fluoroscopic, mammographic and film/screen tests.

Online Quizzes (Courses 2012+)

- Moodle learning management system
  - Question bank - 3500 questions
  - Randomized quizzes
  - Must get 100% to 'unlock' new quizzes
- Khan Academy Methodology



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Cal State Northridge uses a Learning management system known as Moodle. A set of 3500 multiple choice questions were created (2500 for radiologic physics, 1000 for QC) This allowed for randomized online quizzes to be given weekly.

I've borrowed this idea from the Khan Academy which is a non-profit organization that specializes in this flipped format.

Class Format - Cohort

Radiologic Physics Course Year	Quality Control Course Year	RT Graduating Year	# of Students
2001-2004 In-Class	2002-2005 In-Class	2003-2006	14
2005-2007 Half Flipped	2006-2014 Fully Flipped	2007-2015	23
2008-2013 Fully Flipped			

- Class sizes increased in 2005
  - GPA is a factor for acceptance into the program (~50%)

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This is showing the format and changes in the class from year to year.

Only half of the radiologic physics course was flipped in 2005. In 2008, the entire class became flipped. The QC course was fully flipped in 2006.

Also in 2005, approximately 9 additional students were accepted into this program per year (the class went from ~13 to ~24)

Outcomes: Comprehension Before/After the flip

- Final exam scores
  - Common multiple choice questions (Radiologic Physics, 10)
  - Short answer questions: test setups & regulations (QC, 5)
    - Some re-tallied to a common rubric (consistency)
- Uneven samples
  - Questions were not given each year
- Some missing data points
  - All Radiographic Physics 2005 final exams

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One of the outcomes we looked at was comprehension on final exams in-class versus flipped.

We found that there were 10 common multiple choice questions in the physics class and 5 short answer QC setup questions. Some groups needed to be regraded to a consistent rubric.

There was often uneven sampling because questions weren't given in each year. So there may be an uneven year distribution when comparing pre and post flip scores.

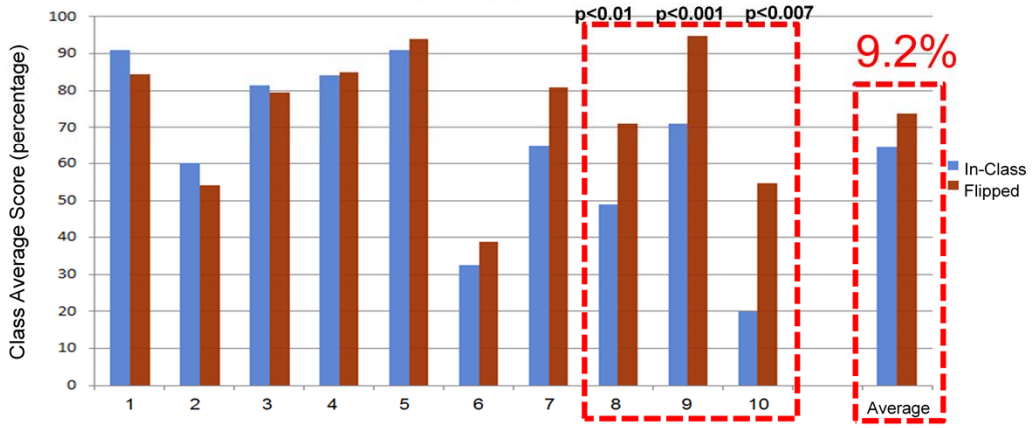
There was also some missing final exam data including the 2005 data above due to my own recordkeeping issues.

Results – Radiologic Physics multiple choice

- Average class size: In-class 17, Flipped 25

Topics

1. Compton
2. Phototimer Location
3. Bremsstrahlung
4. Digital Bit Depth
5. Photoelectric
6. HVL
7. Fluoro Entrance Dose
8. CR Resolution
9. Fluoro Frame Rates
10. Grid Factor



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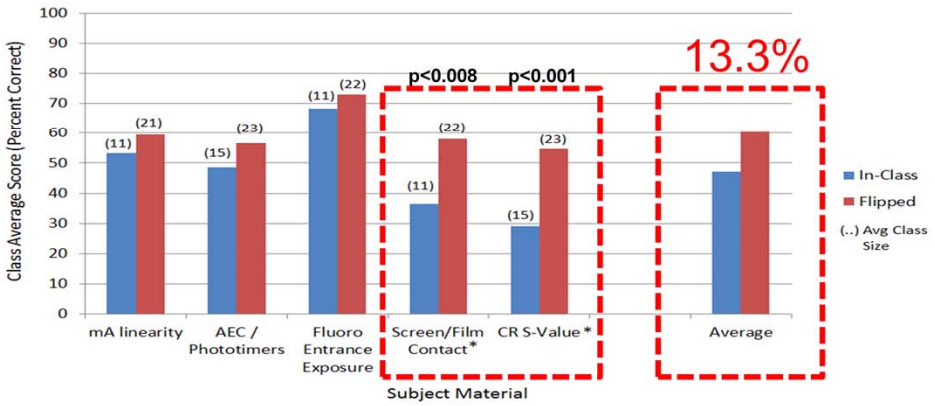
This chart shows the scores on the 10 physics final exam multiple choice questions. Blue represents 'in-class', red represents flipped.

When combined, ("Average" column) we saw a 9.2 percent increase in scores for the flipped classes. And a Students t-test showed significance in 3 of these questions (Questions 8,9,10)

The average class size representing the in-class format was 17 and the flipped classes averaged 25. So even with the larger class size, students performed better on average with the flipped class.

Results – QC setup questions (5)

- Average class size: In-class 13, Flipped 22



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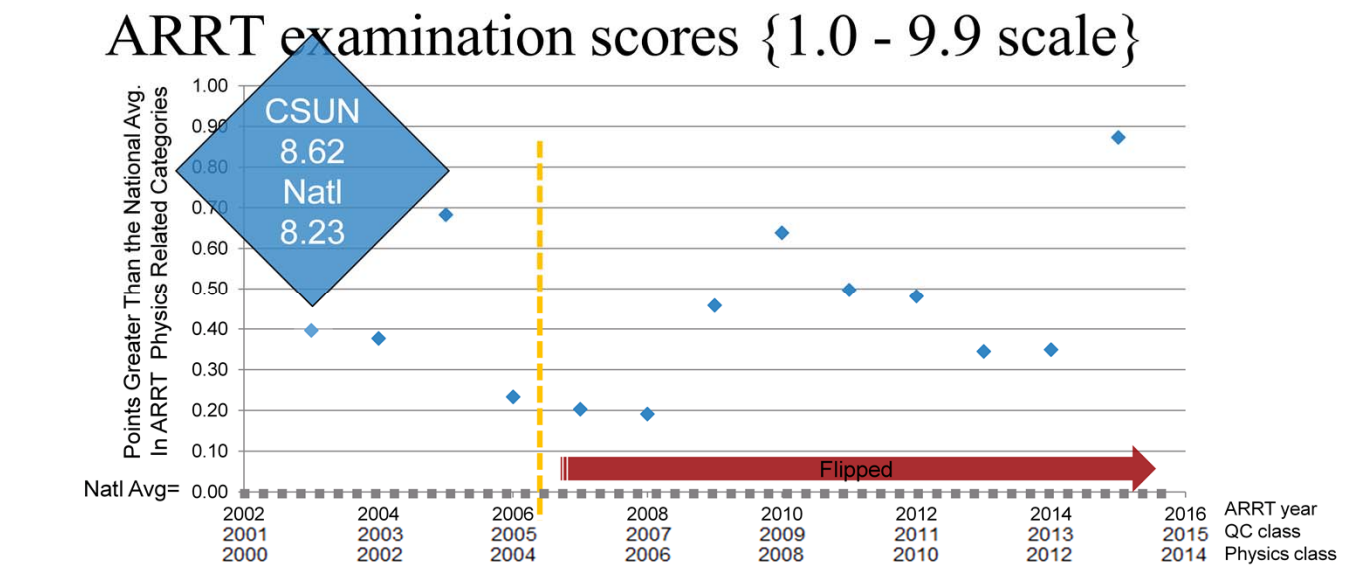
Similar results were found with the short answer questions in the QC class. Flipped lecture classes did about 13.3 percent better.

Statistical significance was found in 2 of the 5 questions. (Screen/film contact, CR S-value)

And the average class size was 13 for in-class results and the flipped class size was 22 students. So the 22 students in the flipped class outperformed the 13 students.



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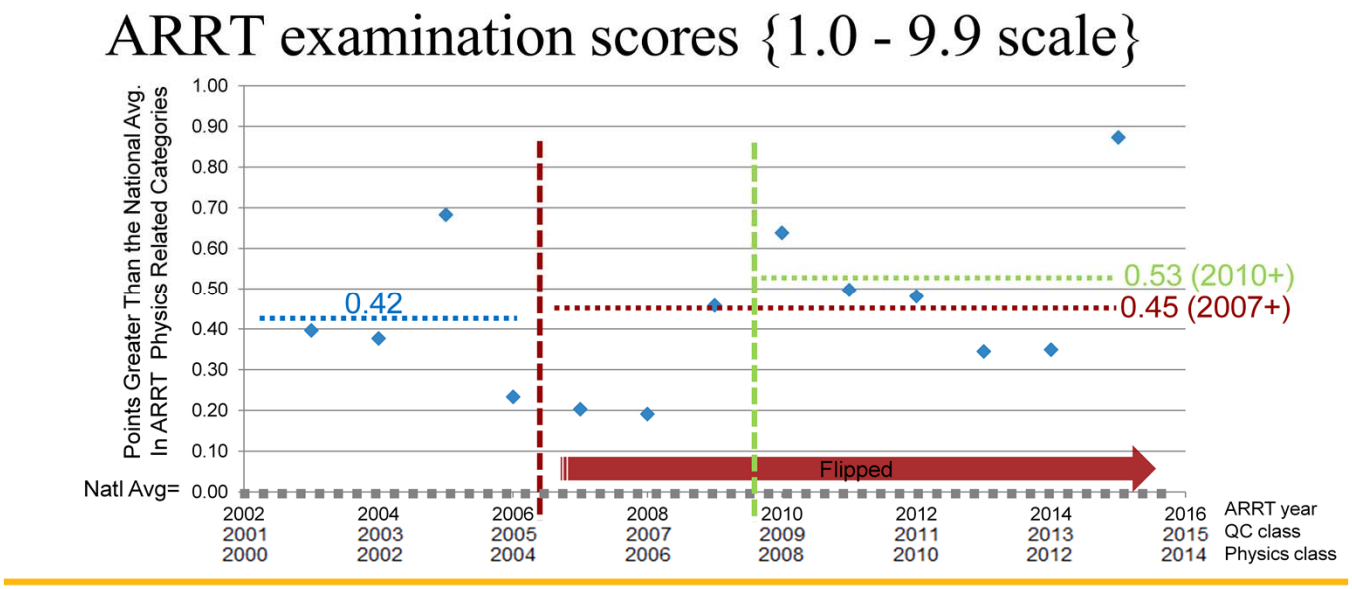
For a much longer term outcome - we looked at the scores on their national examination (ARRT) . This exam is taken ~18 months after completion of the QC class.

Points shown are student scores from the physics related ARRT categories (radiation safety, equipment operation and image evaluation) with respect to the national average. For example - in 2003, the national average was 8.23 on a 1-9.9 scale. Northridge students scored 8.62 – which is would be 0.39 points higher. The 0.39 is noted on this graph. In all cases, students scored above the national average in these physics categories.



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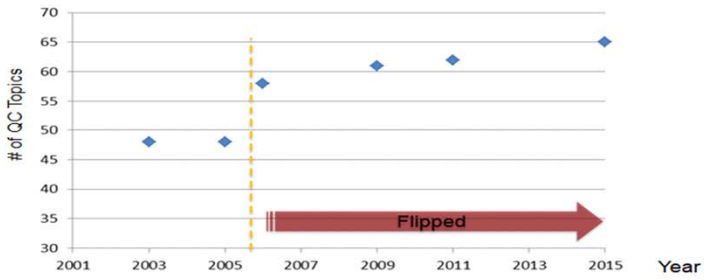
On average, in-class groups scored 0.42 points higher than the national average (blue dashed line).
Post-flip was around 0.45 (red dashed line). However, for the past 6 years this number has increased higher to 0.53 (green). The past 6 years is the timeframe when the radiologic physics class became fully flipped.

FYI: Whether there is an effect of the flip or if the half/fully flipped format is makes a difference is just speculation on my part. But the scores do appear to be heading in the positive direction.

And for class sizes, the average in-class size was 14 and flipped class size was 23. So even with the 50% increase in class size, the students appear to be doing at least equivalent if not slightly better on their national exam.

Other Benefits

- Consistency of content
- Increase in content
  - QC Class
    - 47 to 65



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This structure has provided a lot of consistency to the classroom. If the instructor has to miss a class, the core lecture content is still there for the students.

I've also been able to expand the amount of content in the QC class. This graph is showing that before the flip – 47 tests were covered in the hands on labs. Post-flip we cover 65 different tests.

Other Benefits

- Increased interactions with students
  - In-class reviews & exercises

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Personally, I'm seeing more interactions with students with the flipped format. This may be because in-class sessions are open discussion forums and students can ask questions without fear of interrupting the middle of a lecture.

Other Benefits

- Repurposing
  - ARRT preparation for RT students (2015)
    - 19 hours
  - Pain Management Physicians – Fluoroscopy Review (2016)
    - 20 hours
  - In-services to staff (2014+)

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To make more use out of the content, it's been repurposed into a few different formats:
- An ARRT review guide was made for the RT students in 2015
- Fluoroscopy content was aggregated for pain management physicians in 2016
- Smaller topic based segments were given as in-services to hospital staff

Other Benefits

- More video creation
  - Mammography
    - UCLA Medical Physics graduate program
      - Video content used for 'Pre-Lab"
  - Ultrasound
    - Graduate students, radiology residents, breast imaging fellows

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I'm currently expanding the library of video content. Mammography and ultrasound content is currently being used as either the main or supplemental material for our medical physics graduate students, radiology residents and fellows.

In the medical physics program, some demonstration videos are being used as a 'pre-lab' which appears to make the process go smoother during an actual hands-on sessions.

Additional Notes

- Flipping takes additional time
  - More software availability
- Student accountability is essential
  - Over-communicate expectations
- More data is needed
  - Where does the flip belong?

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The creation of the videos does take additional time – and it can be a factor of 2 or 3 times longer But video creation software has become more accessible to make that transition easier.

Ensuring accountability is essential for a successful flip. Sometimes reminders and expectations need to get over communicated.

Our program has seen benefits. But the current amount of published data is still limited, (as of mid-2016) especially with content in the medical specialties. As more groups adopt this pedagogy, we can find out what the flip can bring to our medical physics classrooms. We may find that it may not be useful in all cases or for all levels of education.

But after doing it for 10 years in our program I think its been working for us. And I

think it potentially allows instructors to set the bar higher for their students.

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- Many RT programs need good medical physics instructors
  - Radiologic physics is often taught by a non-physicist
- Benefits of working with an RT with a strong physics background

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Finally – this is off-topic – but many RT programs struggle to find experts willing to teach. So if you have any interest – contact a local RT program about teaching or guest instruction. It's usually very appreciated.

And I think this ties in with this years theme. In this case we're adding value to the technologist community – but in the long run, there are usually benefits when physicists are working side by side in hospitals with technologists that have a strong physics background.