

Using Optical Analogies While Teaching Physics of X-rays and CAT Scans

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Modern Miracle Medical Machines

Goals

- Conduct research on students' models in the realm of medicine-related physics
- Develop active engagement instructional materials to help students learn applications of modern physics to contemporary medicine

Motivation of Study

- Most students already have models of X-rays
- These models come from several sources
- These models can be investigated
- These investigations can help guide instruction

Investigating Students' Models

Methodology

Two stages:

- Stage 1: Clinical interview
- Stage 2: Teaching interview

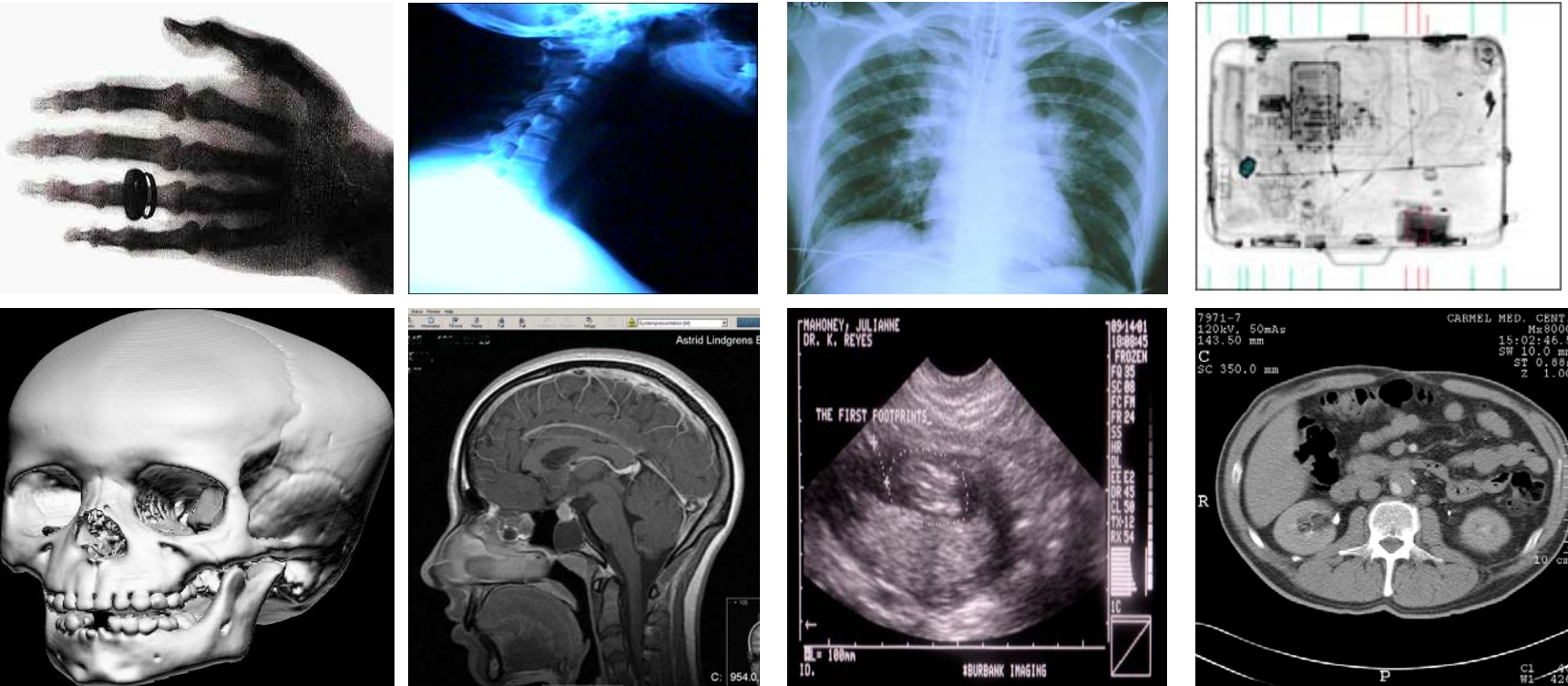
Algebra-based physics students (N=13)

- Six (6) 1st Semester
- Seven (7) 2nd Semester
- Mostly health-related majors

Clinical Interview

Familiarity with X-rays

Have you seen such pictures? Can you group them?



Clinical Interview

Questions

- How do X-rays interact with our body parts?
- What other things are similar to X-rays?
- What makes things visible to X-rays?
- What can you tell about other medical imaging techniques?

Clinical Interview

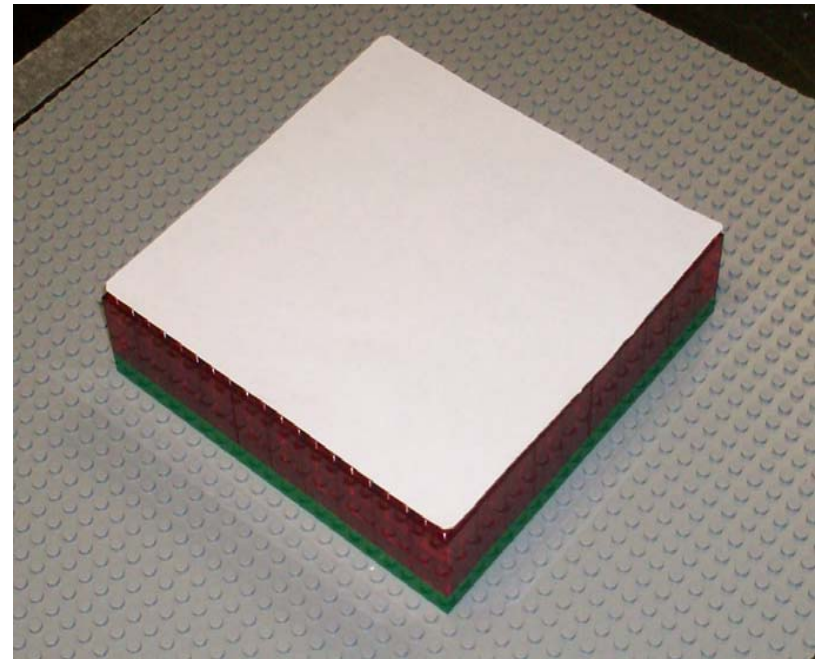
Results

- Almost all identify X-rays as a part of the spectrum
 - Often do not know where to place them in the spectrum
- Most strongly associate
 - Strength of X-rays with their physical danger
 - X-ray visibility with density of material they interact with

Teaching Interview

Closed LEGO® Box

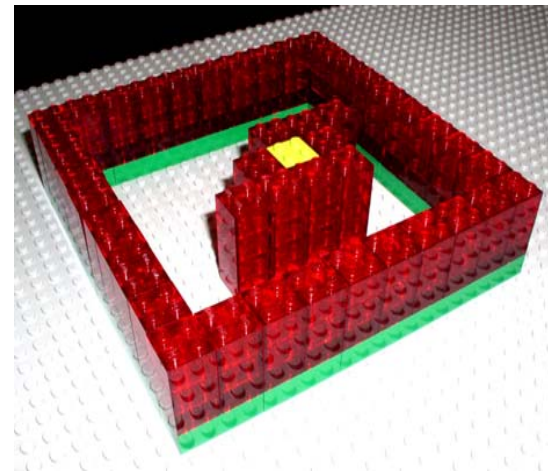
- An object of an unknown shape and size in the closed box
- Students are asked:
 - Can you find the shape and location of an object?
 - What equipment do you need?



Teaching Interview

Open LEGO[®] Box

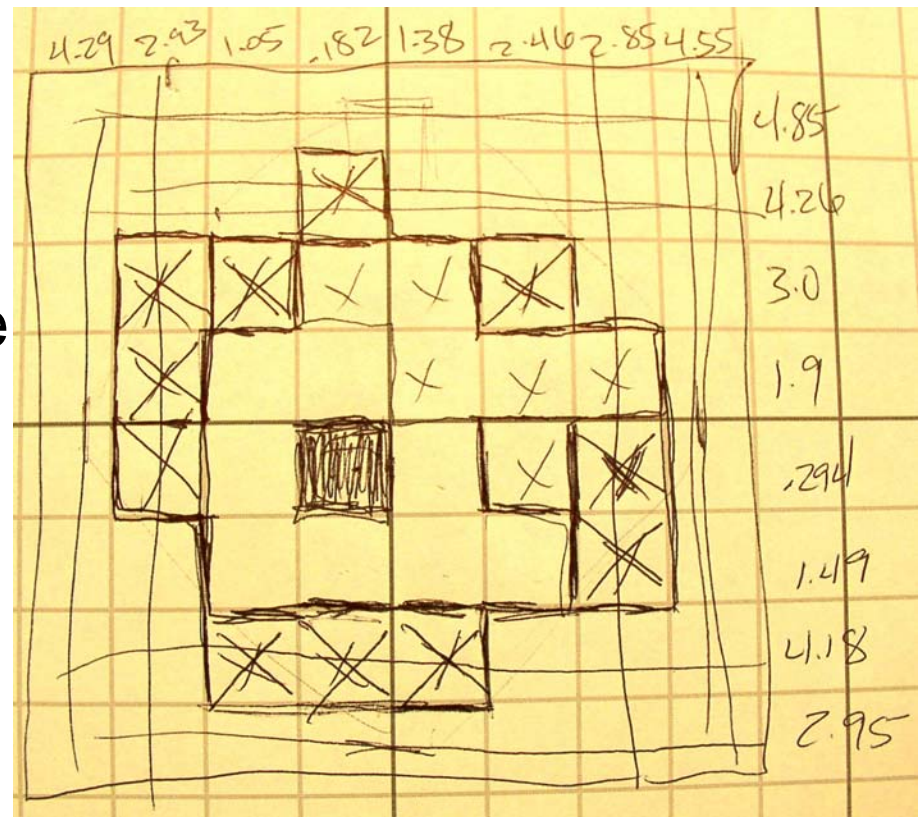
- Students shown
 - Equipment:
 - Photo voltmeter
 - Light source
 - Open LEGO[®] box
- Students are asked:
 - Will this help you solve the task with the closed box?



Teaching Interview

Predict Location & Shape

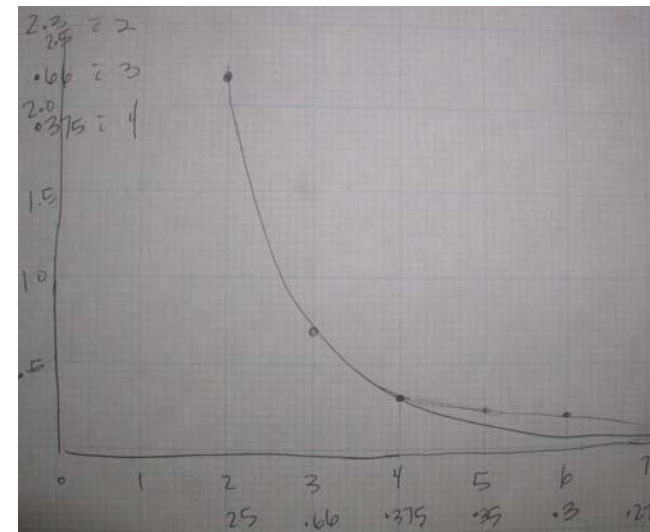
- Go around the box and record the light intensity along the perimeter.
- Make predictions about the shape and location of an object inside the box.
- How does the intensity depend on the number of LEGO® bricks?



Teaching Interview

Understanding Attenuation

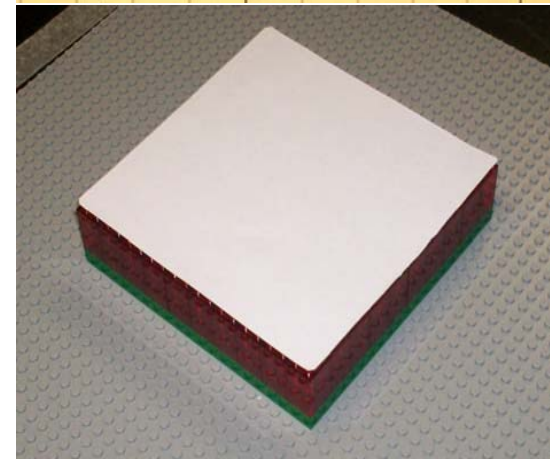
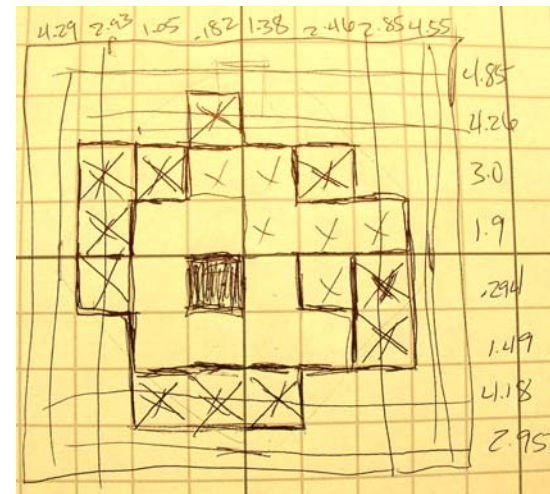
- Predict intensity change as we add bricks one by one.
- Measure intensity vs. number of bricks and modify your prediction.
- Qualitatively explain the intensity measurements.



Teaching Interview

Opening Closed LEGO® Box

- Prompted to apply previous ideas to predict what's inside closed box.
- Open the closed box.
- Discuss reasons for any discrepancies.



Teaching Interview

Concluding Reflections

- How helpful was the lab as the whole?
- How useful were different parts of it?
- What are the limitations of this model?
- What kind of changes would you propose?

Teaching Interview

Results

- All students successfully completed the lab.
 - Most (10 out of 13) needed very little prompting.
- Those (3 out of 13) who needed prompting...
 - Could not identify the type of equipment needed
 - When they were shown the equipment, they understood the qualitative process but not the systematic procedure.
- Most could figure out the sources of errors in the lab

Future Studies

- **Group Teaching Interviews**
 - Closer to real lab settings
- **Develop the lab activity**
 - Based on results of the interviews
- **Implement the lab activity in a real class**
 - Assess students' learning

Thank you!

Modern Miracle Medical Machines website

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