Physics Education is more than techniques

John M. Clement

Some References

- Modeling.asu.edu The best site for teacher workshops.
- mazur-www.harvard.edu Wonderful papers and talks.
- prst-per.aps.org Free online journal edited by Joe (Edward) Redish.
- AAPT - if not a member join and get access to many important papers.

Familiar Results

- Richard Hake in a 6000 student survey
- Conventional teaching gain maximum 25%
- “Interactive Engagement” 30-70% gain
- Up to 90% gain in recent class
- Indirect measurement shows 10% gain in pre-college physics classes

In the Past??

- There is NO evidence to show that this is any different from the past!

Conventional Learning Paradigm

- Lecture (direct instruction)
- “Lecturer transmits concepts to the the students” by talking about them
- “Transmissivist” paradigm

Communication theory

- Lecturer recalls information
- Lecturer encodes a message
- Message travels over medium
- Learner receives message
- Learner decodes message
- Learner stores information

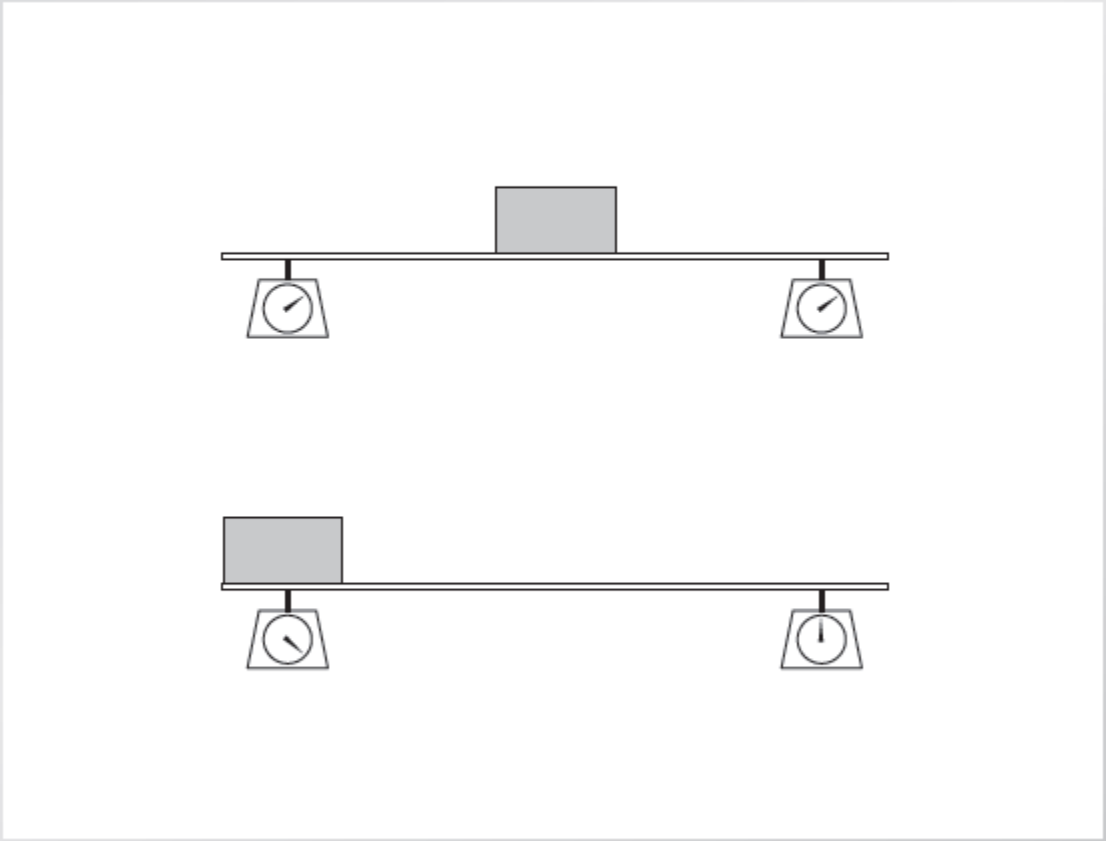
Problems

- Improper encoding
- Noise in transmission
- Improper decoding
- Improper storage
- This depends on learner having same model for decoding as the lecturer uses in encoding!

Mazur demo

- Do students learn by being shown something?
- On a scale of 1 to 5 with 5=Yes, and 1=No

Demo to dispel misconception



Posttest 2 months later

- How many students got it right?
- Vote 1 finger for 10% 2 for 20…

Correct answers

- 18 % get it right on memory posttest
- 82 % get it wrong.
- Common misconception that the plank evens out load even when object is on one side.

One student wrote

“As demonstrated in lecture both scales will read 10N regardless of where the center of mass is located. The platform and the metal block form one unit that is being measured, so the scales show two evenly distributed readings, no matter where the metal block is placed along the platform.”

Why?

- Discuss with your neighbor why and come up with an answer.

Model

- You interpret what you see according to your mental model!
- So what you remember is basically what your mental model tells you happened.

Solution

- Does anyone have a solution?

Solutions

- Treatment Right – Wrong
- No demo 30 70
- Observe 18 82
- Predict 29 71
- Discuss 30 70
- ????

But on test of understanding

Mode	correct	bal torque	no clear reasoning
No demo	31	53	42%
Observe	42	55	42
Predict	41	65	32
Discuss	46	85	15

- Students have to be given time and opportunity to change their mental models.

How does memory work?

- Discuss with your neighbor and come up with an answer.

Why?

- Can anyone give an answer?

Memory

- Part of the answer is that we only remember concepts and facts, but not a photo.
- So when you picture something you saw you use a few concepts and facts to recall.
- You reconstruct most of the memory from your mental models.

Transfer?

- Michelle Perry
- Tested transfer for 4 cases

1. Teach algorithm – NO transfer
2. Teach meaning – near transfer
3. Teach meaning then algorithm?
4. Teach algorithm then meaning?

Transfer?

- Michelle Perry
- Tested transfer for 2 cases

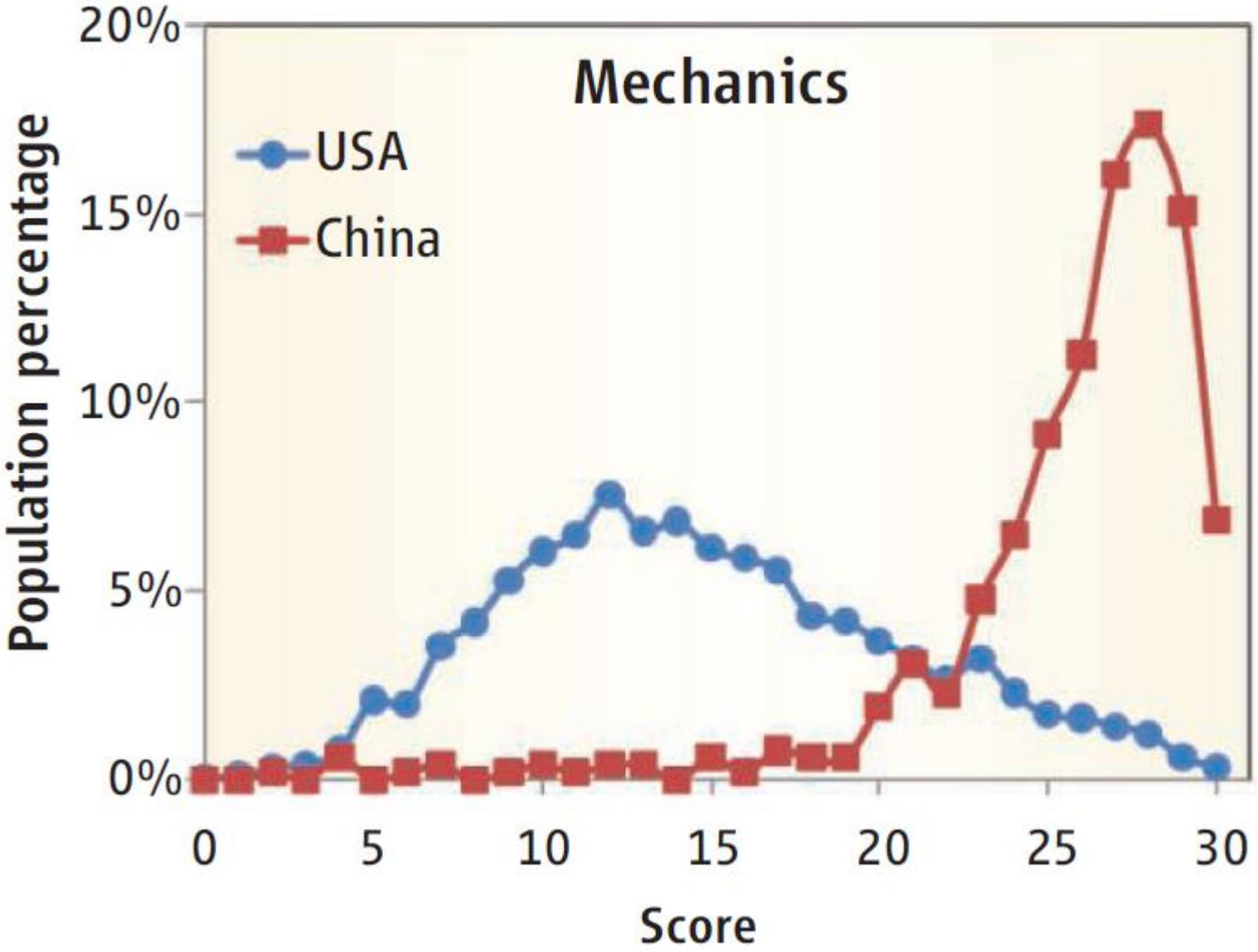
1. Teach algorithm – NO transfer
2. Teach meaning – near transfer
3. Teach meaning then algorithm - NONE
4. Teach algorithm then meaning – NONE

- Algorithm blocks transfer

What is effect of extra study?

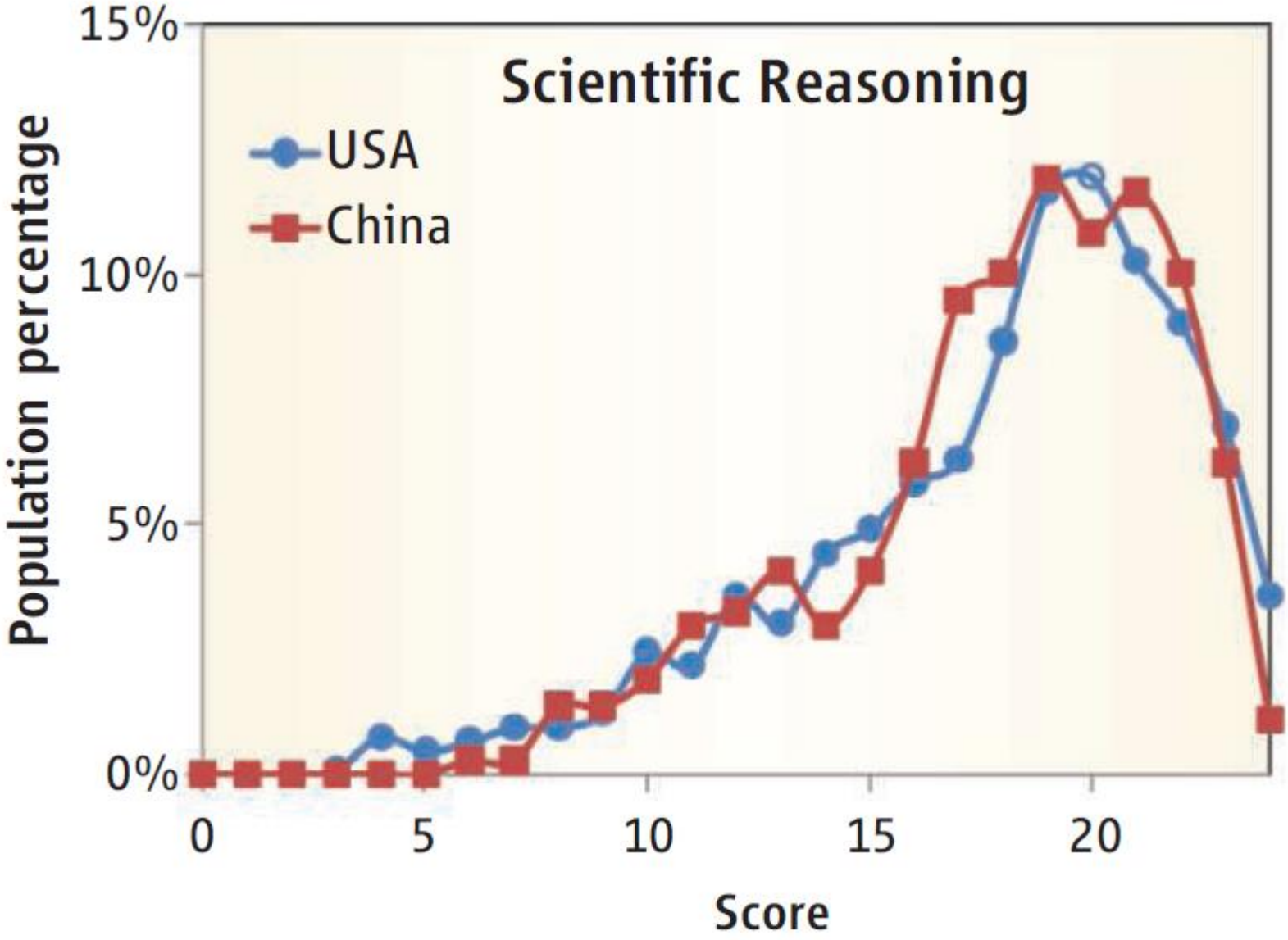
- SCIENCE Feb 2009
- Experiment compares-
- US students ~ 1 year of physics
- Chinese students 5 years of rigorous physics
- How much better did Chinese students score on FCI?

50 – 86%


Mechanics
USA
China
Population percentage
20%
15%
10%
5%
0%
0
5
10
15
20
25
30
Score

Scientific Reasoning?

- Using the Lawson Classroom test of scientific reasoning how much better did Chinese students score?


Scientific Reasoning
USA
China
Population percentage
15%
10%
5%
0%
0
5
10
15
20
Score

How to increase reasoning?

- Inquiry based course using Karplus "Scientific Learning Cycle"

1. Exploration
2. Concept development
3. Application

- After 1 semester 58% → 66%
- Or gain of 0.47 effect size or 20% normalized gain.

Recent evidence from math

- Calculus concept inventory by Jerry Epstein
- Regular calculus courses get 10% gain
- Interactive engagement get 20%

Multimedia

- There is evidence for effectiveness of multimedia designed according to known cognitive research, but none for just showing videos.
- How can you improve conventional video concept presentations?

Video presentation

- Just telling students about a concept, and even including the answers to the posttest produced no gain. 6/24 right
- But including a segment with “peers” discussing misconceptions helped. 12/24 right responses. Or 30% normalized gain.

Paying attention?

- Teachers often tell students to pay attention.
- Does this work???
- J:\12[1]_mpeg2video.mpg

- J:\Inattentional\couple.gif

Conciousness

- “Experience is not something we feel but something we do”
- You can find the full text with demos to this paper on the web.