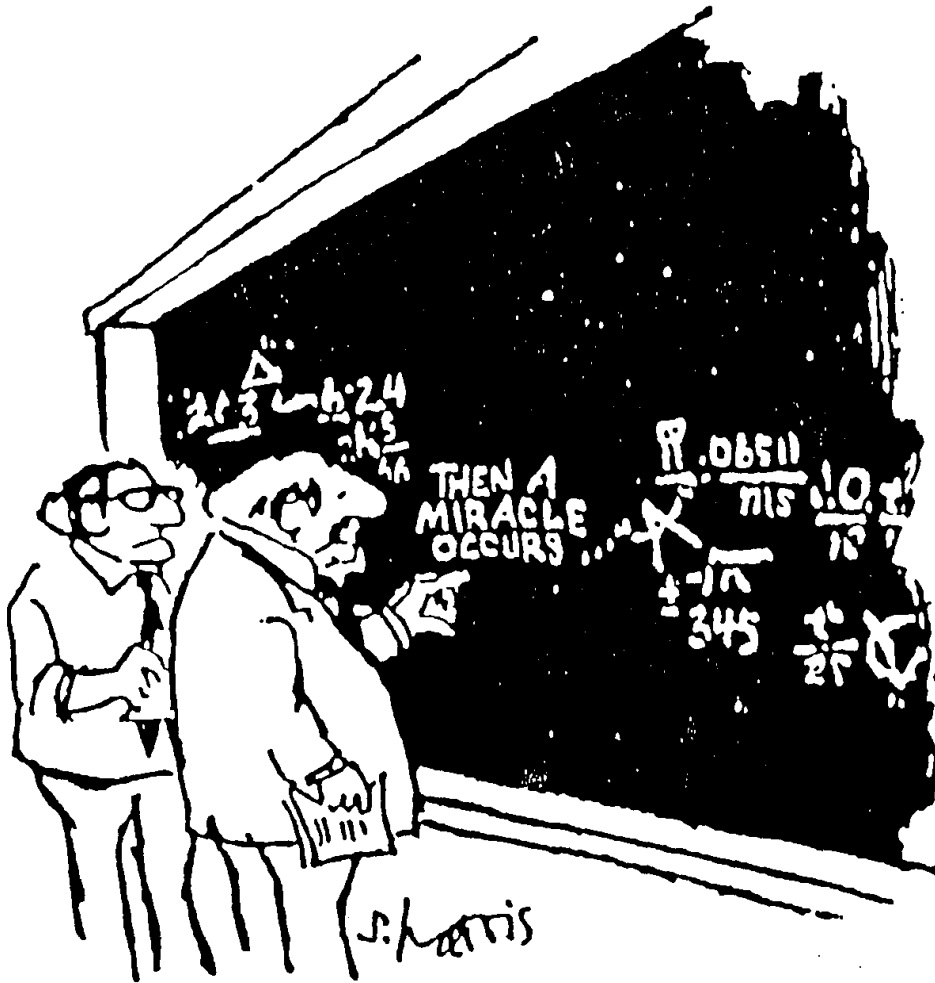


Can you improve thinking skills in physics classes?



**WHY DO
STUDENTS
THINK ABOUT
PHYSICS THIS
WAY?**

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UH Clear Lake Mar 2011

PROBLEMS!

- Disjointed & too much curriculum
- Conventional Lectures have low effectiveness
- Verification labs promote “going through the motions.
- Inadequate thinking skills
 - 25% of advanced HS students &
 - 75% of regular HS students lack proportional reasoning ability

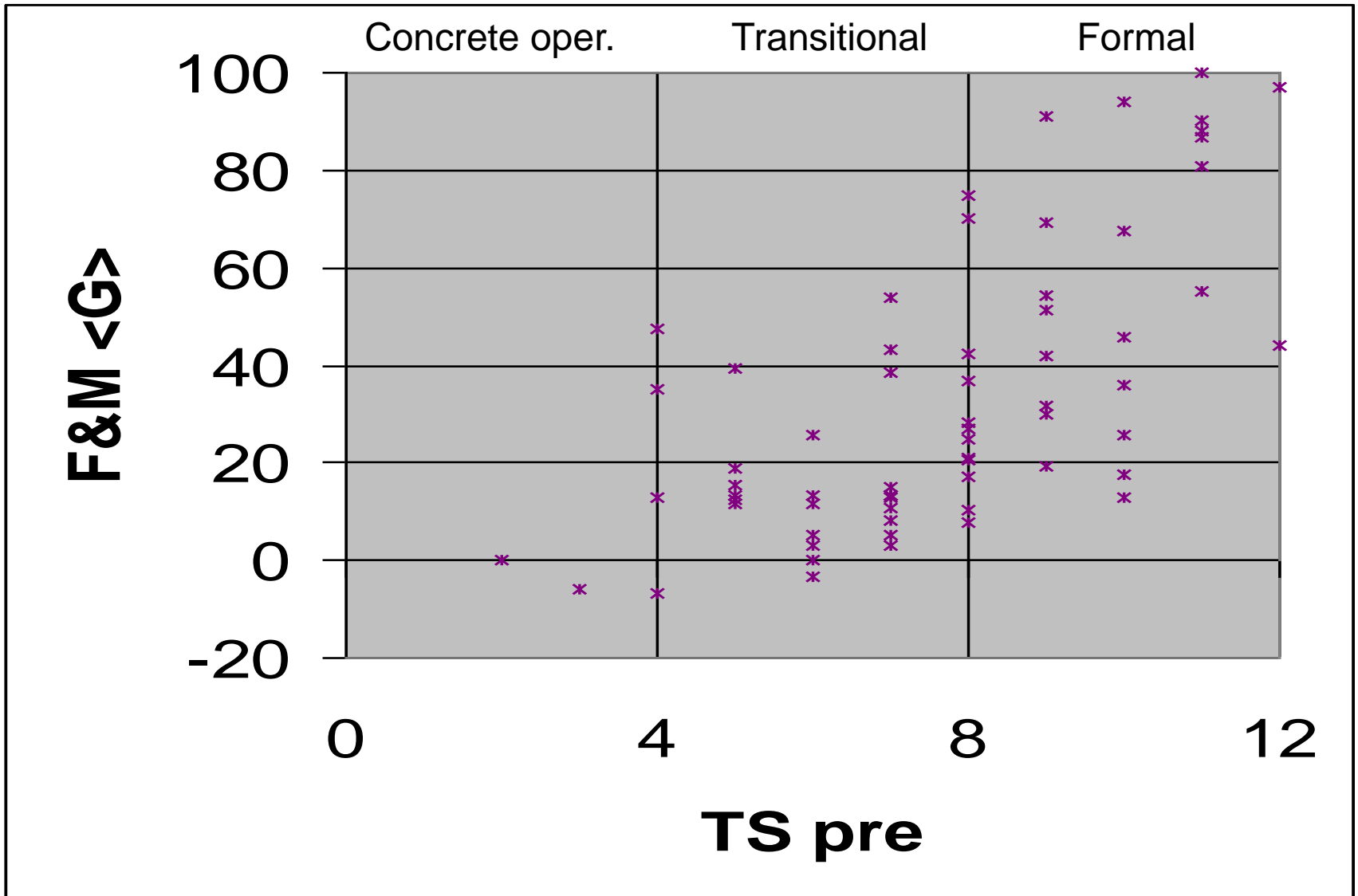
DIMMING DOWN: HOW THE BRAINPOWER OF TODAY'S 14-YEAR-OLDS HAS SLIPPED 'RADICALLY' IN JUST ONE GENERATION

- 26th October 2008 UK
- Previous research by Professor Shayer has shown that 11-year-olds' grasp of concepts such as volume, density, quantity and weight appears to have declined over the last 30 years. Their mental abilities were up to three years behind youngsters tested in in 1975.
- Similar results in US

TESTING IN HS

- “Forces and Motion Conceptual Evaluation” (FMCE)
- Gain calculated $\langle G \rangle = (\text{post-pre})/(\text{max-pre})$
What they learned/What they didn't know
- Thinking Skills test (TS) “Classroom test of Scientific Reasoning” by Anton Lawson from “Science Teaching and the Development of Reasoning”

FMCE GAIN LIMITED BY TS



It appears that the maximum percentage gain on the Force and Motion conceptual evaluation is limited to 10 times the score on the Lawson pretest.

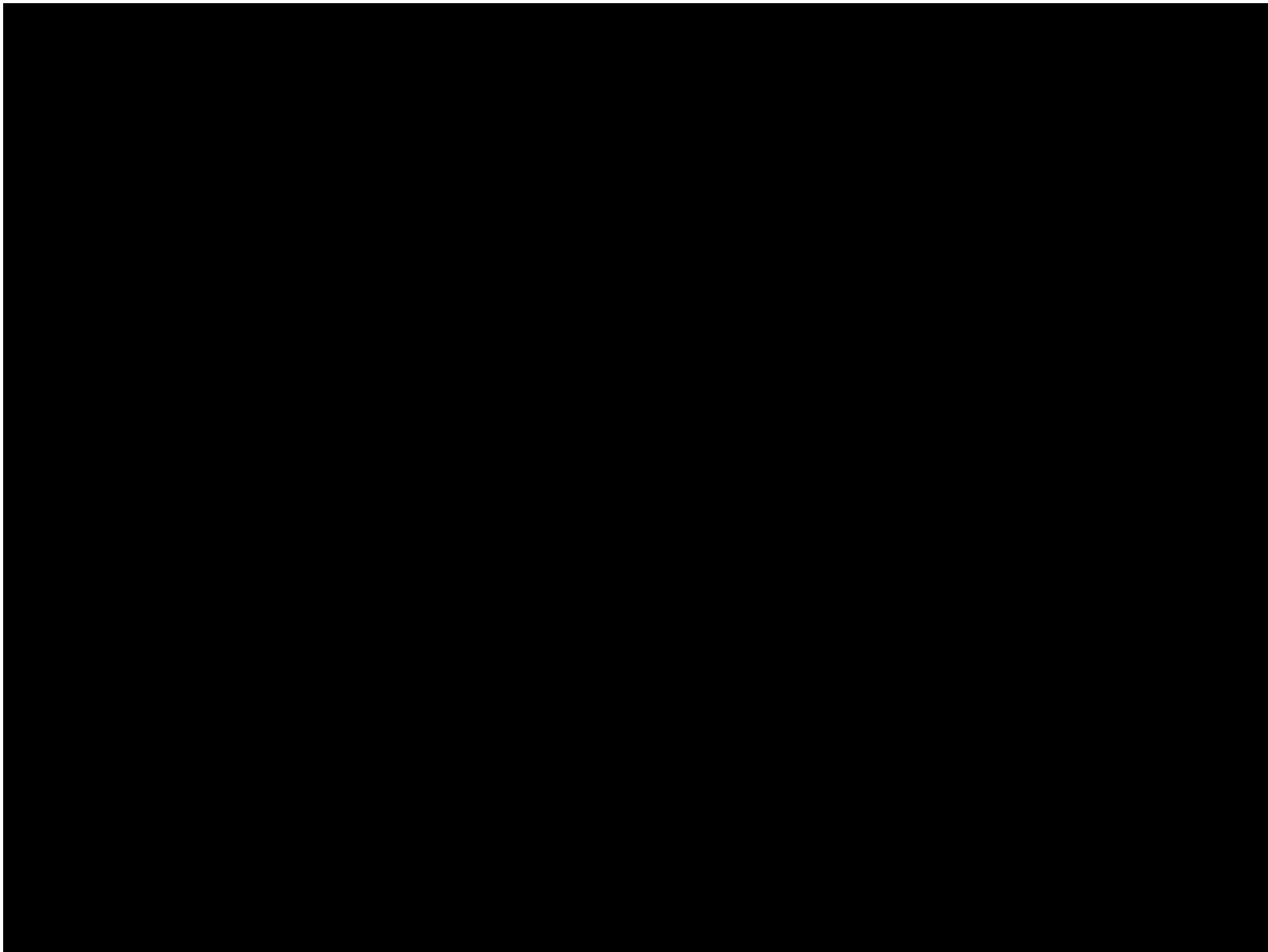
Lawson scores translate:

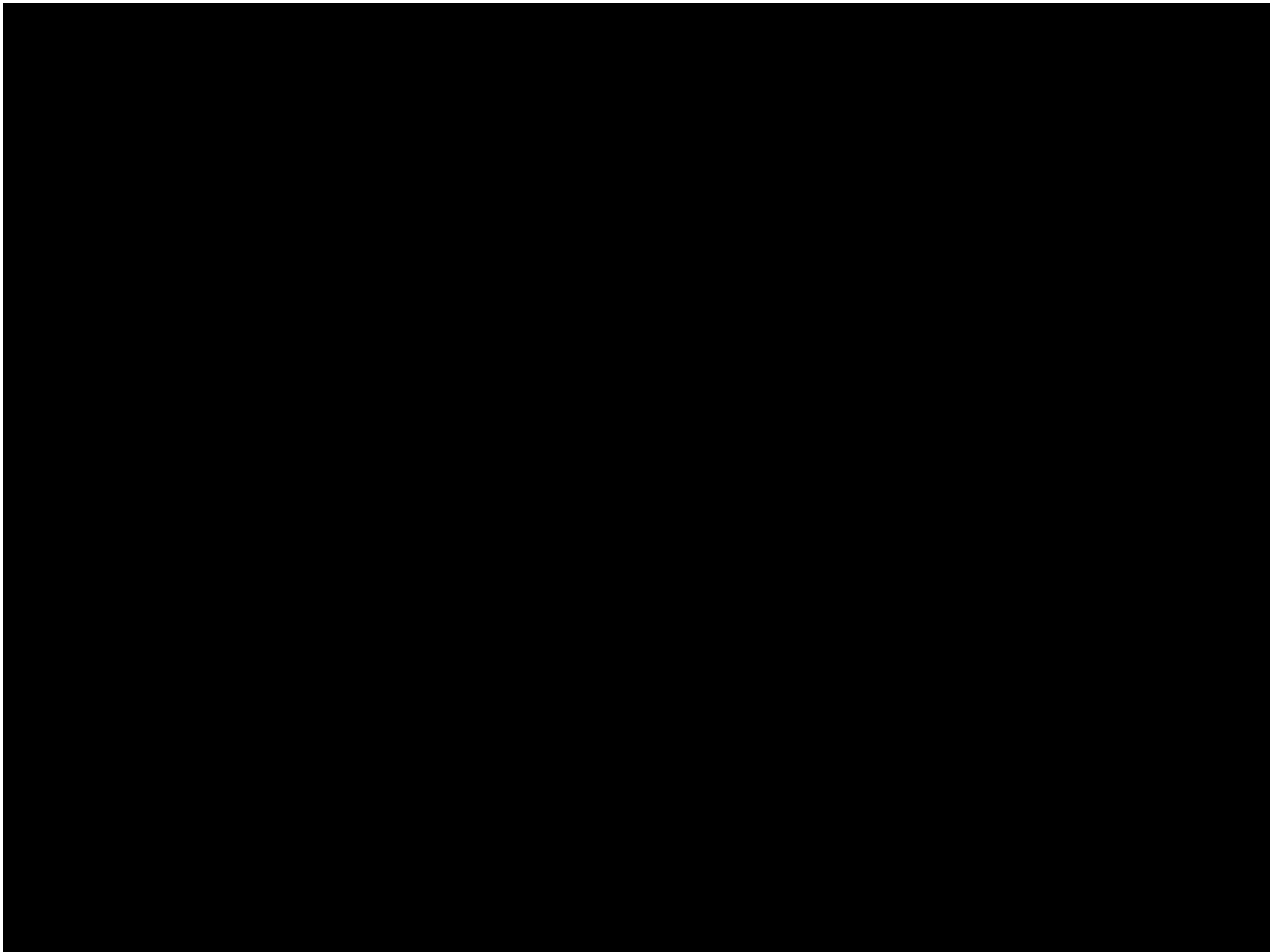
0-4 concrete operational (age 9-) 30% of public

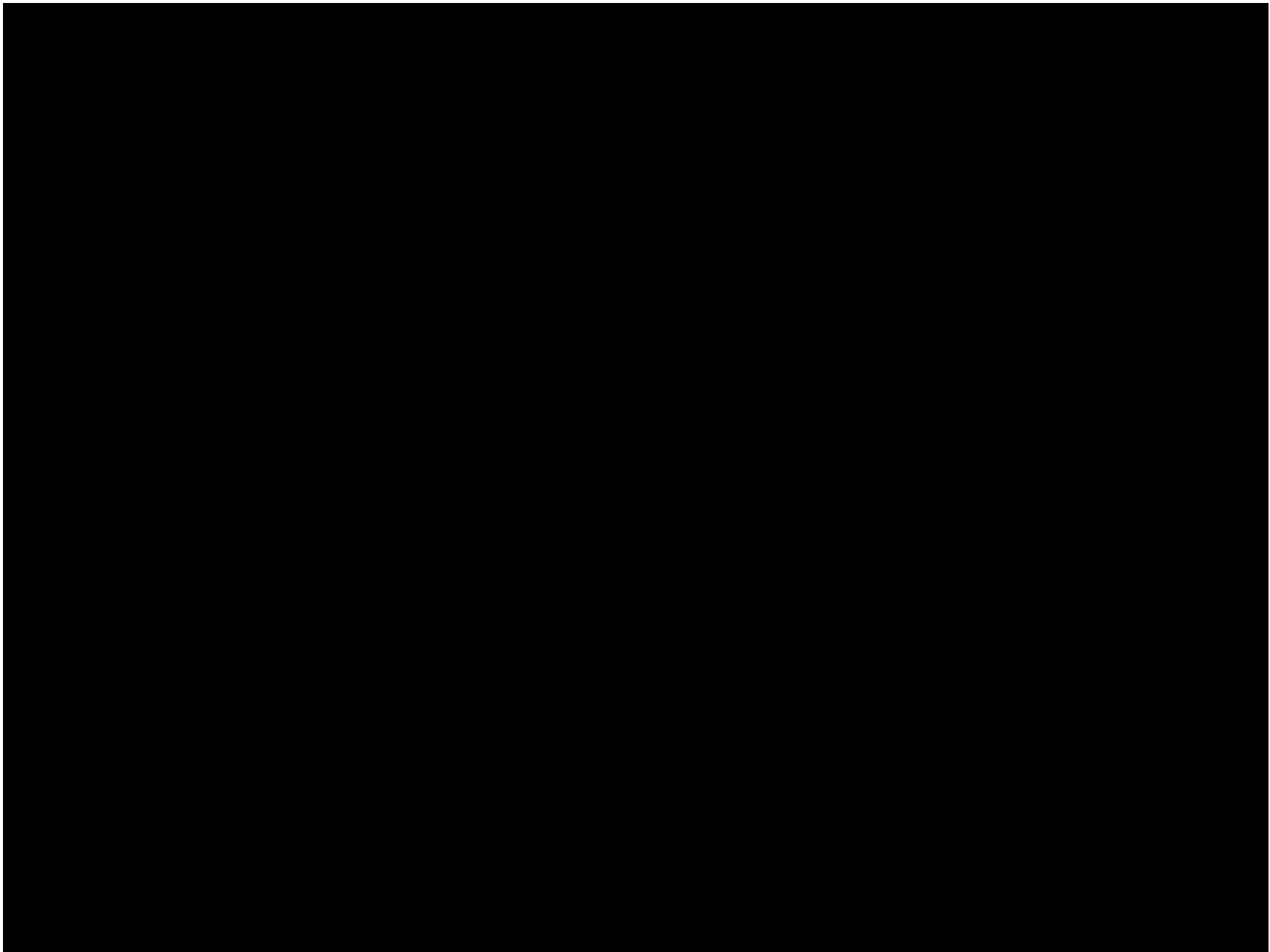
5-8 transitional

9-12 formal operational (possible at age 10+)

**STUDENTS NEED COGNITIVE
ENHANCEMENT!**







COGNITIVE ENHANCEMENT

- Reuven Feuerstein – *Instrumental Enrichment*
- Shayer, Adey, Yates – *Thinking Science*
 - Time (70 min treatment/ 2 weeks)
 - Separate from regular class!
 - Concrete preparation
 - Exploration, cognitive conflict
 - Construction (concept development)
 - Metacognition
 - Bridging (Application)

VERY SIMILAR TO LEARNING CYCLE

LAWSON TEST BREAKDOWN

1.	Weight conservation	84%
2.	Volume conservation	58
3.	Proportionality	42
4.	Adv Proportion	52
5.	Control Var 1	95
6.	Control Var 2	95
7.	2 Var	31
8.	2 Var advanced	26
9.	Probability	89
10.	Probability adv	63
11.	Combinatorial	16
12.	Statistical	16

LAWSON TEST BREAKDOWN

1.	Weight conservation	84%	100	gain	100
2.	Volume conservation	58	68		24
3.	Proportionality	42	63		34
4.	Adv Proportion	52	57		10
5.	Control Var 1	95	95		0
6.	Control Var 2	95	100		100
7.	2 Var	31	47		23
8.	2 Var advanced	26	42		24
9.	Probability	89	89		0
10.	Probability adv	63	63		0
11.	Combinatorial	16	21		6
12.	Statistical	16	32		19

Modeling

- Concrete preparation – brainstorm variables
- Exploration – Do experiment & find equation
- Concept development – wrap up some bridging
- Application & bridging - problems

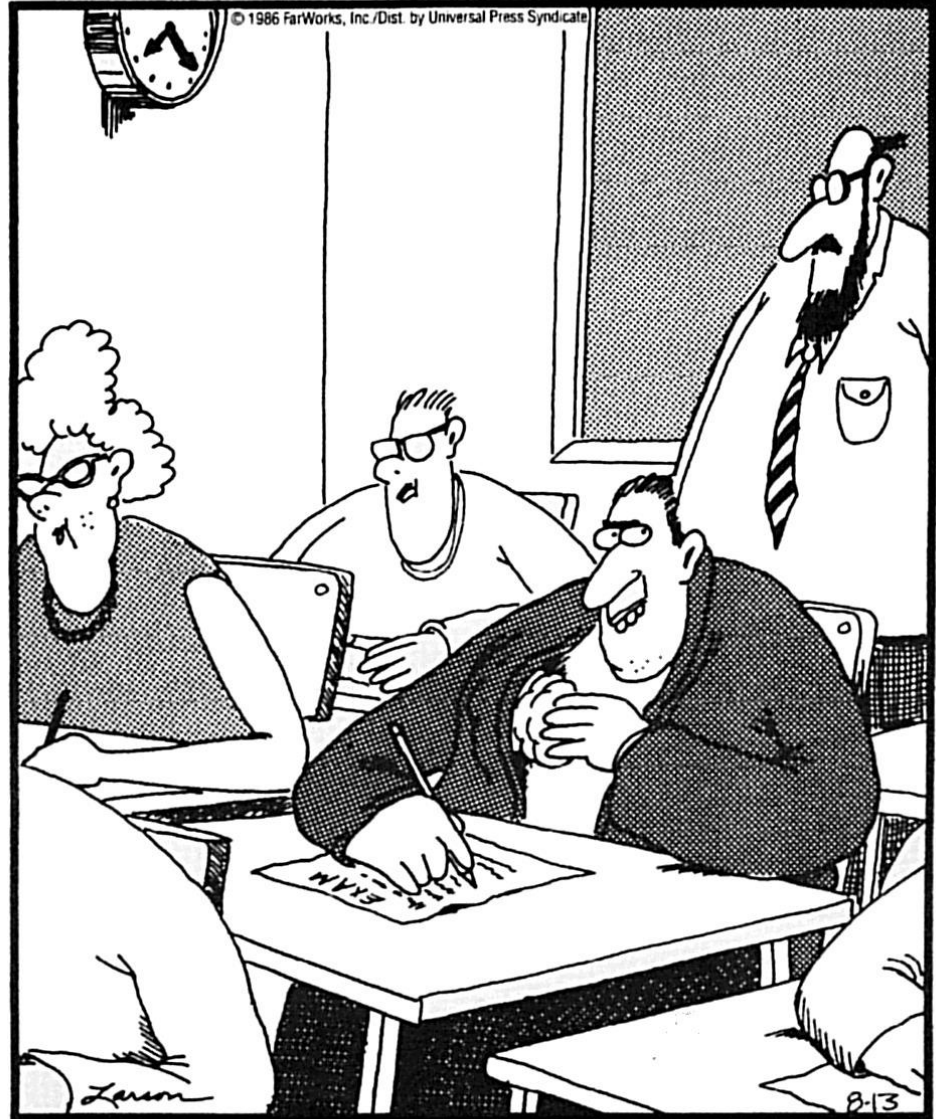
Proportional thinking

- Modeling used “old fashioned” graph linearization to get straight line fit.
- In other words recognize a “squared relationship”
- Make test graph of ordinate vs abscissa squared, and use $Y=mx + b$
- Strong interpretation – what is meaning of slope? Never $\Delta Y/\Delta X$, or V for X vs t

What is new?

- In HS did not see this dramatic change
- Added metacognitive features
- I talked about how proportional thinking is not doing ratios, but also recognizing ratios.

**MY
ULTIMATE
GOAL**



**Midway through the exam,
Allen pulls out a bigger brain.**

REFERENCES

- Lawson - *Science Teaching and the Development of Thinking*
- Shayer, Adey – *Really Raising Standards*
- Fuller, Campbell, Dykstra, Stevens – *College Teaching and the Development of Reasoning*
- Feuerstein – *Instrumental Enrichment* (1980)
- Video – shows students reasoning!
digitalcommons.unl.edu/adaptworkshopmodule4/2/